# Contents

<table>
<thead>
<tr>
<th>Figures</th>
<th>vii</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tables</td>
<td>xiii</td>
</tr>
</tbody>
</table>

**About this document**    xv
Using your documentation    xvi
How to read syntax diagrams    xvii
Symbols    xvii
Syntax items    xvii
Syntax examples    xviii
z/OS information    xix

**How to send your comments to IBM**    xxi
If you have a technical problem    xxi

**Summary of changes**    xxiii
Summary of changes for z/OS Version 2 Release 1 (V2R1) as updated February, 2015    xxiii
z/OS Version 2 Release 1 summary of changes    xxiii

## Part 1. Introduction to debugging in Language Environment     1

### Chapter 1. Preparing your routine for debugging     3
Setting compiler options     3
XL C and XL C++ compiler options     3
COBOL compiler options     5
Fortran compiler options     6
PL/I compiler options     7
Enterprise PL/I for z/OS compiler options     8
Using Language Environment runtime options     9
Determining runtime options in effect     10
Understanding the HEAPZONES and HEAPCHK     12
Using the CLER CICS transaction to display and set runtime options     12
Controlling storage allocation     13
Stack storage statistics     19
Heap storage statistics     20
HEAPPOOLS storage statistics     22
Modifying condition handling behavior     22
Language Environment callable services     22
Language Environment runtime options     23
Customizing condition handlers     25
Invoking the assembler user exit     25
Establishing enclave termination behavior for unhandled conditions     26
Using messages in your routine     27
C/C++     27
COBOL     27
Fortran     27
PL/I     28

Using condition information     28
Using the feedback code parameter     28
Using the symbolic feedback code     30

### Chapter 2. Classifying errors     31
Identifying problems in routines     31
Language Environment module names     31
Common errors in routines     31
Interpreting runtime messages     33
Message prefix     33
Message number     34
Severity code     34
Message text     34
Understanding abend codes     34
User abends     34
System abends     35
Using edcmtxt to obtain information about errno2 values     35
Format     35
Description     35
Usage notes     35
Message returns     36
Examples     36
Exit Values     36

### Chapter 3. Using Language Environment debugging facilities     37
Debug tools     37
Language Environment dump service, CEE3DMP     37
Generating a Language Environment dump with CEE3DMP     37
Generating a Language Environment dump with TERMTHDACT     40
Generating a Language Environment dump with language-specific functions     44
Understanding the Language Environment dump     44
Debugging with specific sections of the Language Environment dump     63
Multiple enclave dumps     80
Generating a system dump     82
Steps for generating a system dump in a batch runtime environment     83
Steps for generating a system dump in an IMS runtime environment     83
Steps for generating a system dump in a CICS runtime environment     84
Steps for generating a Language Environment U4039 abend     84
Steps for generating a system dump in a z/OS UNIX shell     85
Formatting and analyzing system dumps     86
Preparing to use the Language Environment support for IPCS     86
Understanding Language Environment IPCS VERBEXIT – LEDATA     87
Chapter 9. Debugging under CICS . . 331
Accessing debugging information . . . . 331
Locating Language Environment runtime messages . . . . 331
Locating the Language Environment traceback . . . 332
Locating the Language Environment dump . . . . 332
Using CICS transaction dump . . . . 333
Using CICS register and program status word contents . . . 333
Using Language Environment abend and reason codes . . . 333
Using Language Environment return codes to CICS . . . 334
Activating Language Environment feature trace records under CICS . . . . 334
Ensuring transaction rollback . . . . 337
Finding data when Language Environment returns a nonzero return code . . . 337
Finding data when Language Environment abends internally . . . 337
Finding data when Language Environment abends from an EXEC CICS command . . 338
Displaying and modifying runtime options with the CLER transaction . . . 338

Part 3. Debugging Language Environment AMODE 64 applications . . . . 341

Chapter 10. Preparing your AMODE 64 application for debugging . . . . 343
Setting compiler options . . . . 343
XL C and XL C++ compiler options for AMODE 64 applications . . . 343
Using Language Environment runtime options . . . 343
Determining runtime options in effect . . . 344
Understanding the HEAPZONES and HAPCHK runtime options . . . . 345
Controlling storage allocation . . . . 346
Storage statistics for AMODE 64 applications . . . . 350
Modifying exception handling behavior . . . . 352
Language Environment application program interfaces (API). . . . . 352
Language Environment runtime options . . . 352
Customizing exception handlers . . . 353
Using condition information . . . 353
Using the feedback code parameter . . . 353
Using the symbolic feedback code . . . . 355

Chapter 11. Classifying AMODE 64 application errors . . . . 357
Identifying problems in routines . . . 357
Language Environment module names . . . 357
Common errors in routines . . . . 357
Interpreting runtime messages . . . . 358
Message prefix . . . . 359
Message number . . . . 359
Severity code . . . . 359
Message text . . . . 359
Chapter 12. Using Language Environment AMODE 64 debugging facilities. 361

Debugging tools 361
Language Environment dumps 361
Generating a Language Environment dump with TERMTHDACT 361
Generating a Language Environment dump with language-specific functions 363
Understanding the Language Environment dump 363
Generating a system dump 378
Steps for generating a system dump in a batch runtime environment 379
Steps for generating a system dump in a z/OS UNIX shell 379
Formatting and analyzing system dumps 380
Preparing to use the Language Environment support for IPCS 380
Understanding Language Environment IPCS VERBEXIT – LEDATA 380
Understanding the Language Environment IPCS VERBEXIT LEDATA output 385
Understanding the HEAP LEDATA output 399
Understanding the heap pool LEDATA output 409
Understanding the heap pools trace LEDATA output 415
Understanding the C/C++-specific LEDATA output 419
C/C++-specific sections of the LEDATA output 429
Understanding the AUTH LEDATA output 430
Sections of the AUTH LEDATA VERBEXIT formatted output 435
Formatting individual control blocks 435
Requesting a Language Environment trace for debugging 437
Locating the trace dump 438
Using the Language Environment trace table format in a dump report 439
Understanding the trace table entry (TTE) 439
Sample dump for the trace table entry 446
Requesting a UNIX System Services syscall trace for debugging 446

Chapter 13. Debugging AMODE 64 C/C++ routines. 447
Debugging C/C++ programs 447
Using _amrc and _amrc2 structures to debug input/output 448
Using file I/O tracing to debug C/C++ file I/O problems 454
Displaying an error message with the perror() function 455
Using __errno2() to diagnose application problems 455
Using C/C++ listings 457
Finding variables 457
Generating a Language Environment dump of a C/C++ routine 460
cdump() 461
csnap() 461
ctrace() 461
Sample C routine that calls cdump() 461
Sample C++ routine that generates a Language Environment dump 463
Sample Language Environment dump with C/C++-specific information 464
C/C++ contents of the Language Environment trace tables 469
Debugging examples of C/C++ routines 471
Divide-by-zero error 471
Calling a nonexistent function 478
Handling dumps written to the z/OS UNIX file system 478
Multithreading consideration 485
Understanding C/C++ heap information in storage reports 485
Language Environment storage report with heap pools statistics 485
C function __uheapreport() storage report 488

Part 4. Appendixes 491

Appendix A. Diagnosing problems with Language Environment 493
Diagnosis checklist 493
Locating the name of the failing routine for a non-XPLINK application 494
Searching the IBM Software Support Database 497
Preparing documentation for an authorized program analysis report (APAR) 497

Appendix B. Accessibility 501
Accessibility features 501
Consult assistive technologies 501
Keyboard navigation of the user interface 501
Dotted decimal syntax diagrams 501

Notices 505
Policy for unsupported hardware 506
Minimum supported hardware 507
Programming interface information 507
Trademarks 507

Index 509
Figures

1. Options report example produced by runtime option RPTOPTS(ON) ................. 11
2. Storage report produced by run-time option RPTSTG(ON) .......................... 14
3. Storage report produced by run-time option RPTSTG(ON) (continued) ............ 15
4. Storage report produced by RPTSTG(ON) with XPLINK .............................. 16
5. Storage report produced by RPTSTG(ON) with XPLINK (continued) ............... 17
6. Storage report produced by RPTSTG(ON) with XPLINK (continued) ............... 18
7. Language Environment condition token 29
8. The C program CELSAMP ......................................................... 45
9. The C program CELSAMP (continued) ............................................. 46
10. The C DLL CELDLL .............................................................. 48
11. Upward-growing (non-XPLINK) stack frame format ..................................... 64
12. Downward-growing (XPLINK) stack frame format ....................................... 65
13. Condition information block (Part A) .................................................. 76
14. Condition information block (Part B) .................................................... 77
15. Machine state information block .......................................................... 79
16. Language Environment dump of multiple enclaves ..................................... 81
17. Example of formatted output from LEDATA VERBEXIT (Part 1 of 18) ............. 91
18. Example of formatted output from LEDATA VERBEXIT (Part 2 of 18) ............. 92
19. Example of formatted output from LEDATA VERBEXIT (Part 3 of 18) ............. 93
20. Example of formatted output from LEDATA VERBEXIT (Part 4 of 18) ............. 94
21. Example of formatted output from LEDATA VERBEXIT (Part 5 of 18) ............. 95
22. Example of formatted output from LEDATA VERBEXIT (Part 6 of 18) ............. 96
23. Example of formatted output from LEDATA VERBEXIT (Part 7 of 18) ............. 97
24. Example of formatted output from LEDATA VERBEXIT (Part 8 of 18) ............. 98
25. Example of formatted output from LEDATA VERBEXIT (Part 9 of 18) ............. 99
26. Example of formatted output from LEDATA VERBEXIT (Part 10 of 18) .......... 100
27. Example of formatted output from LEDATA VERBEXIT (Part 11 of 18) .......... 101
28. Example of formatted output from LEDATA VERBEXIT (Part 12 of 18) .......... 102
29. Example of formatted output from LEDATA VERBEXIT (Part 13 of 18) .......... 103
30. Example of formatted output from LEDATA VERBEXIT (Part 14 of 18) .......... 104
31. Example of formatted output from LEDATA VERBEXIT (Part 15 of 18) .......... 105
32. Example of formatted output from LEDATA VERBEXIT (Part 16 of 18) .......... 106
33. Example of formatted output from LEDATA VERBEXIT (Part 17 of 18) .......... 107
34. CAA formatted by the CBFORMAT IPCS command ..................................... 151
35. Format of the trace table entry ....................................................... 155
36. __amrc structure ......................................................................... 166
37. __amrc2 structure ........................................................................... 167
38. Example of a routine using perror() .................................................... 172
39. Example of a routine using __errno2() ................................................ 173
40. Sample output of a routine using __errno2() ......................................... 173
41. Example of a routine using _EDC_ADD_ERRNO2 .................................... 173
42. Sample output of a routine using _EDC_ADD_ERRNO2 ................................ 173
43. Example of a routine using __err2ad() in combination with __errno2() ...... 174
44. Sample output of routine using __err2ad() in combination with __errno2() ...... 174
45. Writable static map produced by prelinker .............................................. 177
46. Location of RENT static variable in storage .......................................... 177
47. Writable static map produced by prelinker .............................................. 178
48. Location of NORENT static variable in storage ....................................... 179
49. Example code for parameter variable .................................................... 179
50. Example code for parameter variable .................................................... 180
51. Partial storage offset listing ............................................................... 180
52. Example code for structure variable ..................................................... 181
53. Example of aggregate map ................................................................. 182
54. Writable static map produced by prelinker .............................................. 182
55. Fetched module for C routine ............................................................. 185
56. Example C++ routine with protection exception generating a dump .......... 186
57. Template file STACK.C ............................................................... 186
58. Header file STACK.H ................................................................. 186
59. Memory file control block ................................................................. 194
60. Registers on entry to CEE3DMP ......................................................... 194
61. Parameters, registers, and variables for active routines ............................ 195
62. Condition information for active routines .............................................. 195
63. Registers on entry to CEE3DMP ......................................................... 196
64. Parameters, registers, and variables for active routines ............................ 196
65. Condition information for active routines .............................................. 197
66. Sample XPLINK-compiled program ( Tranmain ) which calls a NOXPLINK-compiled program ................................................................. 198
67. Sample NOXPLINK-compiled program ( Tranmain ) which calls an XPLINK-compiled program ................................................................. 198
68. Trace table with trace table entry types 7 and 8 ...................................... 206
69. C routine with a divide-by-zero error .................................................... 208
70. Sections of the dump from example C/C++ routine (divide-by-zero error) .... 209
71. Pseudo assembly listing (C/C++ routine divide-by-zero error) .................. 210
<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>139</td>
<td>Compiler-generated listings from example Enterprise PL/I routine (Part 3 of 4)</td>
</tr>
<tr>
<td>140</td>
<td>Compiler-generated listings from example Enterprise PL/I routine (Part 4 of 4)</td>
</tr>
<tr>
<td>141</td>
<td>Traceback section of dump (Enterprise PL/I)</td>
</tr>
<tr>
<td>142</td>
<td>Control blocks for active routines section of the dump (Enterprise PL/I)</td>
</tr>
<tr>
<td>143</td>
<td>Control blocks associated with the thread section of the dump (Enterprise PL/I) (Part 1 of 2)</td>
</tr>
<tr>
<td>144</td>
<td>Control blocks associated with the thread section of the dump (Enterprise PL/I) (Part 2 of 2)</td>
</tr>
<tr>
<td>145</td>
<td>Example of moving a value outside an array range (Enterprise PL/I)</td>
</tr>
<tr>
<td>146</td>
<td>Sections of the Language Environment dump (Part 1 of 2)</td>
</tr>
<tr>
<td>147</td>
<td>Sections of the Language Environment dump (Part 2 of 2)</td>
</tr>
<tr>
<td>148</td>
<td>Example of calling a nonexistent subroutine (Enterprise PL/I)</td>
</tr>
<tr>
<td>149</td>
<td>Traceback and condition information of the Language Environment dump (Enterprise PL/I) (Part 1 of 2)</td>
</tr>
<tr>
<td>150</td>
<td>Traceback and condition information of the Language Environment dump (Enterprise PL/I) (Part 2 of 2)</td>
</tr>
<tr>
<td>151</td>
<td>Enterprise PL/I routine with a divide-by-zero error</td>
</tr>
<tr>
<td>152</td>
<td>Variables from routine SAMPLE (Enterprise PL/I)</td>
</tr>
<tr>
<td>153</td>
<td>Object code listing from example Enterprise PL/I routine</td>
</tr>
<tr>
<td>154</td>
<td>Language Environment dump from example Enterprise PL/I routine (Part 1 of 2)</td>
</tr>
<tr>
<td>155</td>
<td>Language Environment dump from example Enterprise PL/I routine (Part 2 of 2)</td>
</tr>
<tr>
<td>156</td>
<td>Language Environment traceback written to the CESE transient data queue</td>
</tr>
<tr>
<td>157</td>
<td>CICS trace output in the ABBREV format</td>
</tr>
<tr>
<td>158</td>
<td>CICS trace output in the FULL format</td>
</tr>
<tr>
<td>159</td>
<td>Sample 64-bit options report</td>
</tr>
<tr>
<td>160</td>
<td>64-bit storage report (Part 1 of 4)</td>
</tr>
<tr>
<td>161</td>
<td>64-bit storage report (Part 2 of 4)</td>
</tr>
<tr>
<td>162</td>
<td>64-bit storage report (Part 3 of 4)</td>
</tr>
<tr>
<td>163</td>
<td>64-bit storage report (Part 4 of 4)</td>
</tr>
<tr>
<td>164</td>
<td>Language Environment condition token</td>
</tr>
<tr>
<td>165</td>
<td>The C program CELQSAMP (AMODE 64) (Part 1 of 2)</td>
</tr>
<tr>
<td>166</td>
<td>The C program CELQSAMP (AMODE 64) (Part 2 of 2)</td>
</tr>
<tr>
<td>167</td>
<td>The C DLL CELQDML (AMODE 64)</td>
</tr>
<tr>
<td>168</td>
<td>Example dump using CEE3DMP (AMODE 64) (Part 1 of 9)</td>
</tr>
<tr>
<td>169</td>
<td>Example dump using CEE3DMP (AMODE 64) (Part 2 of 9)</td>
</tr>
<tr>
<td>170</td>
<td>Example dump using CEE3DMP (AMODE 64) (Part 3 of 9)</td>
</tr>
<tr>
<td>171</td>
<td>Example dump using CEE3DMP (AMODE 64) (Part 4 of 9)</td>
</tr>
<tr>
<td>172</td>
<td>Example dump using CEE3DMP (AMODE 64) (Part 5 of 9)</td>
</tr>
<tr>
<td>173</td>
<td>Example dump using CEE3DMP (AMODE 64) (Part 6 of 9)</td>
</tr>
<tr>
<td>174</td>
<td>Example dump using CEE3DMP (AMODE 64) (Part 7 of 9)</td>
</tr>
<tr>
<td>175</td>
<td>Example dump using CEE3DMP (AMODE 64) (Part 8 of 9)</td>
</tr>
<tr>
<td>176</td>
<td>Example dump using CEE3DMP (AMODE 64) (Part 9 of 9)</td>
</tr>
<tr>
<td>177</td>
<td>Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 1 of 10)</td>
</tr>
<tr>
<td>178</td>
<td>Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 2 of 10)</td>
</tr>
<tr>
<td>179</td>
<td>Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 3 of 10)</td>
</tr>
<tr>
<td>180</td>
<td>Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 4 of 10)</td>
</tr>
<tr>
<td>181</td>
<td>Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 5 of 10)</td>
</tr>
<tr>
<td>182</td>
<td>Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 6 of 10)</td>
</tr>
<tr>
<td>183</td>
<td>Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 7 of 10)</td>
</tr>
<tr>
<td>184</td>
<td>Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 8 of 10)</td>
</tr>
<tr>
<td>185</td>
<td>Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 9 of 10)</td>
</tr>
<tr>
<td>186</td>
<td>Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 10 of 10)</td>
</tr>
<tr>
<td>187</td>
<td>Example of formatted PTBL output from LEDATA VERBEXIT (Part 1 of 2)</td>
</tr>
<tr>
<td>188</td>
<td>Example of formatted PTBL output from LEDATA VERBEXIT (Part 2 of 2)</td>
</tr>
<tr>
<td>189</td>
<td>Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 1 of 8)</td>
</tr>
<tr>
<td>190</td>
<td>Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 2 of 8)</td>
</tr>
<tr>
<td>191</td>
<td>Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 3 of 8)</td>
</tr>
<tr>
<td>192</td>
<td>Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 4 of 8)</td>
</tr>
<tr>
<td>193</td>
<td>Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 5 of 8)</td>
</tr>
<tr>
<td>194</td>
<td>Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 6 of 8)</td>
</tr>
<tr>
<td>195</td>
<td>Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 7 of 8)</td>
</tr>
<tr>
<td>196</td>
<td>Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 8 of 8)</td>
</tr>
<tr>
<td>197</td>
<td>Example formatted detailed heap pool report from LEDATA VERBEXIT (AMODE 64) (Part 1 of 5)</td>
</tr>
</tbody>
</table>

Figures ix
### Tables

1. How to use z/OS Language Environment publications ........................................... xvi
2. Syntax examples ........................................................................................................ v
3. TEST suboptions to simplify debugging ................................................................. 3
4. C/C++ compiler options to simplify runtime debugging ........................................ 4
5. COBOL compiler options for runtime debugging .................................................. 5
6. Fortran compiler options for runtime debugging .................................................. 6
7. PL/I compiler options for debugging .................................................................... 7
8. Enterprise PL/I for z/OS compiler options for debugging ................................. 8
9. Language Environment runtime options for debugging ....................................... 9
10. Storage report fields that display stack storage statistics .................................... 19
11. Storage report fields that display heap storage statistics ..................................... 19
12. Callable services that modify condition handling ............................................... 23
13. Runtime options that modify condition handling .................................................. 23
14. Callable services that can convert condition tokens to routine variables, messages, or signaled conditions ............................................................. 29
15. Common error symptoms, possible causes, and programmer responses ............ 32
16. CEE3DMP options ................................................................................................ 39
17. TERMTHDACT suboptions, level of information, and destinations .................... 41
18. Condition handling of 0Cx abends ..................................................................... 43
19. Contents of the Language Environment dump .................................................... 57
20. Description of CAA fields ...................................................................................... 66
21. Contents of the Language Environment LEDATA VERBEXIT formatted output .... 106
22. Contents of the Heap report sections of LEDATA output ................................... 115
23. Contents of heap pools report sections of LEDATA output .................................. 120
24. Contents of heap pools trace section of LEDATA output .................................... 123
25. Contents of C/C++-specific sections of LEDATA output ...................................... 141
26. Contents of COBOL-specific sections of LEDATA Output .................................... 144
27. Contents of COBOL-specific sections of LEDATA Output (Enterprise COBOL V5.1 and later releases) ................................................................. 144
28. Contents of PL/I-specific sections of LEDATA output ........................................ 150
29. Language Environment Control blocks that can be individually formatted ....... 151
30. TERMTHDACT runtime option settings and dump contents produced ............. 153
31. LE=1 entry records .............................................................................................. 156
32. LE=2 entry records .............................................................................................. 156
33. Format of the mutex/CV/latch records ............................................................... 160
34. LE=8 entry records .............................................................................................. 161
35. LE=20 entry records ............................................................................................ 161
36. __last_op values and diagnosis information ....................................................... 168
37. Finding the WSA base address ............................................................................. 175
38. Contents of the C/C++ sections of the Language Environment ............................. 191
39. Contents of XPLINK information in a Language Environment dump ................... 201
40. Compiler-generated COBOL listings and their contents ..................................... 232
41. Compiler-generated Fortran listings and their contents ......................................... 253
42. Understanding the Language Environment traceback table ................................ 259
43. Compiler-generated PL/I for MVS & VM listings and their contents .................... 268
44. Typical comments in a PL/I for MVS & VM static storage listing ....................... 271
45. Comments in a PL/I for MVS & VM object code listing ....................................... 273
46. PL/I for MVS & VM mnemonics .......................................................................... 274
47. Compiler-generated PL/I listings and their contents ............................................ 302
48. Finding data when Language Environment returns a nonzero return code ......... 337
49. Finding data when Language Environment abends internally ............................ 337
50. Finding data when Language Environment abends from an EXEC CICS command .... 338
51. Common error symptoms, possible causes, and programmer responses ............ 358
52. TERMTHDACT suboptions, level of information, and destinations .................... 361
53. Contents of the Language Environment dump - AMODE 64 ............................... 374
54. Contents of the Language Environment LEDATA VERBEXIT formatted output (AMODE 64) ............................................................... 396
55. Contents of Heap report sections of the LEDATA output (AMODE 64) ............... 408
56. Contents of the heap pool report sections of the LEDATA output (AMODE 64) .... 415
57. Contents of a detailed heap pools trace report from LEDATA VERBEXIT (AMODE 64) ............................................................ 419
58. Contents of C/C++-specific sections of the LEDATA output (AMODE 64) ............ 429
59. Contents of AUTH LEDATA VERBEXIT formatted output (AMODE 64) ............ 435
60. Language Environment control blocks that can be individually formatted ......... 436
61. Preinitialized Environments for Authorized Programs control blocks that can be individually formatted ................................. 437
62. TERMTHDACT runtime option settings and dump contents produced (AMODE 64) ......................................................................................... 438
63. LE=1 entry records (AMODE 64)  . . . . . 440
64. LE=2 entry records (AMODE 64)  . . . . . 441
65. Format of the mutex/CV/latch records
    (AMODE 64).  . . . . . . . . . . . . . . . 445
66. LE=8 entry records (AMODE 64)  . . . . . 446
67. __last_op values and diagnosis information
    (AMODE 64).  . . . . . . . . . . . . . . . 451
68. Problem resolution documentation
    requirements.  . . . . . . . . . . . . . . . 498
About this document

`z/OS Language Environment Debugging Guide` provides assistance with detecting, finding, and fixing programming errors that occur during run time under Language Environment. It can help you establish a debugging process to analyze data and narrow the scope and location of where an error might have occurred. You can read about how to prepare a routine for debugging, how to classify errors, and how to use the debugging facilities Language Environment provides. Also included are chapters on debugging HLL-specific routines and routines that run under CICS®. Debugging for AMODE 64 applications is covered in separate chapters, corresponding to the topics and contents provided above.

This book is intended for application programmers who are interested in techniques for debugging runtime programs. To use this book, you should be familiar with:
- Language Environment
- Appropriate languages that use the compilers listed below
- Program storage concepts

This document supports z/OS (5650-ZOS).

IBM® z/OS Language Environment (also called Language Environment) provides common services and language-specific routines in a single run-time environment for C, C++, COBOL, Fortran (z/OS only; no support for z/OS UNIX System Services or CICS), PL/I, and assembler applications. It offers consistent and predictable results for language applications, independent of the language in which they are written.

Language Environment is the prerequisite run-time environment for applications generated with the following IBM compiler products:
- z/OS XL C/C++ (feature of z/OS)
- z/OS C/C++
- OS/390 C/C++
- C/C++ for MVS/ESA
- C/C++ for z/VM
- XL C/C++ for z/VM
- AD/Cycle C/370™
- VisualAge for Java, Enterprise Edition for OS/390
- Enterprise COBOL for z/OS
- Enterprise COBOL for z/OS and OS/390
- COBOL for OS/390 & VM
- COBOL for MVS & VM (formerly COBOL/370)
- Enterprise PL/I for z/OS
- Enterprise PL/I for z/OS and OS/390
- VisualAge PL/I
- PL/I for MVS & VM (formerly PL/I MVS™ & VM)
- VS FORTRAN and FORTRAN IV (in compatibility mode)

Although not all compilers listed are currently supported, Language Environment supports the compiled objects that they created.

Language Environment supports, but is not required for, an interactive debug tool for debugging applications in your native z/OS environment.
Debug Tool is also available as a standalone product. Debug Tool Utilities and Advanced Functions is also available. For more information, see Debug Tool.

Language Environment supports, but is not required for, VS FORTRAN Version 2 compiled code (z/OS only).

Language Environment consists of the common execution library (CEL) and the run-time libraries for C/C++, COBOL, Fortran, and PL/I.

For more information on VisualAge for Java, Enterprise Edition for OS/390, program number 5655-JAV, see the product documentation.

Using your documentation

The publications provided with Language Environment are designed to help you:

• Manage the runtime environment for applications generated with a Language Environment-conforming compiler.
• Write applications that use the Language Environment callable services.
• Develop interlanguage communication applications.
• Customize Language Environment.
• Debug problems in applications that run with Language Environment.
• Migrate your high-level language applications to Language Environment.

Language programming information is provided in the supported high-level language programming manuals, which provide language definition, library function syntax and semantics, and programming guidance information.

Each publication helps you perform different tasks, some of which are listed in Table 1.

Table 1. How to use z/OS Language Environment publications

<table>
<thead>
<tr>
<th>To ...</th>
<th>Use ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate Language Environment</td>
<td>z/OS Language Environment Concepts Guide</td>
</tr>
<tr>
<td>Plan for Language Environment</td>
<td>z/OS Language Environment Concepts Guide</td>
</tr>
<tr>
<td>Install Language Environment</td>
<td>z/OS V2R1 Program Directory</td>
</tr>
<tr>
<td>Customize Language Environment</td>
<td>z/OS Language Environment Customization</td>
</tr>
<tr>
<td>Understand Language Environment program models and concepts</td>
<td>z/OS Language Environment Concepts Guide</td>
</tr>
<tr>
<td>Find syntax for Language Environment runtime options and callable services</td>
<td>z/OS Language Environment Programming Reference</td>
</tr>
<tr>
<td>Develop applications that run with Language Environment</td>
<td>z/OS Language Environment Programming Guide and your language programming guide</td>
</tr>
</tbody>
</table>
Table 1. How to use z/OS Language Environment publications (continued)

<table>
<thead>
<tr>
<th>To ...</th>
<th>Use ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debug applications that run with Language Environment, diagnose problems with Language Environment</td>
<td>z/OS Language Environment Debugging Guide</td>
</tr>
<tr>
<td>Get details on runtime messages</td>
<td>z/OS Language Environment Runtime Messages</td>
</tr>
<tr>
<td>Develop interlanguage communication (ILC) applications</td>
<td>z/OS Language Environment Writing Interlanguage Communication Applications and your language programming guide</td>
</tr>
<tr>
<td>Migrate applications to Language Environment</td>
<td>z/OS Language Environment Runtime Application Migration Guide and the migration guide for each Language Environment-enabled language</td>
</tr>
</tbody>
</table>

How to read syntax diagrams

This section describes how to read syntax diagrams. It defines syntax diagram symbols, items that may be contained within the diagrams (keywords, variables, delimiters, operators, fragment references, operands) and provides syntax examples that contain these items.

Syntax diagrams pictorially display the order and parts (options and arguments) that comprise a command statement. They are read from left to right and from top to bottom, following the main path of the horizontal line.

For users accessing the IBM Knowledge Center using a screen reader, syntax diagrams are provided in dotted decimal format.

Symbols

The following symbols may be displayed in syntax diagrams:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>➔➔➔➔</td>
<td>Indicates the beginning of the syntax diagram.</td>
</tr>
<tr>
<td>➔➔➔➔</td>
<td>Indicates that the syntax diagram is continued to the next line.</td>
</tr>
<tr>
<td>➔➔➔➔</td>
<td>Indicates that the syntax is continued from the previous line.</td>
</tr>
<tr>
<td>➔➔➔➔</td>
<td>Indicates the end of the syntax diagram.</td>
</tr>
</tbody>
</table>

Syntax items

Syntax diagrams contain many different items. Syntax items include:

- Keywords - a command name or any other literal information.
- Variables - variables are italicized, appear in lowercase, and represent the name of values you can supply.
- Delimiters - delimiters indicate the start or end of keywords, variables, or operators. For example, a left parenthesis is a delimiter.
- Operators - operators include add (+), subtract (-), multiply (*), divide (/), equal (=), and other mathematical operations that may need to be performed.
- Fragment references - a part of a syntax diagram, separated from the diagram to show greater detail.
- Separators - a separator separates keywords, variables or operators. For example, a comma (,) is a separator.
**Note:** If a syntax diagram shows a character that is not alphanumeric (for example, parentheses, periods, commas, equal signs, a blank space), enter the character as part of the syntax.

Keywords, variables, and operators may be displayed as required, optional, or default. Fragments, separators, and delimiters may be displayed as required or optional.

**Item type**

**Definition**

**Required**
Required items are displayed on the main path of the horizontal line.

**Optional**
Optional items are displayed below the main path of the horizontal line.

**Default**
Default items are displayed above the main path of the horizontal line.

### Syntax examples

The following table provides syntax examples.

<table>
<thead>
<tr>
<th>Item</th>
<th>Syntax example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required item</td>
<td>Required items appear on the main path of the horizontal line. You must specify these items.</td>
</tr>
<tr>
<td>Required choice</td>
<td>A required choice (two or more items) appears in a vertical stack on the main path of the horizontal line. You must choose one of the items in the stack.</td>
</tr>
<tr>
<td>Optional item</td>
<td>Optional items appear below the main path of the horizontal line.</td>
</tr>
<tr>
<td>Optional choice</td>
<td>An optional choice (two or more items) appears in a vertical stack below the main path of the horizontal line. You may choose one of the items in the stack.</td>
</tr>
<tr>
<td>Default</td>
<td>Default items appear above the main path of the horizontal line. The remaining items (required or optional) appear on (required) or below (optional) the main path of the horizontal line. The following example displays a default with optional items.</td>
</tr>
<tr>
<td>Variable</td>
<td>Variables appear in lowercase italics. They represent names or values.</td>
</tr>
</tbody>
</table>
### Table 2. Syntax examples (continued)

<table>
<thead>
<tr>
<th>Item</th>
<th>Syntax example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeatable item.</td>
<td>![Diagram of repeatable item]</td>
</tr>
</tbody>
</table>

- An arrow returning to the left above the main path of the horizontal line indicates an item that can be repeated.
- A character within the arrow means you must separate repeated items with that character.
- An arrow returning to the left above a group of repeatable items indicates that one of the items can be selected, or a single item can be repeated.

| Fragment. | ![Diagram of fragment] |

- The fragment symbol indicates that a labelled group is described below the main syntax diagram. Syntax is occasionally broken into fragments if the inclusion of the fragment would overly complicate the main syntax diagram.

---

### z/OS information

This information explains how z/OS references information in other documents and on the web.

When possible, this information uses cross document links that go directly to the topic in reference using shortened versions of the document title. For complete titles and order numbers of the documents for all products that are part of z/OS, see [z/OS Information Roadmap](http://www.ibm.com/support/knowledgecenter/SSLTBW/welcome).

To find the complete z/OS® library, go to the [IBM Knowledge Center](http://www.ibm.com/support/knowledgecenter/SSLTBW/welcome).
How to send your comments to IBM

We appreciate your input on this publication. Feel free to comment on the clarity, accuracy, and completeness of the information or provide any other feedback that you have.

Use one of the following methods to send your comments:
1. Send an email to mhvrdfs@us.ibm.com.
3. Mail the comments to the following address:
   IBM Corporation
   Attention: MHVRCFS Reader Comments
   Department H6MA, Building 707
   2455 South Road
   Poughkeepsie, NY 12601-5400
   US
4. Fax the comments to us, as follows:
   From the United States and Canada: 1+845+432-9405
   From all other countries: Your international access code +1+845+432-9405

Include the following information:
• Your name and address.
• Your email address.
• Your telephone or fax number.
• The publication title and order number:
  z/OS V2R1.0 Language Environment Debugging Guide
  GA32-0908-01
• The topic and page number that is related to your comment.
• The text of your comment.

When you send comments to IBM, you grant IBM a nonexclusive right to use or distribute the comments in any way appropriate without incurring any obligation to you.

IBM or any other organizations use the personal information that you supply to contact you only about the issues that you submit.

If you have a technical problem

Do not use the feedback methods that are listed for sending comments. Instead, take one of the following actions:
• Contact your IBM service representative.
• Call IBM technical support.
Summary of changes

This information includes terminology, maintenance, and editorial changes. Technical changes or additions to the text and illustrations for the current edition are indicated by a vertical line to the left of the change.

Summary of changes for z/OS Version 2 Release 1 (V2R1) as updated February, 2015

The following changes are made for z/OS Version 2 Release 1 (V2R1) as updated February, 2015.

New

• Support was added for vectors. The following topics contain new information for this support:
  - “Understanding the Language Environment dump” on page 44
  - “Vector registers” on page 195
  - Chapter 5, “Debugging COBOL programs,” on page 229
  - “Divide-by-zero error” on page 326
  - “Understanding the Language Environment IPCS VERBEXIT LEDATA output” on page 385
  - “Divide-by-zero error” on page 471

z/OS Version 2 Release 1 summary of changes

See the following publications for all enhancements to z/OS Version 2 Release 1 (V2R1):

• z/OS Migration
• z/OS Planning for Installation
• z/OS Summary of Message and Interface Changes
• z/OS Introduction and Release Guide
Part 1. Introduction to debugging in Language Environment

This part provides information about options and features you can use to prepare your routine for debugging. It describes some common errors that occur in routines and provides methods of generating dumps to help you get the information you need to debug your routine.
Chapter 1. Preparing your routine for debugging

This chapter describes options and features that you can use to prepare your routine for debugging. The following topics are covered:

- Compiler options for C, C++, COBOL, Fortran, and PL/I
- Language Environment runtime options
- Use of storage in routines
- Options for modifying condition handling
- Assembler user exits
- Enclave termination behavior
- User-created messages
- Language Environment feedback codes and condition tokens

Setting compiler options

The following sections discuss language-specific compiler options important to debugging routines in Language Environment. These sections cover only the compiler options that are important to debugging. For a complete list of compiler options, see the appropriate HLL publications.

The use of some compiler options (such as TEST) can affect the performance of your routine. You must set these options before you compile. In some cases, you might need to remove the option and recompile your routine before delivering your application.

**XL C and XL C++ compiler options**

When using XL C, set the TEST(ALL) suboption; this is equivalent to specifying TEST(LINE,BLOCK,PATH,SYM,HOOK). For XL C++, the option TEST is equivalent to TEST(HOOK). Table 3 lists the TEST suboptions that you can use to simplify runtime debugging.

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
</tr>
<tr>
<td>BLOCK</td>
</tr>
<tr>
<td>HOOK</td>
</tr>
<tr>
<td>LINE</td>
</tr>
<tr>
<td>PATH</td>
</tr>
</tbody>
</table>
Table 3. TEST suboptions to simplify debugging (continued)

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
</table>
| SYM         Generates symbol table information and enables Language Environment to generate a dump at run time. When you specify SYM, you also get the value and type of variables displayed in the Local Variables section of the dump. For example, if in block 4 the variable \( x \) is a signed integer of 12, and in block 2 the variable \( x \) is a signed integer of 1, the following output appears in the Local Variables section of the dump:

\[
\%\text{BLOCK4:} >x \text{ signed int 12} \\
\%\text{BLOCK2:} >x \text{ signed int 1}
\]

If a nonzero optimization level is used, variables do not appear in the dump.

You can use the C/C++ compiler options shown in Table 4 to make runtime debugging easier. For a detailed explanation of these options, see z/OS XL C/C++ User’s Guide.

Table 4. C/C++ compiler options to simplify runtime debugging

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGGREGATE (C) Specifies that a layout for struct and union type variables appear in the listing.</td>
</tr>
<tr>
<td>ATTRIBUTE (C++) For XL C++ compile, cross reference listing with attribute information. If XREF is specified, the listing also contains reference, definition and modification information.</td>
</tr>
<tr>
<td>CHECKOUT (C) Provides informational messages indicating possible programming errors.</td>
</tr>
<tr>
<td>EVENTS Produces an events file that contains error information and source file statistics.</td>
</tr>
<tr>
<td>EXPMAC Macro expansions with the original source.</td>
</tr>
<tr>
<td>FLAG Specifies the minimum severity level that is tolerated.</td>
</tr>
<tr>
<td>GONUMBER Generates line number tables corresponding to the input source file. This option is turned on when the TEST option is used. This option is needed to show statement numbers in dump output.</td>
</tr>
<tr>
<td>INFO (C++) Indication of possible programming errors.</td>
</tr>
<tr>
<td>INLINE Inline Summary and Detailed Call Structure Reports. (Specify with the REPORT sub-option).</td>
</tr>
<tr>
<td>INLRPT Generates a report on status of functions that were inlined. The OPTIMIZE option must also be specified.</td>
</tr>
<tr>
<td>LIST Listing of the pseudo-assembly listing produced by the compiler.</td>
</tr>
<tr>
<td>OFFSET Displays the offset addresses relative to the entry point of each function.</td>
</tr>
<tr>
<td>PHASEID Causes each compiler module (phase) to issue an informational message which identifies the compiler phase module name, product identifier, and build level.</td>
</tr>
<tr>
<td>PPONLY Completely expanded z/OS XL C, or z/OS XL C++ source code, by activating the preprocessor (PP) only. The output shows, for example, all the “#include” and “#define” directives.</td>
</tr>
<tr>
<td>SERVICE Places a string in the object module, which is displayed in the traceback if the application fails abnormally.</td>
</tr>
<tr>
<td>SHOWINC All included text in the listing.</td>
</tr>
</tbody>
</table>
Table 4. C/C++ compiler options to simplify runtime debugging (continued)

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOURCE</td>
</tr>
<tr>
<td>TERMINAL</td>
</tr>
<tr>
<td>TEST</td>
</tr>
<tr>
<td>XPLINK (BACKCHAIN)</td>
</tr>
<tr>
<td>XPLINK (STOREARGS)</td>
</tr>
<tr>
<td>XREF</td>
</tr>
</tbody>
</table>

See the Inter-procedural Analysis chapter in the z/OS XL C/C++ Programming Guide for an overview and more details about Inter-procedural Analysis.

**COBOL compiler options**

When using COBOL V4R2 and prior releases, set the SYM suboption of the TEST compiler option. The SYM suboption of TEST causes the compiler to add debugging information into the object program to resolve user names in the routine and to generate a symbolic dump of the DATA DIVISION. With this suboption specified, statement numbers will also be used in the dump output along with offset values.

When using COBOL V5R1 and later releases, instead of setting the SYM suboption, set the DWARF suboption of the TEST compiler option. This has the same effect as the SYM option above concerning debug information in the object program.

To simplify debugging, use the NOOPTIMIZE compiler option. Program optimization can change the location of parameters and instructions in the dump output.

You can use the COBOL compiler options shown in Table 5 to prepare your program for runtime debugging. For more detail on these options and functions, see the appropriate programming guide in the Enterprise COBOL for z/OS library (http://www-01.ibm.com/support/docview.wss?uid=swg27036733).

Table 5. COBOL compiler options for runtime debugging

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST</td>
</tr>
<tr>
<td>MAP</td>
</tr>
<tr>
<td>OFFSET</td>
</tr>
</tbody>
</table>
Table 5. COBOL compiler options for runtime debugging (continued)

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTDD</td>
</tr>
<tr>
<td>SOURCE</td>
</tr>
</tbody>
</table>
| TEST        | Produces object code that can run with a debugging tool, or adds information to the object program to produce formatted dumps. With or without any suboptions, this option forces the OBJECT option. When specified with any of the hook-location suboption values except NONE, this option forces the NOOPTIMIZE option. DWARF suboption includes statement numbers in the Language Environment dump and produces a symbolic dump.  
  
  Note: For COBOL V4R2 and prior releases, use the SYM suboption instead of DWARF. |
| VBREF       | Produces a cross-reference of all verb types used in the source program and a summary of how many times each verb is used. |
| XREF        | Creates a sorted cross-reference listing. |

Fortran compiler options

You can use these Fortran compiler options shown in Table 6 to prepare your program for runtime debugging. For more detail on these options and functions, see VS FORTRAN Version 2 Programming Guide for CMS and MVS or VS FORTRAN Version 2 Language and Library Reference.

Table 6. Fortran compiler options for runtime debugging

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIPS</td>
</tr>
<tr>
<td>FLAG</td>
</tr>
<tr>
<td>GOSTMT</td>
</tr>
<tr>
<td>ICA</td>
</tr>
<tr>
<td>LIST</td>
</tr>
<tr>
<td>MAP</td>
</tr>
<tr>
<td>OPTIMIZE</td>
</tr>
<tr>
<td>SDUMP</td>
</tr>
<tr>
<td>SOURCE</td>
</tr>
</tbody>
</table>
Table 6. Fortran compiler options for runtime debugging (continued)

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRCFLG Controls insertion of error messages in the source listing. SRCFLG allows you to view error messages after the initial line of each source statement that caused the error, rather than at the end of the listing.</td>
</tr>
<tr>
<td>SXM Formats SREF or MAP listing output to a 72-character width.</td>
</tr>
<tr>
<td>SYM Invokes the production of SYM cards in the object text file. SYM cards contain location information for variables within a Fortran program.</td>
</tr>
<tr>
<td>TERMINAL Specifies whether error messages and compiler diagnostics are to be written on the SYSTERM data set and whether a summary of messages for all the compilations is to be written at the end of the listing.</td>
</tr>
<tr>
<td>TEST Specifies whether to override any optimization level above OPTIMIZE(0). This option adds runtime overhead.</td>
</tr>
<tr>
<td>TRMFLG Specifies whether to display the initial line of source statements in error and their associated error messages at the terminal.</td>
</tr>
<tr>
<td>XREF Creates a cross-reference listing.</td>
</tr>
<tr>
<td>VECTOR Specifies whether to invoke the vectorization process. A vectorization report provides detailed information about the vectorization process.</td>
</tr>
</tbody>
</table>

**PL/I compiler options**

When using PL/I, specify the TEST compiler option to control the level of testing capability that are generated as part of the object code. Suboptions of the TEST option such as SYM, BLOCK, STMT, and PATH control the location of test hooks and specify whether or not a symbol table is generated. For more information about TEST, its suboptions, and the placement of test hooks, see the...

To simplify debugging and decrease compile time, set optimization to NOOPTIMIZE or OPTIMIZE(0). Higher optimization levels can change the location where parameters and instructions appear in the dump output.

You can use the compiler options listed in Table 7 to prepare PL/I routines for debugging. For more detail on PL/I compiler options, see the [IBM Enterprise PL/I for z/OS library](http://www.ibm.com/support/docview.wss?uid=swg27036735).

Table 7. PL/I compiler options for debugging

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGGREGATE Specifies that a layout for arrays and major structures appears in the listing.</td>
</tr>
<tr>
<td>ESDIncludes the external symbol dictionary in the listing.</td>
</tr>
<tr>
<td>GONUMBER / GOSTMT Tells the compiler to produce additional information specifying that line numbers from the source routine can be included in runtime messages and in the Language Environment dump.</td>
</tr>
<tr>
<td>INTERRUPT Specifies that users can establish an ATTENTION ON-unit that gains control when an attention interrupt occurs.</td>
</tr>
<tr>
<td>LIST Produces a listing of the assembler expansion of source code and global tables, literal pools, information about working storage, and size of routine’s working storage.</td>
</tr>
<tr>
<td>LMESSAGE Tells the compiler to produce runtime messages in a long form. If the cause of a runtime malfunction is a programmer’s understanding of language semantics, specifying LMESSAGE could better explain warnings or other information generated by the compiler.</td>
</tr>
</tbody>
</table>
Table 7. PL/I compiler options for debugging (continued)

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP</td>
</tr>
<tr>
<td>OFFSET</td>
</tr>
<tr>
<td>SOURCE</td>
</tr>
<tr>
<td>STORAGE</td>
</tr>
<tr>
<td>TERMINAL</td>
</tr>
<tr>
<td>TEST</td>
</tr>
<tr>
<td>XREF and ATTRIBUTES</td>
</tr>
</tbody>
</table>

Enterprise PL/I for z/OS compiler options

Table 8 lists the Enterprise PL/I for z/OS compiler options that you can specify when preparing your Enterprise PL/I for z/OS routines for debugging. For further details on the Enterprise PL/I for z/OS compiler options, see the IBM Enterprise PL/I for z/OS library (http://www.ibm.com/support/docview.wss?uid=swg27036735).

Table 8. Enterprise PL/I for z/OS compiler options for debugging

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGGREGATE</td>
</tr>
<tr>
<td>GONUMBER / GOSTMT</td>
</tr>
<tr>
<td>INTERRUPT</td>
</tr>
<tr>
<td>LIST</td>
</tr>
<tr>
<td>OFFSET</td>
</tr>
<tr>
<td>SOURCE</td>
</tr>
<tr>
<td>STORAGE</td>
</tr>
</tbody>
</table>
Table 8. Enterprise PL/I for z/OS compiler options for debugging (continued)

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEST</td>
</tr>
<tr>
<td>Specifies the level of testing capability that is generated as part of the object code. TEST also controls the location of test hooks and whether or not the symbol table is generated. Because the TEST option increases the size of the object code and can affect performance, limit the number and placement of hooks.</td>
</tr>
</tbody>
</table>

XREF and ATTRIBUTES

Creates a sorted cross-reference listing with attributes.

Using Language Environment runtime options

Several runtime options affect debugging in Language Environment. The TEST runtime option, for example, can be used with a debugging tool to specify the level of control the debugging tool has when the routine being initialized is started. The ABPERC, CHECK, DEPTHCONDLMT, DYNDUMP, ERRCOUNT, HEAPCHK, INTERRUPT, TERMTHDACT, TRACE, TRAP, and USRHDLR options affect condition handling. The ABTERMENC option affects how an application ends (that is, with an abend or with a return code and reason code) when an unhandled condition of severity 2 or greater occurs. Table 9 lists the Language Environment runtime options that affect debugging. For a more detailed discussion of these runtime options, see z/OS Language Environment Programming Reference.

Table 9. Language Environment runtime options for debugging

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABPERC</td>
</tr>
<tr>
<td>Specifies that the indicated abend code bypasses the condition handler.</td>
</tr>
</tbody>
</table>

| ABTERMENC |
| Specifies enclave termination behavior for an enclave ending with an unhandled condition of severity 2 or greater. |

| CEEDUMP |
| Specifies options to control the processing of the Language Environment dump report. |

| CHECK |
| Determines if runtime checking is performed. |

| DEBUG |
| Controls the COBOL USE FOR DEBUGGING declarative. |

| DEPTHCONDLMT |
| Specifies the limit for the depth of nested synchronous conditions in user-written condition handlers. (Asynchronous signals do not affect DEPTHCONDLMT.) |

| DYNDUMP |
| Provides a way to obtain IPCS-readable dumps of user applications that would ordinarily be lost due to the absence of a SYSMDUMP, SYSDUMP, or SYSABEND DD statement. |

| ERRCOUNT |
| Specifies the number of synchronous conditions of severity 2 or greater tolerated. (Asynchronous signals do not affect ERRCOUNT.) |

| HEAPCHK |
| Determines if additional heap check tests are performed. |

| HEAPZONES |
| Activates user heap overlay toleration and checking. |

| INFOMSGFILTER |
| Filters user specified informational messages from the MSGFILE. Note: Affects only those messages generated by Language Environment and any routine that calls CEEMSG. Other routines that write to the message file, such as CEEMOUT, do not have a filtering option. |

| INTERRUPT |
| Causes Language Environment to recognize attention interrupts. |

| MSGFILE |
| Specifies the ddname of the Language Environment message file. |
Table 9. Language Environment runtime options for debugging (continued)

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSGQ</td>
</tr>
<tr>
<td>PROFILE</td>
</tr>
<tr>
<td>RPTOPTS</td>
</tr>
<tr>
<td>RPTSTG</td>
</tr>
<tr>
<td>STORAGE</td>
</tr>
<tr>
<td>TERMTHDACT</td>
</tr>
<tr>
<td>TEST</td>
</tr>
<tr>
<td>TRACE</td>
</tr>
<tr>
<td>TRAP</td>
</tr>
<tr>
<td>USRHDLR</td>
</tr>
<tr>
<td>XUFLOW</td>
</tr>
</tbody>
</table>

Determining runtime options in effect

The runtime options in effect at the time the routine is run can affect routine behavior. Use RPTOPTS(ON) to generate an options report in the Language Environment message file when your routine terminates. The options report lists runtime options, and indicates where they were set. Figure 1 on page 11 shows a sample options report.
<table>
<thead>
<tr>
<th>LAST WHERE SET</th>
<th>OPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM-supplied default</td>
<td>ABPERC(NONE)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>ABTERMENC(ABEND)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>NOAIXBLD</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>ALL31(ON)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>ANYHEAP(16384,8192,ANYWHERE,FREE)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>NOAUTOTASK</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>BELOWHEAP(6192,4096,FREE)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>CBLOPTS(ON)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>CBLOTPS(ON)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>CBLQQP(ON)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>CEBDUMP(60,SYSOUT=*,FREE=END,SPIN=UNALLOC)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>CHECK(ON)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>COUNTRY(US)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>NODERAB</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>DEPTHCONDLM(10)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>DYNDUMP(+USERID,NODYNAM,TDDUMP)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>ENVAR(<strong>),ENVAR(</strong><em>),ENVAR(</em>***)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>ERRCOUNT(0)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>ERRUNIT(6)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>FILELIST</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>FILETAG(NOAUTOCVT,NOAUTOTAG)</td>
</tr>
<tr>
<td>Default setting</td>
<td>NOFLOW</td>
</tr>
<tr>
<td>PARMLIB(CEEPROMML)</td>
<td>HEAP(4194304,5242880,ANYWHERE,KEEP,8192,4096)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>HEAPCHK(FF,1,0,0,0,1024,10,1024,0)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>HEAPPOOLS(FF,8,10,32,10,128,10,256,10,1024,</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>10,2048,10,0,10,0,10,0,10,0,10,0,10,0,10)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>INFOMSGFILTER(FF,...)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>INQCPMN</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>INTERRUPT(OFF)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>LIBSTACK(4096,4096,FREE)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>MSGFILE(SYSOUT,FBA,121,0,NOENQ)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>MSGQ(15)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>NATLANG(ENU)</td>
</tr>
<tr>
<td>Ignored</td>
<td>NONONIPTSTACK(See THREADSTACK)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>OSTATUS</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>PAGESIZE(4K,4K,4K)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>NPC</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>PLIKJ-AK(20)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>POSIX(FF)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>PROFILE(FF,&quot;&quot;&quot;)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>PRJUNIT(6)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>PUNUNIT(7)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>RDRUNIT(5)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>RECPAD(FF)</td>
</tr>
<tr>
<td>Invocation command</td>
<td>RPTOPTS(ON)</td>
</tr>
<tr>
<td>SETCEE command</td>
<td>RPTSTG(ON)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>NORTERUS</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>NOSEVRD</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>STACK(131072,131072,ANYWHERE,KEEP,524288,131072)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>STORAGE(NONE,NONE,NONE)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>TERMTHDACT(TRACE.,96)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>NOTEST(ALL.*,&quot;PROMPT&quot;,&quot;INSPPREF&quot;)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>THREADPER(4096,4096,ANYWHERE,KEEP)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>THREADSTACK(FF,4096,4096,ANYWHERE,KEEP,131072,</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>131072)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>TRACE(FF,4096,DUMP,LE=0)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>TRAP(ON,SPIE)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>UPSI(00000000)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>NOUSRDLLR(,</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>VCRTSAVE(FF)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>XPLINK(FF)</td>
</tr>
<tr>
<td>IBM-supplied default</td>
<td>XUFLOW(AUTO)</td>
</tr>
</tbody>
</table>

Figure 1. Options report example produced by runtime option RPTOPTS(ON)
Understanding the HEAPZONES and HEAPCHK runtime options

The HEAPZONES and HEAPCHK runtime options are useful for debugging overlay damage problems that occur in the user heap. Though similar in that both options can be used for debugging purposes, the runtime options activate very different behavior in the runtime when specified.

HEAPZONES is a lightweight mechanism that detects heap overlay damage only during the freeing of an element. It looks for damage in the heap check zone of the freed element only.

Selecting a non-quiet output option causes HEAPZONES to display information about the damaged heap element. When messaging is requested, the address of the damaged element along with information specific to the heap check zone are included in the message. Depending on the type of damage, the value of the heap check zone is displayed. The data area of the damaged location is displayed following any issued informational messages. This runtime option can also be used as a mechanism to tolerate heap overlay damage by simply requesting no output (QUIET).

Depending on the size of the heap check zone and the number of allocation requests, the user may notice a significant amount of extra storage being used by the application. Performance may be affected due to the overhead of examining each heap check zone.

HEAPCHK investigates the entire user heap for damage during heap related calls at a frequency based on the specified settings in the option. Because HEAPCHK will traverse the entire user heap, a slow down in application performance will occur. Information about HEAPCHK diagnostic output is discussed in Chapter 3, “Using Language Environment debugging facilities,” on page 37.

When deciding which runtime option is better suited to use with your application, consider the differences between HEAPZONES and HEAPCHK relating to performance, storage usage, and time of damage detection. Although both runtime options affect performance, an application that chooses HEAPCHK will perform slower than an application that chooses HEAPZONES. If storage usage is a concern, HEAPCHK will not consume extra amounts of storage in the manner that HEAPZONES will. Determining when heap damage has occurred may be simpler to accomplish if HEAPCHK is chosen because of the frequency and scope of its analysis.

For more information about the HEAPZONES and HEAPCHK runtime options, see z/OS Language Environment Programming Reference.

Using the CLER CICS transaction to display and set runtime options

The CICS transaction CLER allows you to display all the current Language Environment runtime options for a region, and to modify a subset of these options. For more information about the CICS CLER transaction, see “Displaying and modifying runtime options with the CLER transaction” on page 338.
Controlling storage allocation

The following runtime options control storage allocation:
- STACK
- THREADSTACK
- LIBSTACK
- THREADHEAP
- HEAP
- ANYHEAP
- BELOWHEAP
- STORAGE
- HEAPPOOLS

Z/OS Language Environment Programming Guide provides useful tips to assist with the tuning process. Appropriate tuning is necessary to avoid performance problems.

To generate a report of the storage a routine (or more specifically, an enclave) used during its run, specify the RPTSTG(ON) runtime option. The storage report, generated during enclave termination provides statistics that can help you understand how space is being consumed as the enclave runs. If storage management tuning is desired, the statistics can help you set the corresponding storage-related runtime options for future runs. The output is written to the Language Environment message file.

Neither the storage report nor the corresponding runtime options include the storage that Language Environment acquires during early initialization, before runtime options processing, and before the start of space management monitoring. In addition, Language Environment does not report alternative Vendor Heap Manager activity.

Figure 2 on page 14 and Figure 4 on page 16 are examples of storage reports that are produced when RPTSTG(ON) is specified. The sections that follow these reports describe the contents of the reports.
<table>
<thead>
<tr>
<th>Stack Statistics</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Increment size</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Maximum used by all</td>
<td>7488</td>
<td></td>
</tr>
<tr>
<td>concurrent threads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Largest used by any</td>
<td>7488</td>
<td></td>
</tr>
<tr>
<td>thread</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of segments</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>allocated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of segments</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>freed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ThreadStack Statistics</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Increment size</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Maximum used by all</td>
<td>3352</td>
<td></td>
</tr>
<tr>
<td>concurrent threads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Largest used by any</td>
<td>3352</td>
<td></td>
</tr>
<tr>
<td>thread</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of segments</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>allocated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of segments</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>freed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LibStack Statistics</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Increment size</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Maximum used by all</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>concurrent threads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Largest used by any</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>thread</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of segments</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>allocated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of segments</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>freed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ThreadHeap Statistics</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Increment size</td>
<td>4096</td>
<td></td>
</tr>
<tr>
<td>Maximum used by all</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>concurrent threads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Largest used by any</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>thread</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successful Get Heap</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>requests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successful Free Heap</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>requests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of segments</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>allocated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of segments</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>freed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Storage report produced by run-time option RPTSTG(ON)
HEAP statistics:
- Initial size: 49152
- Increment size: 16384
- Total heap storage used (sugg. initial size): 29112
- Successful Get Heap requests: 251
- Successful Free Heap requests: 218
- Number of segments allocated: 1
- Number of segments freed: 0

HEAP24 statistics:
- Initial size: 8192
- Increment size: 4096
- Total heap storage used (sugg. initial size): 0
- Successful Get Heap requests: 0
- Successful Free Heap requests: 0
- Number of segments allocated: 0
- Number of segments freed: 0

ANYHEAP statistics:
- Initial size: 32768
- Increment size: 16384
- Total heap storage used (sugg. initial size): 104696
- Successful Get Heap requests: 28
- Successful Free Heap requests: 15
- Number of segments allocated: 6
- Number of segments freed: 5

BELOWHEAP statistics:
- Initial size: 8192
- Increment size: 8192
- Total heap storage used (sugg. initial size): 0
- Successful Get Heap requests: 0
- Successful Free Heap requests: 0
- Number of segments allocated: 0
- Number of segments freed: 0

Additional Heap statistics:
- Successful Create Heap requests: 1
- Successful Discard Heap requests: 1
- Total heap storage used: 4912
- Successful Get Heap requests: 3
- Successful Free Heap requests: 3
- Number of segments allocated: 2
- Number of segments freed: 2

Largest number of threads concurrently active: 2

End of Storage Report

Figure 3. Storage report produced by run-time option RPTSTG(ON) (continued)

Figure 4 on page 16 shows an example of a storage report that is produced with XPLINK
### Stack Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>131072</td>
</tr>
<tr>
<td>Increment size</td>
<td>131072</td>
</tr>
<tr>
<td>Maximum used by all concurrent threads</td>
<td>5416</td>
</tr>
<tr>
<td>Largest used by any thread</td>
<td>5416</td>
</tr>
<tr>
<td>Number of segments allocated</td>
<td>1</td>
</tr>
<tr>
<td>Number of segments freed</td>
<td>0</td>
</tr>
</tbody>
</table>

### Threadstack Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>4096</td>
</tr>
<tr>
<td>Increment size</td>
<td>4096</td>
</tr>
<tr>
<td>Maximum used by all concurrent threads</td>
<td>45536</td>
</tr>
<tr>
<td>Largest used by any thread</td>
<td>6552</td>
</tr>
<tr>
<td>Number of segments allocated</td>
<td>60</td>
</tr>
<tr>
<td>Number of segments freed</td>
<td>0</td>
</tr>
</tbody>
</table>

### Xlink Stack Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>524288</td>
</tr>
<tr>
<td>Increment size</td>
<td>131072</td>
</tr>
<tr>
<td>Largest used by any thread</td>
<td>20400</td>
</tr>
<tr>
<td>Number of segments allocated</td>
<td>1</td>
</tr>
<tr>
<td>Number of segments freed</td>
<td>0</td>
</tr>
</tbody>
</table>

### Xlink Threadstack Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>131072</td>
</tr>
<tr>
<td>Increment size</td>
<td>131072</td>
</tr>
<tr>
<td>Largest used by any thread</td>
<td>22160</td>
</tr>
<tr>
<td>Number of segments allocated</td>
<td>30</td>
</tr>
<tr>
<td>Number of segments freed</td>
<td>0</td>
</tr>
</tbody>
</table>

### Libstack Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>4096</td>
</tr>
<tr>
<td>Increment size</td>
<td>4096</td>
</tr>
<tr>
<td>Maximum used by all concurrent threads</td>
<td>0</td>
</tr>
<tr>
<td>Largest used by any thread</td>
<td>0</td>
</tr>
<tr>
<td>Number of segments allocated</td>
<td>0</td>
</tr>
<tr>
<td>Number of segments freed</td>
<td>0</td>
</tr>
</tbody>
</table>

### Threadheap Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>4096</td>
</tr>
<tr>
<td>Increment size</td>
<td>4096</td>
</tr>
<tr>
<td>Maximum used by all concurrent threads</td>
<td>0</td>
</tr>
<tr>
<td>Largest used by any thread</td>
<td>0</td>
</tr>
<tr>
<td>Successful Get Heap requests</td>
<td>0</td>
</tr>
<tr>
<td>Successful Free Heap requests</td>
<td>0</td>
</tr>
<tr>
<td>Number of segments allocated</td>
<td>0</td>
</tr>
<tr>
<td>Number of segments freed</td>
<td>0</td>
</tr>
</tbody>
</table>

### Heap Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial size</td>
<td>32768</td>
</tr>
<tr>
<td>Increment size</td>
<td>32768</td>
</tr>
<tr>
<td>Total heap storage used (sugg. initial size)</td>
<td>286576</td>
</tr>
<tr>
<td>Successful Get Heap requests</td>
<td>71</td>
</tr>
<tr>
<td>Successful Free Heap requests</td>
<td>1</td>
</tr>
<tr>
<td>Number of segments allocated</td>
<td>10</td>
</tr>
<tr>
<td>Number of segments freed</td>
<td>0</td>
</tr>
</tbody>
</table>

*Figure 4. Storage report produced by RPTSTG(ON) with XPLINK*
HEAP24 statistics:
- Initial size: 8192
- Increment size: 4096
- Total heap storage used (suggested initial size): 0
- Successful Get Heap requests: 0
- Successful Free Heap requests: 0
- Number of segments allocated: 0
- Number of segments freed: 0

ANYHEAP statistics:
- Initial size: 16384
- Increment size: 8192
- Total heap storage used (suggested initial size): 1139712
- Successful Get Heap requests: 487
- Successful Free Heap requests: 431
- Number of segments allocated: 50
- Number of segments freed: 36

BELOWHEAP statistics:
- Initial size: 8192
- Increment size: 4096
- Total heap storage used (suggested initial size): 0
- Successful Get Heap requests: 0
- Successful Free Heap requests: 0
- Number of segments allocated: 0
- Number of segments freed: 0

Additional Heap statistics:
- Successful Create Heap requests: 0
- Successful Discard Heap requests: 0
- Total heap storage used: 0
- Successful Get Heap requests: 0
- Successful Free Heap requests: 0
- Number of segments allocated: 0
- Number of segments freed: 0

HEAPPOOLS Statistics:
- Pool 1 size: 8 Get Requests: 3
  - Successful Get Heap requests: 1-8: 3
- Pool 2 size: 32 Get Requests: 268
  - Successful Get Heap requests: 9-16: 36
  - Successful Get Heap requests: 17-24: 3
  - Successful Get Heap requests: 25-32: 229
- Pool 3 size: 128 Get Requests: 186
  - Successful Get Heap requests: 33-40: 3
  - Successful Get Heap requests: 41-48: 8
  - Successful Get Heap requests: 49-56: 111
  - Successful Get Heap requests: 57-64: 4
  - Successful Get Heap requests: 65-72: 2
  - Successful Get Heap requests: 73-80: 4
  - Successful Get Heap requests: 81-88: 6
  - Successful Get Heap requests: 89-96: 2
  - Successful Get Heap requests: 97-104: 1
  - Successful Get Heap requests: 105-112: 5
  - Successful Get Heap requests: 113-120: 31
  - Successful Get Heap requests: 121-128: 9

Figure 5. Storage report produced by RPTSTG(ON) with XPLINK (continued)
The statistics for initial and incremental allocations of storage types that have a corresponding runtime option differ from the runtime option settings when their values have been rounded up by the implementation, or when allocations larger than the amounts specified were required during execution. All of the following are rounded up to an integral number of double-words:

- Initial STACK allocations
- Initial allocations of THREADSTACK
- Initial allocations of all types of heap
- Incremental allocations of all types of stack and heap

HEAPPOOLS Summary:

<table>
<thead>
<tr>
<th>Specified Element</th>
<th>Extent</th>
<th>Cells Per Extent</th>
<th>Extents Allocated</th>
<th>Maximum Cells Used</th>
<th>Cells In Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Size Size</td>
<td>Percent</td>
<td>Extent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>16</td>
<td>10</td>
<td>204</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>32</td>
<td>40</td>
<td>10</td>
<td>81</td>
<td>3</td>
<td>226</td>
</tr>
<tr>
<td>128</td>
<td>136</td>
<td>10</td>
<td>24</td>
<td>4</td>
<td>88</td>
</tr>
<tr>
<td>256</td>
<td>264</td>
<td>10</td>
<td>12</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1024</td>
<td>1032</td>
<td>10</td>
<td>4</td>
<td>57</td>
<td>228</td>
</tr>
<tr>
<td>1024</td>
<td>1032</td>
<td>10</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1024</td>
<td>1032</td>
<td>10</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2048</td>
<td>2056</td>
<td>10</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Requests greater than the largest cell size: 2

Suggested Percentages for current Cell Sizes:

HEAPP(ON,8,1,32,28,128,37,256,1,(1024,3),90,2048,13,0)

Suggested Cell Sizes:

HEAPP(ON,

32,56,88,120,128,168,
208,248,288,848,1144,2080)

Largest number of threads concurrently active: 11

End of Storage Report
The runtime options should be tuned appropriately to avoid performance problems. See z/OS Language Environment Programming Guide for tips on tuning.

## Stack storage statistics

Language Environment stack storage is managed at the thread level; each thread has its own stack-type resources. Table 10 describes the fields in the storage report that contain various statistics about stack storage.

Table 10. Storage report fields that display stack storage statistics

<table>
<thead>
<tr>
<th>Statistics categories</th>
<th>Field contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>• STACK</td>
<td>The following fields display statistics for the upward-growing stack.</td>
</tr>
<tr>
<td>• THREADSTACK</td>
<td><strong>Initial size</strong></td>
</tr>
<tr>
<td>• LIBSTACK</td>
<td>Actual size of the initial segment assigned to each thread. If a pthread-attributes-table is provided on the invocation of pthread-create, then the stack size specified in the pthread-attributes-table will take precedence over the STACK runtime option.</td>
</tr>
<tr>
<td>• IPT STACK</td>
<td>Increment size</td>
</tr>
<tr>
<td></td>
<td>Size of each incremental segment acquired, as determined by the increment portion of the corresponding runtime option.</td>
</tr>
<tr>
<td></td>
<td><strong>Maximum used by all concurrent threads</strong></td>
</tr>
<tr>
<td></td>
<td>Maximum amount allocated in total at any one time by all concurrently executing threads.</td>
</tr>
<tr>
<td></td>
<td><strong>Largest used by any thread</strong></td>
</tr>
<tr>
<td></td>
<td>Largest amount allocated ever by any single thread.</td>
</tr>
<tr>
<td></td>
<td><strong>Number of segments allocated</strong></td>
</tr>
<tr>
<td></td>
<td>Number of segments allocated by all threads which includes the initial segments.</td>
</tr>
<tr>
<td></td>
<td><strong>Number of segments freed</strong></td>
</tr>
<tr>
<td></td>
<td>Number of incremental segments freed by all threads during the life of the threads. This does not include any incremental segments that were freed during thread termination.</td>
</tr>
<tr>
<td>• XPLINK STACK</td>
<td>The following sections of the storage report display statistics for the downward-growing stack; they are only apply if XPLINK is in effect.</td>
</tr>
<tr>
<td>• XPLINK THREADSTACK</td>
<td><strong>Initial size</strong></td>
</tr>
<tr>
<td></td>
<td>Actual size of the initial segment assigned to each thread.</td>
</tr>
<tr>
<td></td>
<td>Increment size</td>
</tr>
<tr>
<td></td>
<td>Size of each incremental segment acquired, as determined by the increment portion of the corresponding runtime option.</td>
</tr>
<tr>
<td></td>
<td><strong>Maximum used by all concurrent threads</strong></td>
</tr>
<tr>
<td></td>
<td>Maximum amount allocated in total at any one time by all concurrently executing threads.</td>
</tr>
<tr>
<td></td>
<td><strong>Number of segments allocated</strong></td>
</tr>
<tr>
<td></td>
<td>Number of segments allocated by all threads which includes the initial segments.</td>
</tr>
<tr>
<td></td>
<td><strong>Number of segments freed</strong></td>
</tr>
<tr>
<td></td>
<td>Number of incremental segments freed by all threads during the life of the threads. This does not include any incremental segments that were freed during thread termination.</td>
</tr>
</tbody>
</table>
**Determining the applicable threads**
If the application is not a multithreading or PL/I multitasking application, then the STACK statistics are for the one and only thread that executed, and the THREADSTACK statistics are all zero.

If the application is a multithreading or PL/I multitasking application, and THREADSTACK(ON) was specified, then the STACK statistics are for the initial thread (the IPT), and the THREADSTACK statistics are for the other threads. However, if THREADSTACK(OFF) was specified, then the STACK statistics are for all of the threads, initial and other.

**Allocating stack storage**
Another type of stack, called the reserve stack, is allocated for each thread and used to handle out-of-storage conditions. Its size is controlled by the 4th subparameter of the STORAGE runtime option, but its usage is neither tracked nor reported in the storage report.

In a single-threaded environment, Language Environment allocates the initial segments for STACK, LIBSTACK and reserve stack using GETMAIN. The LIBSTACK initial segment allocation is deferred until first use, except when STACK(,,BELOW,,) is in effect. The reserve stack is allocated with STACK. In a multi-threaded POSIX(ON) environment, allocation of stack storage for the initial processing thread (IPT) is the same as the single-threaded environment. For threads other than the IPT, the initial STACK (or THREADSTACK) segment and reserve stack is allocated from ANYHEAP or BELOWHEAP, according to the STACK (or THREADSTACK) location. The initial LIBSTACK segment allocation is again deferred until first use, except when STACK(,,BELOW,,) or THREADSTACK(ON,,BELOW,,) is in effect. When a STACK, THREADSTACK, or LIBSTACK overflow occurs on any thread, Language Environment obtains the new segment using GETMAIN. The reserve stack does not tolerate overflow.

**Heap storage statistics**
Language Environment heap storage, other than what is explicitly defined using THREADHEAP, is managed at the enclave level. Each enclave has its own heap-type resources, which are shared by the threads that execute within the enclave. Heap storage defined using THREADHEAP is controlled at the thread level.

[Table 11 on page 2] describes the fields in the storage report that contain various statistics about heap storage. These statistics, in all cases, specify totals for the whole enclave. For THREADHEAP, they indicate the total across all threads in the enclave.
<table>
<thead>
<tr>
<th>Statistics categories</th>
<th>Field contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>THREADHEAP</td>
<td></td>
</tr>
<tr>
<td><strong>Initial size</strong></td>
<td>Default initial allocation, as specified by the corresponding runtime option. For HEAP24, the initial size is the value of the \texttt{initsz24} of the \texttt{HEAP} option.</td>
</tr>
<tr>
<td><strong>Increment size</strong></td>
<td>Minimum incremental allocation, as specified by the corresponding runtime option. For HEAP24, the increment size is the value of the \texttt{incrsz24} of the \texttt{HEAP} option.</td>
</tr>
<tr>
<td><strong>Maximum used by all concurrent threads</strong></td>
<td>Maximum total amount used by all concurrent threads at any one time.</td>
</tr>
<tr>
<td><strong>Largest used by any thread</strong></td>
<td>Largest amount used by any single thread</td>
</tr>
<tr>
<td><strong>Successful Get Heap requests</strong></td>
<td>Number of Get Heap requests.</td>
</tr>
<tr>
<td><strong>Successful Free Heap requests</strong></td>
<td>Number of Free Heap requests.</td>
</tr>
<tr>
<td><strong>Number of segments allocated</strong></td>
<td>Number of incremental segments allocated.</td>
</tr>
<tr>
<td><strong>Number of segments freed</strong></td>
<td>Number of incremental segments individually freed.</td>
</tr>
<tr>
<td>• HEAP</td>
<td></td>
</tr>
<tr>
<td>• HEAP24</td>
<td></td>
</tr>
<tr>
<td>• ANYHEAP</td>
<td></td>
</tr>
<tr>
<td>• BELOWHEAP</td>
<td></td>
</tr>
<tr>
<td>Initial size</td>
<td>Default initial allocation, as specified by the corresponding runtime option. For HEAP24, the initial size is the value of the \texttt{initsz24} of the \texttt{HEAP} option.</td>
</tr>
<tr>
<td>Increment size</td>
<td>Minimum incremental allocation, as specified by the corresponding runtime option. For HEAP24, the increment size is the value of the \texttt{incrsz24} of the \texttt{HEAP} option.</td>
</tr>
<tr>
<td>Total heap storage used</td>
<td>Largest total amount used by the enclave at any one time.</td>
</tr>
<tr>
<td><strong>Successful Get Heap requests</strong></td>
<td>Number of Get Heap requests.</td>
</tr>
<tr>
<td><strong>Successful Free Heap requests</strong></td>
<td>Number of Free Heap requests. The number of Free Heap requests could be less than the number of Get Heap requests if the pieces of heap storage acquired by individual Get Heap requests were not freed individually, but rather were freed implicitly in the course of enclave termination.</td>
</tr>
<tr>
<td><strong>Number of segments allocated</strong></td>
<td>Number of incremental segments allocated.</td>
</tr>
<tr>
<td><strong>Number of segments freed</strong></td>
<td>Number of incremental segments individually freed. The number of incremental segments individually freed could be less than the number allocated if the segments were not freed individually, but rather were freed implicitly in the course of enclave termination.</td>
</tr>
</tbody>
</table>
Table 11. Storage report fields that display heap storage statistics (continued)

<table>
<thead>
<tr>
<th>Statistics categories</th>
<th>Field contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional heap statistics</td>
<td>Besides the fixed types of heap, additional types of heap can be created, each with its own heap ID. You can create and discard these additional types of heap by using the CEECRHP callable service.</td>
</tr>
<tr>
<td></td>
<td><strong>Successful Create Heap requests</strong> Number of successful Create Heap requests.</td>
</tr>
<tr>
<td></td>
<td><strong>Successful Discard Heap requests</strong> Number of successful Discard Heap requests. The number of Discard Heap requests could be less than the number of Create Heap requests if the special heaps allocated by individual Create Heap requests were not freed individually, but rather were freed implicitly in the course of enclave termination.</td>
</tr>
<tr>
<td></td>
<td><strong>Total heap storage used</strong> Largest total amount used by the enclave at any one time.</td>
</tr>
<tr>
<td></td>
<td><strong>Successful Get Heap requests</strong> Number of Get Heap requests.</td>
</tr>
<tr>
<td></td>
<td><strong>Successful Free Heap requests</strong> Number of Free Heap requests.</td>
</tr>
<tr>
<td></td>
<td><strong>Number of segments allocated</strong> Number of incremental segments allocated.</td>
</tr>
<tr>
<td></td>
<td><strong>Number of segments freed</strong> Number of incremental segments individually freed.</td>
</tr>
</tbody>
</table>

**HEAPPOOLS storage statistics**

The HEAPPOOLS runtime option (for C/C++ applications only) controls usage of the HEAPPOOLS storage algorithm at the enclave level. The HEAPPOOLS algorithm allows for the definition of one to twelve heap pools, each consisting of a number of storage cells of a specified length. For further details regarding HEAPPOOLS storage statistics in the storage report, see “HEAPPOOLS storage statistics” on page 220.

**Modifying condition handling behavior**

Setting the condition handling behavior of your routine affects the response that occurs when the routine encounters an error. You can modify condition handling behavior in the following ways:

- Callable services
- Runtime options
- User-written condition handlers
- POSIX functions (used to specifically set signal actions and signal masks)

**Language Environment callable services**

Table 12 on page 23 lists the callable services that you can use to modify condition handling. For more information about callable services, see z/OS Language Environment Programming Reference. Note that Fortran programs cannot directly call Language Environment callable services. For more information about how to invoke callable services from Fortran, see Language Environment for MVS & VM Fortran Run-Time Migration Guide.
Table 12. Callable services that modify condition handling

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE3ABD Terminates an enclave using an abend.</td>
</tr>
<tr>
<td>CEE3AB2 Terminate enclave with an abend and reason code.</td>
</tr>
<tr>
<td>CEEMRCE Moves the resume cursor to an explicit location where resumption is to occur after a condition has been handled.</td>
</tr>
<tr>
<td>CEEMRCR Moves the resume cursor relative to the current position of the handle cursor.</td>
</tr>
<tr>
<td>CEE3CIB Returns a pointer to a condition information block (CIB) associated with a given condition token. The CIB contains detailed information about the condition.</td>
</tr>
<tr>
<td>CEE3GRO Returns the offset of the location within the most current Language Environment-conforming routine where a condition occurred.</td>
</tr>
</tbody>
</table>
| CEE3SPM Specifies the settings of the routine mask. The routine mask controls:  
  - Fixed overflow  
  - Decimal overflow  
  - Exponent underflow  
  - Significance  
  You can use CEE3SPM to modify Language Environment hardware conditions. Because such modifications can affect the behavior of your routine, however, you should be careful when doing so. |
| CEE3SRP Sets a resume point within user application code to resume from a Language Environment user condition handler. |

Language Environment runtime options

Table 13 shows the Language Environment runtime options that can affect your routine's condition handling behavior.

Table 13. Runtime options that modify condition handling

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
</table>
| ABPERC Specifies a system- or user-specified abend code that percolates without further action while the Language Environment condition handler is enabled. Normal condition handling activities are performed for everything except the specified abend code. System abends are specified as $hhhh$, where $hhhh$ is a hexadecimal system abend code. User abends are specified as $Uddd$, where $ddd$ is a decimal user abend code. Any other 4-character EBCDIC string, such as NONE, that is not of the form $Snhh$ can also be specified as a user-specified abend code. You can specify only one abend code with this option. This option assumes the use of TRAP(ON). ABPERC is not supported in CICS.  
Language Environment ignores ABPERC(0Cx). No abend is percolated and Language Environment condition handling semantics are in effect. |
| CHECK Specifies that checking errors within an application are detected. The Language Environment-conforming languages can define error checking differently. |
### Table 13. Runtime options that modify condition handling (continued)

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEPTHCONDLMT</strong></td>
</tr>
<tr>
<td><strong>ERRCOUNT</strong></td>
</tr>
<tr>
<td><strong>INTERRUPT</strong></td>
</tr>
<tr>
<td><strong>TERMTHDACT</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>TRAP(ON)</strong></td>
</tr>
<tr>
<td><strong>TRAP(OFF)</strong></td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>-------------</td>
</tr>
</tbody>
</table>
| **USRHDLR** Specifies the behavior of two user-written condition handlers. The first handler specified will be registered at stack frame 0. The second handler specified will be registered before any other user-written condition handlers, once the handler is enabled by a condition.  
When you specify USRHDLR(lastname,supername), lastname gets control at stack frame 0. The supername will get control first, before any user-written condition handlers but after supername has gone through the enablement phase, when a condition occurs. |
| **XUFLOW** Specifies if an exponent underflow causes a routine interrupt. |

**Customizing condition handlers**

User-written condition handlers permit you to customize condition handling for certain conditions. You can register a user-written condition handler for the current stack frame by using the CEEHDLR callable service. You can use the Language Environment USRHDLR runtime option to register a user-written condition handler for stack frame 0. You can also use USRHDLR to register a user-written condition handler before any other user condition handlers.

When the Language Environment condition manager encounters the condition, it requests that the condition handler associated with the current stack frame handle the condition. If the condition is not handled, the Language Environment condition manager percolates the condition to the next (earlier) stack frame, and so forth to earlier stack frames until the condition has been handled. Conditions that remain unhandled after the first (earliest) stack frame has been reached are presented to the Language Environment condition handler. One of the following Language Environment default actions is then taken, depending on the severity of the condition:

- Resume
- Percolate
- Promote
- Fix-up and resume


**Invoking the assembler user exit**

For debugging purposes, the CEEBXITA assembler user exit can be invoked during:

- Enclave initialization
- Enclave termination
- Process termination

The functions of the CEEBXITA user exit depend on when the user exit is invoked and whether it is application-specific or installation-wide. Application-specific user exits must be linked with the application load module and run only when that application runs. Installation-wide user exits must be linked with the Language Environment initialization/termination library routines and run with all Language Environment library routines. Because an application-specific user exit has priority...
over any installation-wide user exit, you can customize a user exit for a particular application without affecting the user exit for any other applications.

At enclave initialization, the CEEBXITA user exit runs prior to the enclave establishment. Thus you can modify the environment in which your application runs in the following ways:

- Specify runtime options
- Allocate data sets/files in the user exit
- List abend codes to be passed to the operating system
- Check the values of routine arguments

At enclave termination, the CEEBXITA user exit runs prior to the termination activity. Thus, you can request an abend and perform specified actions based on received return and reason codes. (This does not apply when Language Environment terminates with an abend.)

At process termination, the CEEBXITA user exit runs after the enclave termination activity completes. Thus you can request an abend and deallocate files.

The assembler user exit must have an entry point of CEEBXITA, must be reentrant, and must be capable of running in AMODE(ANY) and RMODE(ANY).

You can use the assembler user exit to establish enclave termination behavior for an enclave ending with an unhandled condition of severity 2 or greater in the following ways:

- If you do not request an abend in the assembler user exit for the enclave termination call, Language Environment honors the setting of the ABTERMENC option to determine how to end the enclave.
- If you request an abend in the assembler user exit for the enclave termination call, Language Environment issues an abend to end the enclave.

For more information on the assembler user exit, see \textit{z/OS Language Environment Programming Guide}.

\textbf{Establishing enclave termination behavior for unhandled conditions}

To establish enclave termination behavior when an unhandled condition of severity 2 or greater occurs, use one of the following methods:

- The assembler user exit (see "Invoking the assembler user exit" on page 25 and \textit{z/OS Language Environment Programming Guide})
- POSIX signal default action (see \textit{z/OS Language Environment Programming Guide})
- The ABTERMENC runtime option (discussed below)

The ABTERMENC runtime option sets the enclave termination behavior for an enclave ending with an unhandled condition of severity 2 or greater.

If you specify the IBM-supplied default suboption ABEND, Language Environment issues an abend to end the enclave regardless of the setting of the CEEAUE_ABND flag. Additionally, the assembler user exit can alter the abend code, abend reason code, abend dump attribute, and the abend task/step attribute. For more information on using ABTERMENC, see \textit{z/OS Language Environment Programming Reference} and for more information on the assembler user exit, see \textit{z/OS Language Environment Programming Guide}.
If you specify the RETCODE suboption, Language Environment uses the CEEAU_ABND flag value set by the assembler user exit (which is called for enclave termination) to determine whether or not to issue an abend to end the enclave when an unhandled condition of severity 2 or greater occurs.

Using messages in your routine

You can create messages and use them in your routine to indicate the status and progress of the routine during run time, and to display variable values. The process of creating messages and using them requires that you create a message source file, and convert the source file into loadable code for use in your routine.

You can use the Language Environment callable service CEEMOUT to direct user-created message output to the Language Environment message file. To direct the message output to another destination, use the Language Environment MSGFILE runtime option to specify the ddname of the file.

When multiple Language Environment environments are running in the same address space and the same MSGFILE ddname is specified, writing contention can occur. To avoid contention, use the MSGFILE suboption ENQ. ENQ tells Language Environment to perform serialization around writes to the MSGFILE ddname specified which eliminates writing contention. Writing contention can also be eliminated by specifying unique MSGFILE ddnames.

Each Language Environment-conforming language also provides ways to display both user-created and runtime messages. (For an explanation of Language Environment runtime messages, see “Interpreting runtime messages” on page 33.)

The following sections discuss how to create messages in each of the HLLs. For a more detailed explanation of how to create messages and use them in C, C++, COBOL, Fortran, or PL/I routines, see z/OS Language Environment Programming Guide.

C/C++

For C/C++ routines, output from the printf function is directed to stdout, which is associated with SYSPRINT. All C/C++ runtime messages and perror() messages are directed to stderr. stderr corresponds to the ddname associated with the Language Environment MSGFILE runtime option. The destination of the printf function output can be changed by using the redirection > &2 at routine invocation to redirect stdout to the stderr destination. Both streams can be controlled by the MSGFILE runtime option.

COBOL

For COBOL programs, you can use the DISPLAY statement to display messages. Output from the DISPLAY statement is directed to SYSOUT. SYSOUT is the IBM-supplied default for the Language Environment message file. The OUTDD compiler option can be used to change the destination of the DISPLAY messages.

Fortran

For Fortran programs, runtime messages, output written to the print unit, and other output (such as output from the SDUMP callable service) are directed to the file specified by the MSGFILE runtime option. If the print unit is different than the
error message unit (PRTUNIT and ERRUNIT runtime options have different values), however, output from the PRINT statement won't be directed to the Language Environment message file.

PL/I

Under PL/I, runtime messages are directed to the file specified in the Language Environment MSGFILE runtime option, instead of the PL/I SYSPRINT STREAM PRINT file. User-specified output is still directed to the PL/I SYSPRINT STREAM PRINT file. To direct this output to the Language Environment MSGFILE file, specify the runtime option MSGFILE(SYSPRINT).

Using condition information

If a condition that might require attention occurs while an application is running, Language Environment builds a condition token. The condition token contains 12 bytes (96 bits) of information about the condition that Language Environment or your routines can use to respond appropriately. Each condition is associated with a single Language Environment runtime message. You can use this condition information in two primary ways:

- To specify the feedback code parameter when calling Language Environment services (see "Using the feedback code parameter").
- To code a symbolic feedback code in a user-written condition handler (see "Using the symbolic feedback code" on page 30).

Using the feedback code parameter

The feedback code is an optional parameter of the Language Environment callable services. (For COBOL/370 programs, you must provide the fc parameter in each call to a Language Environment callable service. For C/C++, Enterprise COBOL for z/OS, COBOL for OS/390 & VM, COBOL for MVS & VM, and PL/I routines, this parameter is optional. For more information about fc and condition tokens, see z/OS Language Environment Programming Guide.

When you provide the feedback code (fc) parameter, the callable service in which the condition occurs sets the feedback code to a specific value called a condition token.

The condition token does not apply to asynchronous signals. For a discussion of the distinctions between synchronous signals and asynchronous signals with POSIX(ON), see z/OS Language Environment Programming Guide.

When you do not provide the fc parameter, any nonzero condition is signaled and processed by Language Environment condition handling routines. If you have registered a user-written condition handler, Language Environment passes control to the handler, which determines the next action to take. If the condition remains unhandled, Language Environment writes a message to the Language Environment message file. The message is the translation of the condition token into English (or another supported national language).

Language Environment provides callable services that can be used to convert condition tokens to routine variables, messages, or signaled conditions. Table 14 on page 29 lists these callable services and their functions.
Table 14. Callable services that can convert condition tokens to routine variables, messages, or signaled conditions

<table>
<thead>
<tr>
<th>Description</th>
<th>CEEMSG</th>
<th>Transforms the condition token into a message and writes the message to the message file.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CEEMGET</td>
<td>Transforms the condition token into a message and stores the message in a buffer.</td>
</tr>
<tr>
<td></td>
<td>CEEDCOD</td>
<td>Decodes the condition token; that is, separates it into distinct user-supplied variables. Also, if a language does not support structures, CEEDCOD provides direct access to the token.</td>
</tr>
<tr>
<td></td>
<td>CEESGL</td>
<td>Signals the condition. This passes control to any registered user-written condition handlers. If a user-written condition handler does not exist, or the condition is not handled, Language Environment by default writes the corresponding message to the message file and terminates the routine for severity 2 or higher. For severity 0 and 1, Language Environment continues without writing a message. COBOL, however, issues severity 1 messages before continuing. CEESGL can signal a POSIX condition. For details, see z/OS Language Environment Programming Guide.</td>
</tr>
</tbody>
</table>

There are two types of condition tokens. Case 1 condition tokens contain condition information, including the Language Environment message number. All Language Environment callable services and most application routines use case 1 condition tokens. Case 2 condition tokens contain condition information and a user-specified class and cause code. Application routines, user-written condition handlers, assembler user exits, and some operating systems can use case 2 condition tokens.

For Case 1 condition tokens, Condition_ID is:

<table>
<thead>
<tr>
<th>0 - 15</th>
<th>16 - 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity Number</td>
<td>Message Number</td>
</tr>
</tbody>
</table>

For Case 2 condition tokens, Condition_ID is:

<table>
<thead>
<tr>
<th>0 - 15</th>
<th>16 - 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Code</td>
<td>Cause Code</td>
</tr>
</tbody>
</table>

A symbolic feedback code represents the first 8 bytes of a condition token. It contains the Condition_ID, Case Number, Severity Number, Control Code, and Facility_ID, whose bit offsets are indicated.

Figure 7. Language Environment condition token

For example, in the condition token: X'0003032D 59C3C5C5 00000000'
- X'0003' is severity.
- X'032D' is message number 813.
- X'59' are hexadecimal flags for case, severity, and control.
- X'C3C5C5' is the CEE facility ID.
- X'00000000' is the ISI. (In this case, no ISI was provided.)

If a Language Environment traceback or dump is generated while a condition token is being processed or when a condition exists, Language Environment writes the runtime message to the condition section of the traceback or dump. If a condition is detected when a callable service is invoked without a feedback code, the condition token is passed to the Language Environment condition manager.
The condition manager polls active condition handlers for a response. If a condition of severity 0 or 1 remains unhandled, Language Environment resumes without issuing a message. Language Environment does issue messages, however, for COBOL severity 1 conditions. For unhandled conditions of severity 2 or greater, Language Environment issues a message and terminates. For a list of Language Environment runtime messages and corrective information, see z/OS Language Environment Runtime Messages.

If a second condition is raised while Language Environment is attempting to handle a condition, the message CEE0374C CONDITION = <message no.> is displayed using a write-to-operator (WTO). The message number in the CEE0374C message indicates the original condition that was being handled when the second condition was raised. This can happen when a critical error is signaled (for example, when internal control blocks are damaged).

If the output for this error message appears several times in sequence, the conditions appear in order of occurrence. Correcting the earliest condition can cause your application to run successfully.

Using the symbolic feedback code

The symbolic feedback code represents the first 8 bytes of a 12-byte condition token. You can think of the symbolic feedback code as the nickname for a condition. As such, the symbolic feedback code can be used in user-written condition handlers to screen for a given condition, even if it occurs at different locations in an application. For more details on symbolic feedback codes, see z/OS Language Environment Programming Guide.
Chapter 2. Classifying errors

This chapter describes errors that commonly occur in Language Environment routines. It also explains how to use runtime messages and abend codes to obtain information about errors in your routine.

Identifying problems in routines

The following sections describe how you can identify errors in Language Environment routines. Included are common error symptoms and solutions.

Language Environment module names

You can identify Language Environment-supplied module elements by any of the following three-character prefixes:

- CEE (Language Environment)
- CEL (Language Environment and C/C++ runtime library)
- EDC (C/C++)
- FOR (Fortran)
- IBM (PL/I)
- IGZ (COBOL)

Module elements or text files with other prefixes are not part of the Language Environment product.

Common errors in routines

These common errors have simple solutions:

- If you do not have enough virtual storage, increase your region size or decrease your storage usage (stack size) by using the storage-related runtime options and callable services. (See "Controlling storage allocation" on page 13 for information about using storage in routines.)
- If you do not have enough disk space, increase your disk allocation.
- If executable files are not available, check your executable library to ensure that they are defined. For example, check your STEPLIB or JOBLIB definitions.

If your error is not caused by any of the items listed above, examine your routine or routines for changes since the last successful run. If there have been changes, review these changes for errors that might be causing the problem. One way to isolate the problem is to branch around or comment out recent changes and rerun the routine. If the run is successful, the error can be narrowed to the scope of the changes.

Duplicate names shared between Fortran routines and C library routines can produce unexpected results. Language Environment provides several cataloged procedures to properly resolve duplicate names. For more information on how to avoid name conflicts, see "z/OS Language Environment Programming Guide".

Changes in optimization levels, addressing modes, and input/output file formats can also cause unanticipated problems in your routine.
In most cases, generated condition tokens or runtime messages point to the nature of the error. The runtime messages offer the most efficient corrective action. To help you analyze errors and determine the most useful method to fix the problem, Table 15 lists common error symptoms, possible causes, and programmer responses.

**Table 15. Common error symptoms, possible causes, and programmer responses**

<table>
<thead>
<tr>
<th>Error Symptom</th>
<th>Possible Cause</th>
<th>Programmer Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbered runtime message appears</td>
<td>Condition raised in routine</td>
<td>For any messages you receive, read the Programmer Response. For information about</td>
</tr>
<tr>
<td></td>
<td></td>
<td>message structure, see “Interpreting runtime messages” on page 33.</td>
</tr>
<tr>
<td>User abend code &lt; 4000</td>
<td>• A non-Language Environment abend occurred .</td>
<td>See the Language Environment abend codes in <a href="#">z/OS Language Environment Runtime Messages</a>. Check for a subsystem-generated abend or a user-specified abend.</td>
</tr>
<tr>
<td></td>
<td>• The assembler user exit requested an abend for an unhandled condition of severity ≥2.</td>
<td></td>
</tr>
<tr>
<td>User abend code ≥ 4000</td>
<td>• Language Environment detected an error and could not proceed.</td>
<td>For any abends you receive, read the appropriate explanation listed in the abend</td>
</tr>
<tr>
<td></td>
<td>• An unhandled software-raised condition occurred and ABTERMENC(ABEND) was in</td>
<td>codes section of <a href="#">z/OS Language Environment Runtime Messages</a>.</td>
</tr>
<tr>
<td></td>
<td>effect.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The assembler user exit requested an abend for an unhandled condition of severity 4.</td>
<td></td>
</tr>
<tr>
<td>System abend with TRAP(OFF)</td>
<td>Cause depends on type of malfunction</td>
<td>Respond appropriately. See the messages and codes book of the operating system.</td>
</tr>
<tr>
<td>System abend with TRAP(ON)</td>
<td>System-detected error</td>
<td>See the messages and codes information of the operating system.</td>
</tr>
<tr>
<td>No response (wait/loop)</td>
<td>Application logic failure</td>
<td>Check routine logic. Ensure ERRCOUNT and DEPTHCONDLMT runtime options are set to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a nonzero value.</td>
</tr>
<tr>
<td>Unexpected message (message received was not from most recent service)</td>
<td>Condition caused by something related to current service</td>
<td>Generate a traceback using CEE3DMP.</td>
</tr>
<tr>
<td>Incorrect output</td>
<td>Incorrect file definitions, storage overlay, incorrect routine mask setting, references to uninitialized variables, data input errors, or application routine logic error</td>
<td>Correct the appropriate parameters.</td>
</tr>
<tr>
<td>No output</td>
<td>Incorrect ddname, file definitions, or message file setting</td>
<td>Correct the appropriate parameters.</td>
</tr>
<tr>
<td>Nonzero return code from enclave</td>
<td>Unhandled condition of severity 2, 3, or 4, or the return code was issued by the application routine</td>
<td>Check the Language Environment message file for runtime message.</td>
</tr>
<tr>
<td>Unexpected output</td>
<td>Conflicting library module names</td>
<td>See the name conflict resolution steps outlined in <a href="#">z/OS Language Environment Programming Guide</a>.</td>
</tr>
</tbody>
</table>
Interpreting runtime messages

The first step in debugging your routine is to look up any runtime messages. To find runtime messages, check the message file:

- On z/OS, runtime messages are written by default to ddname SYSOUT. If SYSOUT is not specified, then the messages are written to SYSOUT=*.
- On CICS, the runtime messages are written to the CESE transient data QUEUE.

The default message file ddname can be changed by using the MSGFILE runtime option. For information about displaying runtime messages for C/C++, COBOL, Fortran, or PL/I routines, see z/OS Language Environment Programming Guide.

Runtime messages provide users with additional information about a condition, and possible solutions for any errors that occurred. They can be issued by Language Environment common routines or language-specific runtime routines and contain a message prefix, message number, severity code, and descriptive text.

In the following example Language Environment message:

```
CEE3206S The system detected a specification exception.
```

- The message prefix is CEE.
- The message number is 3206.
- The severity code is S.
- The message text is The system detected a specification exception.

Language Environment messages can appear even though you made no explicit calls to Language Environment services. C/C++, COBOL, and PL/I runtime library routines commonly use the Language Environment services. This is why you can see Language Environment messages even when the application routine does not directly call common runtime services.

Message prefix

The message prefix indicates the Language Environment component that generated the message. The message prefix is the first three characters of the message number and is also the facility ID in the condition token. See the following table for more information about Language Environment runtime messages.

<table>
<thead>
<tr>
<th>Message Prefix</th>
<th>Language Environment Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE</td>
<td>Common run time</td>
</tr>
<tr>
<td>EDC</td>
<td>C/C++ run time</td>
</tr>
<tr>
<td>FOR</td>
<td>Fortran run time</td>
</tr>
<tr>
<td>IBM</td>
<td>PL/I run time</td>
</tr>
<tr>
<td>IGZ</td>
<td>COBOL run time</td>
</tr>
</tbody>
</table>

The messages for the various components can be found in z/OS Language Environment Runtime Messages and in z/OS MVS Diagnosis: Reference.
Message number

The message number is the 4-digit number following the message prefix. Leading zeros are inserted if the message number is less than four digits. It identifies the condition raised and references additional condition and programmer response information.

Severity code

The severity code is the letter following the message number and indicates the level of attention called for by the condition. Messages with severity of I are informational messages and do not usually require any corrective action. In general, if more than one runtime message appears, the first noninformational message indicates the problem. For a complete list of severity codes, severity values, condition information, and default actions, see z/OS Language Environment Programming Guide.

Message text

The message text provides a brief explanation of the condition.

Understanding abend codes

Under Language Environment, abnormal terminations generate abend codes. There are two types of abend codes: 1) user (Language Environment and user-specified) abends and 2) system abends. User abends follow the format of Udddd, where dddd is a decimal user abend code. System abends follow the format of Shhh, where hhh is a hexadecimal abend code. Language Environment abend codes are usually in the range of 4000 to 4095. However, some subsystem abend codes can also fall in this range. User-specified abends use the range of 0 to 3999. The following figure shows examples of abend codes.

- User (Language Environment) abend code:U4041
- User-specified abend code:U0005
- System abend code:S80A

The Language Environment callable service CEE3ABD terminates your application with an abend. You can set the clean-up parameter value to determine how the abend is processed and how Language Environment handles the raised condition. For more information about CEE3ABD and clean-up, see z/OS Language Environment Programming Reference.

You can specify the ABTERMENC runtime option to determine what action is taken when an unhandled condition of severity 2 or greater occurs. For more information on ABTERMENC, see “Establishing enclave termination behavior for unhandled conditions” on page 26, as well as z/OS Language Environment Programming Reference.

User abends

If you receive a Language Environment abend code, see z/OS Language Environment Runtime Messages for a list of abend codes, error descriptions, and programmer responses.
System abends

If you receive a system abend code, look up the code and the corresponding information in the publications for the system you are using.

When a system abend occurs, the operating system can generate a system dump. System dumps are written to ddname SYSMDUMP, SYSABEND, or SYSUDUMP. If the DYNDUMP runtime option is used in combination with the TERMTHDACT runtime option, the system dump can be written without the ddname specified. System dumps show the memory state at the time of the condition. See "Generating a system dump" on page 82 for more information about system dumps.

Using edcmtext to obtain information about errno2 values

Language Environment provides the edcmtext utility (similar to bpxmtext), which allows faster error resolution when an errno2 is encountered in Language Environment. Use the edcmtext utility to display errno2 reason code text. This utility produces a description and action for the errno2 value.

The bpxmtext utility calls edcmtext when the errno2 value is in the range reserved for the C runtime library or edcmtext can be invoked directly with the errno2 value as input.

Format

<table>
<thead>
<tr>
<th>z/OS UNIX environment</th>
<th>TSO/E environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>edcmtext errno2_value</td>
<td>EDCMTEXT errno2_value</td>
</tr>
</tbody>
</table>

Description

The edcmtext utility displays the description and action text for C/C++ runtime library errno2 values, no other values are supported by this command. This command is intended as an aid for problem determination.

The errno2_value is specified as 8 hexadecimal characters.

You can specify one of the following in place of a errno2 value to view a help dialog: -h, help, ?. You can also specify the -U option to display the output in uppercase.

Usage notes

- The errno2_values are also accepted in mixed case and with hex digits prefixed with the "0x".
- The range of values for the C/C++ runtime library is 0XC0000000' through 0XCFFFFFFF'.
- The utility bpxmtext displays the description and action text for reason codes returned from the kernel, in addition to errno2_values returned from the C/C++ runtime library. You should use bpxmtext when the source of the errno2_value is unknown. For more information, see z/OS UNIX System Services Command.

Reference
Message returns

If you specify a -h, help or ? in place of the errno2_value, the following message is displayed:

Usage: edcmtext errno2_value

If no text is available for the errno2_value, the following message is displayed:

errno2_value: No information is currently available for this errno2_value.

If the errno2_value is not comprised of 1-8 hex digits, the following message is displayed:

Usage: edcmtext errno2_value

If the errno2_value is not in the C/C++ runtime library range, the following message is displayed:

Notice: The errno2_value is not in the C/C++ runtime library range.

If edcmtext is not run in a TSO/E or z/OS UNIX environment, the following message is displayed:

Error: The environment is not TSO/E or z/OS UNIX.

Examples

The command edcmtext C00B0021 produces data displayed in the following format:

JrEdclosEinval01: The mode argument passed to fopen() or freopen() did not begin with r, w, or a.
Action: Correct the mode argument. The first keyword of the mode argument must be the open mode. Ensure the open mode is specified first and begins with r, w, or a.
Source: edclopst.c

Exit Values

<table>
<thead>
<tr>
<th></th>
<th>Successful completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Failure due to an argument that is not 1–8 hex digits</td>
</tr>
<tr>
<td>2</td>
<td>Bad Input due to an errno2_value out of the C/C++ runtime range.</td>
</tr>
<tr>
<td>8</td>
<td>Environment not TSO/E or z/OS UNIX</td>
</tr>
<tr>
<td>14</td>
<td>Contact IBM due to Internal Error</td>
</tr>
</tbody>
</table>
Chapter 3. Using Language Environment debugging facilities

This chapter describes methods of debugging routines in Language Environment. Currently, most problems in Language Environment and member language routines can be determined through the use of a debugging tool or through information provided in the Language Environment dump.

Debug tools

Debug tools are designed to help you detect errors early in your routine. IBM offers Debug Tool, a comprehensive compile, edit, and debug product that is provided with the C/C++ for MVS/ESA, COBOL for OS/390 & VM, COBOL for MVS & VM, PL/I for MVS & VM, and VisualAge for Java compiler products. IBM Debug Tool for z/OS is also available as a standalone product for debugging XL C/C++ applications. For more information on Debug Tool, see:

http://www.ibm.com/software/awdtools/debugtool/

You can use the IBM Debug Tool to examine, monitor, and control how your routines run, and debug your routines interactively or in batch mode. Debug Tool also provides facilities for setting breakpoints and altering the contents and values of variables. Language Environment runtime options can be used with Debug Tool to debug or analyze your routine. See the Debug Tool publications for a detailed explanation of how to invoke and run Debug Tool. For more information, see:


You can use IBM WebSphere® Developer Debugger for System z® to get a workstation graphical interface to IBM Debug Tool for z/OS. For more information, see the following URL:


You can also use dbx to debug Language Environment applications, including C/C++ programs. z/OS UNIX System Services Command Reference has information on dbx subcommands, while z/OS UNIX System Services Programming Tools contains usage information.

Language Environment dump service, CEE3DMP

The following sections provide information about using the Language Environment dump service, and describe the contents of the Language Environment dump. The Language Environment dump service can be invoked by the following methods:

- CEE3DMP callable service (non-64-bit only)
- TERMTHDACT runtime option
- HLL-specific functions

Generating a Language Environment dump with CEE3DMP

For non-64-bit, the CEE3DMP callable service generates a dump of the runtime environment for Language Environment and the member language libraries at the point of the CEE3DMP call. You can call CEE3DMP directly from an application routine.
Depending on the CEE3DMP options you specify, the dump can contain information about conditions, tracebacks, variables, control blocks, stack and heap storage, file status and attributes, and language-specific information.

All output from CEE3DMP is written to the default ddname CEEDUMP. CEEDUMP, by default, sends the output to the SDSF output queue. You can direct the output from the CEEDUMP to a specific sysout class by using the environment variable, _CEE_DMPTARG=SYSOUT(x), where x is the output class.

Under z/OS UNIX, if the application is running in an address-space created as a result of a\fork,\spawn,\spawnp,\vfork, or one of the exec family of functions, then the CEEDUMP is placed in the HFS in one of the following directories in the specified order:
1. the directory found in environment variable _CEE_DMPTARG, if found
2. the current working directory, if this is not the root directory (/), the directory is writable, and the CEEDUMP pathname does not exceed 1024 characters.
3. the directory found in environment variable TMPDIR (an environment variable that indicates the location of a temporary directory if it is not /tmp)
4. the /tmp directory.

The syntax for CEE3DMP is:

```
Syntax
>>>CEE3DMP(--title--,--options--,--fc--)<<<
```

**title**

An 80-byte fixed-length character string that contains a title that is printed at the top of each page of the dump.

**options**

A 255-byte fixed-length character string that contains options describing the type, format, and destination of dump information. The options are declared as a string of keywords separated by blanks or commas. Some options also have suboptions that follow the option keyword, and are contained in parentheses. The last option declaration is honored if there is a conflict between it and any preceding options. Table 16 on page 39 lists the CEE3DMP options and related information.

The IBM-supplied default settings for CEE3DMP are:

```
ENCLAVE(ALL) TRACEBACK
THREAD(CURRENT) FILES VARIABLES NOBLOCKS NOSTORAGE
STACKFRAME(ALL) PAGESIZE(60) FNAME(CEEDUMP)
CONDITION ENTRY NOGENOPTS REGSTOR(96)
```

**fc (output)**

A 12-byte feedback token code that indicates the result of a call to CEE3DMP. If specified as an argument, feedback information, in the form of a condition token, is returned to the calling routine. If not specified, and the requested operation was not successfully completed, the condition is signaled to the condition manager.
Table 16 summarizes the dump options available to CEE3DMP. For more information about the CEE3DMP callable service and dump options, see `Language Environment Programming Reference`. For an example of a Language Environment dump, see "Understanding the Language Environment dump" on page 44.

<table>
<thead>
<tr>
<th>Dump Options</th>
<th>Abbreviation</th>
<th>Action Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENCLAVE(ALL)</td>
<td>ENCL</td>
<td>Dumps all enclaves associated with the current process. (In ILC applications in which a C/C++ routine calls another member language routine, and that routine in turn calls CEE3DMP, traceback information for the C/C++ routine is not provided in the dump.) This is the default setting for ENCLAVE.</td>
</tr>
<tr>
<td>ENCLAVE(CURRENT)</td>
<td>ENCL(CUR)</td>
<td>Dumps the current enclave.</td>
</tr>
<tr>
<td>ENCLAVE(n)</td>
<td>ENCL(n)</td>
<td>Dumps a fixed number of enclaves, indicated by n.</td>
</tr>
<tr>
<td>THREAD(ALL)</td>
<td>THR(ALL)</td>
<td>Dumps all threads in this enclave (including in a PL/I multitasking environment).</td>
</tr>
<tr>
<td>THREAD(CURRENT)</td>
<td>THR(CUR)</td>
<td>Dumps the current thread in this enclave.</td>
</tr>
<tr>
<td>TRACEBACK</td>
<td>TRACE</td>
<td>Includes a traceback of all active routines. The traceback shows transfer of control from calls or exceptions. Calls include PL/I transfers of control from BEGIN-END blocks or ON-units.</td>
</tr>
<tr>
<td>NOTRACEBACK</td>
<td>NOTRACE</td>
<td>Does not include a traceback of all active routines.</td>
</tr>
<tr>
<td>FILES</td>
<td>FILE</td>
<td>Includes attributes of all open files. File control blocks are included when the BLOCKS option is also specified. File buffers are included when the STORAGE option is specified.</td>
</tr>
<tr>
<td>NOFILES</td>
<td>NOFILE</td>
<td>Does not include file attributes.</td>
</tr>
<tr>
<td>VARIABLES</td>
<td>VAR</td>
<td>Includes a symbolic dump of all variables, arguments, and registers.</td>
</tr>
<tr>
<td>NO VARIABLES</td>
<td>NOVAR</td>
<td>Does not include variables, arguments, and registers.</td>
</tr>
<tr>
<td>BLOCKS</td>
<td>BLOCK</td>
<td>Dumps control blocks from Language Environment and member language libraries. Global control blocks, as well as control blocks associated with routines on the call chain, are printed. Control blocks are printed for the routine that called CEE3DMP. The dump proceeds up the call chain for the number of routines specified by the STACKFRAME option. Control blocks for files are also dumped if the FILES option was specified. See the FILES option above for more information. If the TRACE runtime option is set to ON, the trace table is dumped if BLOCKS is specified. If the Heap Storage Diagnostics report is requested using the HEAPCHK runtime option, the report is displayed when BLOCKS is specified.</td>
</tr>
<tr>
<td>NO BLOCKS</td>
<td>NOBLOCK</td>
<td>Does not include control blocks.</td>
</tr>
<tr>
<td>STORAGE</td>
<td>STOR</td>
<td>Dumps the storage used by the routine. The number of routines dumped is controlled by the STACKFRAME option.</td>
</tr>
<tr>
<td>NOSTORAGE</td>
<td>NOSTOR</td>
<td>Suppresses storage dumps.</td>
</tr>
</tbody>
</table>
### Table 16. CEE3DMP options (continued)

<table>
<thead>
<tr>
<th>Dump Options</th>
<th>Abbreviation</th>
<th>Action Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>STACKFRAME(ALL)</td>
<td>SF(ALL)</td>
<td>Dumps all stack frames from the call chain. This is the default setting for STACKFRAME.</td>
</tr>
<tr>
<td>STACKFRAME(n)</td>
<td>SF(n)</td>
<td>Dumps a fixed number of stack frames, indicated by n, from the call chain. The specific information dumped for each stack frame depends on the VARIABLES, BLOCK, and STORAGE options declarations. The first stack frame dumped is the caller of CEE3DMP, followed by its caller, and proceeding backward up the call chain.</td>
</tr>
<tr>
<td>PAGESIZE(n)</td>
<td>PAGE(n)</td>
<td>Specifies the number of lines, n, on each page of the dump.</td>
</tr>
<tr>
<td>FNAME(s)</td>
<td>FNAME(s)</td>
<td>Specifies the ddname of the file to which the dump is written.</td>
</tr>
<tr>
<td>CONDITION</td>
<td>COND</td>
<td>Dumps condition information for each condition active on the call chain.</td>
</tr>
<tr>
<td>NOCONDITION</td>
<td>NOCOND</td>
<td>For each condition active on the call chain, does not dump condition information.</td>
</tr>
<tr>
<td>ENTRY</td>
<td>ENT</td>
<td>Includes a description of the program unit that called CEE3DMP and the registers on entry to CEE3DMP.</td>
</tr>
<tr>
<td>NOENTRY</td>
<td>NOENT</td>
<td>Does not include a description of the program unit that called CEE3DMP or registers on entry to CEE3DMP.</td>
</tr>
<tr>
<td>GENOPTS</td>
<td>GENO</td>
<td>Generates a runtime options report in the dump output. This will be the default if an unhandled condition occurs, and a CEEDUMP is generated due to the setting of the TERMTHDACT runtime option setting.</td>
</tr>
<tr>
<td>NOGENOPTS</td>
<td>NOGENO</td>
<td>Does not generate a runtime options report in the dump output. NOGENOPTS is the default for user-called dumps.</td>
</tr>
<tr>
<td>REGSTOR(reg_stor_amount)</td>
<td>REGST(reg_stor_amount)</td>
<td>Controls the amount of storage to be dumped around registers. Default is 96 bytes. Specify REGSTOR(0) if no storage around registers is required.</td>
</tr>
</tbody>
</table>

---

### Generating a Language Environment dump with TERMTHDACT

The TERMTHDACT runtime option produces a dump during program checks, abnormal terminations, or calls to the CEESGL service. You must use TERMTHDACT(DUMP) in conjunction with TRAP(ON) to generate a Language Environment dump. You can use TERMTHDACT to produce a traceback, Language Environment dump, or user address space dump when a thread ends abnormally because of an unhandled condition of severity 2 or greater. If this is the last thread in the process, the enclave goes away. A thread terminating in a non-POSIX environment is analogous to an enclave terminating because Language Environment Version 1 supports only single threads. For information on enclave termination, see [z/OS Language Environment Programming Guide](https://www.ibm.com/support/docview.wss?uid=swg27044763).

The TERMTHDACT suboptions QUIET, MSG, TRACE, DUMP, UAONLY, UATRACE, UADUMP, and UAIMM control the level of information available. Table 17 on page 41 lists the suboptions, the levels of information produced, and the destination of each.
Table 17. TERMTHDACT suboptions, level of information, and destinations

<table>
<thead>
<tr>
<th>Suboption</th>
<th>Level of Information</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUIET</td>
<td>No information</td>
<td>No destination.</td>
</tr>
<tr>
<td>MSG</td>
<td>Message</td>
<td>Terminal or ddname specified in MSGFILE runtime option.</td>
</tr>
<tr>
<td>TRACE</td>
<td>Message and Language Environment dump containing only a traceback</td>
<td>Message goes to terminal or ddname specified in MSGFILE runtime option. Traceback goes to CEEDUMP file.</td>
</tr>
<tr>
<td>DUMP</td>
<td>Message and complete Language Environment dump</td>
<td>Message goes to terminal or ddname specified in MSGFILE runtime option. Language Environment dump goes to CEEDUMP file.</td>
</tr>
<tr>
<td>UAONLY</td>
<td>SYSMDUMP, SYSABEND dump, or SYSUDUMP depending on the DD card used in the JCL in z/OS. In CICS, a transaction dump is created. In non-CICS you will get a system dump of your user address space if the appropriate DD statement is used. Note: A Language Environment dump is not generated.</td>
<td>Language Environment generates a U4039 abend which allows a system dump of the user address space to be generated. For z/OS, the system dump is written to the ddname specified; for CICS the transaction dump goes to DFHDMPA or the DFHDMPB data set.</td>
</tr>
<tr>
<td>UATRACE</td>
<td>Message, Language Environment dump containing only a traceback, and a system dump of the user address space</td>
<td>Message goes to terminal or ddname specified in MSGFILE runtime option. Traceback goes to CEEDUMP file. Language Environment generates a U4039 abend which allows a system dump of the user address space to be generated. For z/OS, the system dump is written to the ddname specified; for CICS the transaction dump goes to DFHDMPA or the DFHDMPB data set.</td>
</tr>
<tr>
<td>UADUMP</td>
<td>Message, Language Environment dump, and SYSMDUMP, SYSABEND dump, or SYSUDUMP depending on the DD card used in the JCL in z/OS. In CICS, a transaction dump is created.</td>
<td>Message goes to terminal or ddname specified in MSGFILE runtime option. Language Environment dump goes to CEEDUMP file. Language Environment generates a U4039 abend which allows a system dump of the user address space to be generated. For z/OS, the system dump is written to the ddname specified; for CICS the transaction dump goes to DFHDMPA or the DFHDMPB data set.</td>
</tr>
<tr>
<td>UAIMM</td>
<td>Language Environment generates a system dump of the original abend/program interrupt of the user address space. In CICS, a transaction dump is created. In non-CICS you will get a system dump of your user address space if the appropriate DD statement is used. After the dump is taken by the operating system, Language Environment condition manager continues processing. Note: Under CICS, UAIMM yields UAONLY behavior. Under non-CICS, TRAP(ON,NOSPIE) must be in effect. When TRAP(ON,SPIE) is in effect, UAIMM yields UAONLY behavior. For software raised conditions or signals, UAIMM behaves the same as UAONLY.</td>
<td>Message goes to terminal or ddname specified in MSGFILE runtime option. User address space dump goes to ddname specified for z/OS; or a CICS transaction dump goes to the DFHDMPA or DFHDMPB data set.</td>
</tr>
</tbody>
</table>

The TRACE and UATRACE suboptions of TERMTHDACT use these dump options:
The DUMP and UADUMP suboptions of TERMTHDACT use these dump options:
- BLOCKS
- CONDITION
- ENCLAVE(ALL)
- FILES
- FNAME(CEEDUMP)
- GENOPTS
- NOBLOCKS
- NOENTRY
- NOSTORAGE
- STACKFRAME(ALL)
- THREAD(ALL)
- TRACEBACK
- VARIABLES

Although you can modify CEE3DMP options, you cannot change options for a traceback or dump produced by TERMTHDACT.

**Considerations for setting TERMTHDACT options**

The output of TERMTHDACT may vary depending upon which languages and subsystems are processing the request. This section describes the considerations associated with issuing the TERMTHDACT suboptions. For more information about the TERMTHDACT runtime option, see [z/OS Language Environment Programming Reference](#).

- **COBOL Considerations**
  The following TERMTHDACT suboptions for COBOL are recommended: UAONLY, UATRACE, and UADUMP. A system dump will always be generated when one of these suboptions is specified.

- **PL/I Considerations**
  After a normal return from a PL/I ERROR ON-unit, or from a PL/I FINISH ON-unit, Language Environment considers the condition unhandled. If a GOTO is not performed and the resume cursor is not moved, then the thread terminates. The TERMTHDACT setting guides the amount of information that is produced, so the message is not presented twice.

- **PL/I MTF Considerations**
  TERMTHDACT applies to a task that terminates abnormally due to an unhandled condition of severity 2 or higher that is percolated beyond the initial routine's stack frame. All active subtasks that were created from the incurring task will terminate abnormally, but the enclave will continue to run.

- **z/OS UNIX Considerations**
  - The TERMTHDACT option applies when a thread terminates abnormally. Abnormal termination of a single thread causes termination of the entire
enclave. If an unhandled condition of severity 2 or higher percolates beyond
the first routine’s stack frame the enclave terminates abnormally.

- If an enclave terminates due to a POSIX default signal action, then
  TERMTHDACT applies to conditions that result from software signals,
  program checks, or abends.
- If running under a shell and Language Environment generates a system
dump, then a storage dump is generated to a file based on the kernel
environment variable, _BPXK_MDUMP.

- CICS Considerations
  - TERMTHDACT output is written to a transient data queue named CESE, or
to the CICS transaction dump, depending on the setting of the
  CESE|CICSDDS suboption of the TERMTHDACT runtime option. Table 18
  shows the behavior of CESE|CICSDDS when they are used with the other
  suboptions of TERMTHDACT.
  - Because Language Environment does not own the ESTAE, the suboption
    UAIMM will be treated as UAONLY.
  - All associated Language Environment dumps will be suppressed if
    termination processing is the result of an EXEC CICS ABEND with NODUMP.
  - Program checks and other abends will cause CICS to produce a CICS
    transaction dump.

Table 18. Condition handling of 0Cx abends

<table>
<thead>
<tr>
<th>Options</th>
<th>TERMTHDACT(X,CESE,)</th>
<th>TERMTHDACT(X,CICSDDS,)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUIET</td>
<td>No output.</td>
<td>No output.</td>
</tr>
<tr>
<td>MSG</td>
<td>Message written to CESE queue or MSGFILE.</td>
<td>Message written to CESE queue or MSGFILE.</td>
</tr>
<tr>
<td>TRACE</td>
<td>The traceback is written to the CESE queue, followed by U4038 abend with nodump option.</td>
<td>Language Environment will write traceback, variables, COBOL working storage, C writeable static. The member handlers will be invoked to provide the desired output to the new transaction server queue (which CICS will read and write to CICS transaction dump later).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U4039 abend to force CICS transaction dump followed by U4038 abend with nodump option.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Message to CESE or MSGFILE.</td>
</tr>
<tr>
<td>DUMP</td>
<td>CEEDUMP to CESE queue followed by U4038 abend with nodump option.</td>
<td>CEEDUMP to new transaction server queue which CICS will read and write to CICS transaction dump later.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U4039 abend to force CICS transaction dump followed by U4038 abend with nodump option.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Message to CESE or MSGFILE.</td>
</tr>
<tr>
<td>UATRACE</td>
<td>U4039 abend with traceback to CESE queue followed by U4038 abend with nodump option.</td>
<td>Language Environment will write traceback, variables, COBOL working storage, C writeable statics. The member handlers will be invoked to provide the desired output to the new transaction server queue (which CICS will read and write to CICS transaction dump later).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U4039 abend to force CICS transaction dump followed by U4038 abend with nodump option.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Message to CESE or MSGFILE.</td>
</tr>
</tbody>
</table>
### Generating a Language Environment dump with language-specific functions

In addition to the CEE3DMP callable service and the TERMTHDACT runtime option, you can use language-specific routines such as C functions, the Fortran SDUMP service, and the PL/I PLIDUMP service to generate a dump.

C/C++ routines can use the functions cdump(), csnap(), and ctrace() to produce a Language Environment dump. All three functions call the CEE3DMP callable service, and each function includes an options string consisting of different CEE3DMP options that you can use to control the information contained in the dump. For more information on these functions, see “Generating a Language Environment dump of a C/C++ routine” on page 182.

Fortran programs can call SDUMP, DUMP/PDUMP, or CDUMP/CPDUMP to generate a Language Environment dump. CEE3DMP cannot be called directly from a Fortran program. For more information on these functions, see “Generating a Language Environment dump of a Fortran routine” on page 253.

PL/I routines can call PLIDUMP instead of CEE3DMP to produce a dump. PLIDUMP includes options that you can specify to obtain a variety of information in the dump. For a detailed explanation about PLIDUMP, see “Generating a Language Environment dump of a PL/I for MVS & VM routine” on page 274.

### Understanding the Language Environment dump

The Language Environment dump service generates output of data and storage from the Language Environment runtime environment on an enclave basis. This output contains the information needed to debug most basic routine errors.

This sample illustrates a dump for enclave main. The example assumes full use of the CEE3DMP dump options. Ellipses are used to summarize some sections of the dump and information regarding unhandled conditions may not be present at all. Sections of the dump are numbered to correspond with the descriptions given in “Sections of the Language Environment dump” on page 56.

The CEE3DMP was generated by the C program CELSAMP shown in Figure 8 on page 45. CELSAMP uses the DLL CELDLL shown in Figure 11 on page 48.
#pragma options(SERVICE("1.1.d"),NOOPT,TEST(SYM))
#pragma runopts(TERMTHDACT(UADUMP),POSIX(ON),DYNDUMP(DYNAMIC,))
#pragma runopts(TRACE(ON,IM,NODUMP,LE=1),HEAPCHK(ON,1,0,10))
#pragma runopts(RPTSTG(ON),HEAPPOOLS(ON))
#define _OPEN_THREADS
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#include <dll.h>
#include <signal.h>
#include <leawi.h>
#include <ceeedcct.h>

pthread_mutex_t mut;
pthread_t thread[2];
int threads_joined = 0;
char * t1 = "Thread 1";
char * t2 = "Thread 2";

.AddListener(thread_cleanup(_FEEDBACK *cond,_INT4 *input_token,
                          _INT4 *result, _FEEDBACK *new_cond) {

    /* values for handling the conditions */
    #define percolate 20

    printf(">>> Thread_CleanUp: Msg # is %d\n",cond->tok_msgno);
    if (!threads_joined) {
        printf(">>> Thread_CleanUp: Unlocking mutex\n");
        pthread_mutex_unlock(&mut);
        printf(">>> Thread_CleanUp: Joining threads\n");
        if (pthread_join(thread[0],NULL) == -1 )
            perror("Join of Thread #1 failed");
        if (pthread_join(thread[1],NULL) == -1 )
            perror("Join of Thread #2 failed");
        threads_joined = 1;
    }
    *result = percolate;
    printf(">>> Thread_CleanUp: Percolating condition\n");
}

.AddListener(thread_func(void *parm) {
    printf(">>> Thread_func: %s locking mutex\n",parm);
    pthread_mutex_lock(&mut);
    printf(">>> Thread_func: %s exiting\n",parm);
    pthread_exit(NULL);
})

Figure 8. The C program CELSAMP

Chapter 3. Using Language Environment debugging facilities 45
main()
{
dllhandle * handle;
int i = 0;
FILE* fp1;
FILE* fp2;
_FEEDBACK fc;
_INT4 token;
_ENTRY pgmptr;

printf("Init MUTEX...
");
if (pthread_mutex_init(&mut, NULL) == -1) {
    perror("Init of mut failed");
    exit(101);
}

printf("Lock Mutex Lock...
");
if (pthread_mutex_lock(&mut) == -1) {
    perror("Lock of mut failed");
    exit(102);
}

printf("Create 1st thread...
");
if (pthread_create(&thread[0],NULL,thread_func,(void *)t1) ==
-1) {
    perror("Could not create thread #1");
    exit(103);
}

printf("Create 2nd thread...
");
if (pthread_create(&thread[1],NULL,thread_func,(void *)t2) ==
-1) {
    perror("Could not create thread #2");
    exit(104);
}
printf("Register thread cleanup condition handler...
");
pgmptr.address = (_POINTER)thread_cleanup;
pgmptr.nesting = NULL;
token = 1;
CEEHDLR(&pgmptr, &token, &fc);
if (FBCHECK (fc, CEE000 ) != 0 ) {
    printf( "CEEHDLR failed with message number %d\n",fc.tok_msgno);
    exit(105);
}

printf("Load DLL...
");
handle = dllload("CELDLL");
if (handle == NULL) {
    perror("Could not load DLL CELDLL");
    exit(106);
}

printf("Query DLL with incorrect function name...
");
pgmptr.address = (_POINTER)dllqueryfn(handle,"name_not_in_dll");
if (pgmptr.address != NULL) {
    perror("Found incorrect function name in DLL");
    exit(111);
}

printf("Query DLL...
");
pgmptr.address = (_POINTER)dllqueryfn(handle,"dump_n_perc");
if (pgmptr.address == NULL) {
    perror("Could not find dump_n_perc");
    exit(107);
}
printf("Register condition handler...\n");
pgmptr.nesting = NULL;
token = 2;
CEEHDLR (&pgmptr, &token, &fc);
if ( _FBCHECK ( fc , CEE000 ) != 0 ) {
    printf("CEEHDLR failed with message number \d\n", fc.tok_msgno);
    exit(108);
}

printf("Write to some files...\n");
fp1 = fopen("myfile.data", "w");
if (!fp1) {
    perror("Could not open myfile.data for write");
    exit(109);
}
fprintf(fp1, "record 1\n");
fprintf(fp1, "record 2\n");
fprintf(fp1, "record 3\n");

fp2 = fopen("memory.data", "wb,type=memory");
if (!fp2) {
    perror("Could not open memory.data for write");
    exit(112);
}
fprintf(fp2, "some data");
fprintf(fp2, "some more data");
fprintf(fp2, "even more data");

printf("Divide by zero...\n");
i = 1/i;
printf("Error -- Should not get here\n");
exit(110);
}

Figure 10. The C program CELSAMP (continued)
/* DLL containing Condition Handler that takes dump and percolates */
#pragma options(SERVICE("1.3.b"),TEST(SYM),NOOPT)
#pragma export(dump_n_perc)
#include <stdio.h>
#include <leawi.h>
#include <stdlib.h>
#include <string.h>
#include <ceeedcct.h>

char wsa_array[10] = { 'C','E','L','D','L',' ','W','S','A'};
#define OPT_STR "THREAD(ALL) BLOCKS STORAGE GENOPTS"
#define TITLE_STR "Sample dump produced by calling CEE3DMP"

void dump_n_perc(_FEEDBACK *cond, _INT4 *input_token, 
                 _INT4 *result, _FEEDBACK *new_cond) { 

    /* values for handling the conditions */
    #define percolate 20

    _CHAR80 title;
    _CHAR255 options;
    _FEEDBACK fc;

    printf(">>> dump_n_perc: Msg # is %d\n", cond->tok_msgno);

    /* check if the DIVIDE-BY-ZERO message (0C9) */
    if (cond->tok_msgno == 3209) {
        memset(options, ' ', sizeof(options));
        memcpy(options, OPT_STR, sizeof(OPT_STR) - 1);

        memset(title, ' ', sizeof(title));
        memcpy(title, TITLE_STR, sizeof(TITLE_STR) - 1);

        printf(">>> dump_n_perc: Taking dump\n");
        CEE3DMP(title, options, &fc);
        if ( _FBCHECK ( fc , CEE000 ) != 0 ) {
            printf("CEE3DMP failed with msgno %d\n", fc.tok_msgno);
            exit(299);
        }
    }
    *result = percolate;
    printf(">>> dump_n_perc: Percolating condition\n");
}

Figure 11. The C DLL CELDLL

For easy reference, the sections of the following dump are numbered to correspond with the descriptions in "Sections of the Language Environment dump" on page 56.
Chapter 3. Using Language Environment debugging facilities
Condition Information for //’POSIX.CRTL.C(CELSAMP)’ (DSA address 265E9208)
CIB Address: 265EA5D8
Current Condition:
CEE3209S The system detected a fixed-point divide exception (System Completion Code=0C9).
Location:
Program Unit: //’POSIX.CRTL.C(CELSAMP)’
Entry:
main Statement: 150 Offset: +000009BA
Machine State:
ILC..... 0002
Interruption Code..... 0009
PSW..... 078D2400 A5E00A7C
GPR0..... 00000000_00000000 GPR1..... 00000000_A647FE0A GPR2..... 00000000_265E92C5 GPR3.....
GPR4..... 00000000_265E92C2 GPR5..... 00000000_25E00ED0 GPR6..... 00000000_00000000 GPR7.....
GPR8..... 00000000_00000030 GPR9..... 00000000_80000000 GPR10.... 00000000_A659CF62 GPR11....
GPR12.... 00000000_25E16B48 GPR13.... 00000000_265E9208 GPR14.... 00000000_A5E00A66 GPR15....

00000000_25E000FA
00000000_00000001
00000000_A5E92F60
00000000_00000012

Storage dump near condition, beginning at location: 25E00A6A
+000000 25E00A6A 4400C1AC 5800D0AC 41600001 8E600020 1D601807 5000D0AC 4400C1AC 58F039E2 |..A......-...-...-..&.....A..0.S|
GPREG STORAGE:
Storage around GPR0 (00000000)
+0000 00000000
Inaccessible storage.
+0020 00000020
Inaccessible storage.
+0040 00000040
Inaccessible storage.
.
.
.
[9]Parameters, Registers, and Variables for Active Routines:
dump_n_perc (DSA address 265ECE90):
UPSTACK DSA
Parameters:
new_cond
struct _FEEDBACK *
0x25E0EA5C
result

signed long int *

input_token

signed long int *

cond

struct _FEEDBACK *

0x265EA6C4
0x265EA6B8
0x265EA5F0
Saved Registers:
GPR0..... 265ED088 GPR1..... 265ECF28 GPR2..... 265ECF88 GPR3..... 2699A0FA
GPR4..... 265ECF38 GPR5..... 2699A330 GPR6..... 00000002 GPR7..... 25E0E410
GPR8..... A5ECD622 GPR9..... 265E6148 GPR10.... 265EACDF GPR11.... A5F97290
GPR12.... 25E16B48 GPR13.... 265ECE90 GPR14.... A699A1F0 GPR15.... A5EF8428
GPREG STORAGE:
Storage around GPR0 (265ED088)
-0020 265ED068 40404040 40404040 40404040 40404040 40404040 40404040 40404040 404040CC |
.
.
.
Local Variables:
title[0..6]
unsigned char
title[7..13]
title[14..20]
title[21..27]
title[28..34]
title[35..41]
title[42..48]
title[49..55] to title[70..76]
title[77..79]
options[0..6]
unsigned char
options[7..13]

’S’
’a’
’m’
’d’
’u’
’m’
’o’
’d’
’u’
’b’
’y’
’ ’
’i’
’n’
’g’
’3’
’D’
’M’
’ ’
’ ’
’ ’
elements same as above.
’ ’
’ ’
’ ’
’T’
’H’
’R’
’A’
’L’
’L’

options[14..20]
’O’
’C’
’K’
options[21..27]
’O’
’R’
’A’
options[28..34]
’E’
’N’
’O’
options[35..41]
’ ’
’ ’
’ ’
options[42..48] to options[245..251] elements same as
options[252..254]
’ ’
’ ’
’ ’
fc
struct _FEEDBACK
tok_sev
signed short int -13108
tok_msgno
signed short int -13108
tok_case
unsigned:2
3
tok_sever
unsigned:3
1
tok_ctrl
unsigned:3
4
tok_facid[0..2] unsigned char
’\xCC’ ’\xCC’ ’\xCC’
tok_isi
signed int
-858993460
__func__[0..6] static unsigned char
’d’
’u’
’m’
__func__[7..11]
’p’
’e’
’r’

’p’
’p’
’c’
’c’
’ ’
’P’
’ ’

’l’
’ ’
’e’
’a’
’C’
’ ’
’ ’

’e’
’p’
’d’
’l’
’E’
’ ’
’ ’

’ ’
’r’
’ ’
’l’
’E’
’ ’
’ ’

’E’
’)’

’A’
’ ’

’D’
’B’

’(’
’L’

’S’
’G’
’P’
’ ’
above.

’ ’
’E’
’T’
’ ’

’S’
’ ’
’S’
’ ’

’T’
’G’
’ ’
’ ’

’p’
’c’

’_’
’\0’

’n’

’_’

.
.
.
main (DSA address 265E9208):
UPSTACK DSA
Saved Registers:
GPR0..... 00000000 GPR1.....
GPR4..... 265E92C2 GPR5.....
GPR8..... 00000030 GPR9.....
GPR12.... 25E16B48 GPR13....

50

A647FE0A
25E00ED0
80000000
265E9208

GPR2.....
GPR6.....
GPR10....
GPR14....

265E92C5
00000000
A659CF62
A5E00A66

z/OS V2R1.0 Language Environment Debugging Guide

GPR3.....
GPR7.....
GPR11....
GPR15....

25E000FA
00000001
A5E92F60
00000012

.|


Storage for Active Routines:

GPREG STORAGE:

DSA for main:

DSA for dump_n_perc:

DSA for CEE3DMP:

DSA for main:

CIB for main:

Storage for Active Routines:

DSA frame:

DSA frame:

DSA frame:

Chapter 3. Using Language Environment debugging facilities 51
[12] Control Blocks Associated with the Thread:

CAA: 25E16B48

Thread Synchronization Queue Element (SQEL): 25E0F158

CEEDLLF: 26999C28

DUMMY DSA: 25E175F0

[6] Information for thread 2625970000000001

Registers on Entry to CEE3DMP:

PM........ 0100
GPR0...... 00000000_00000001 GPR1...... 26935D78 GPR2...... 2671C43C GPR3...... 26935D78
GPR4...... D96CA288 GPR5...... 00000000 GPR6...... 265E61A0 GPR7...... 2660A930
GPR8...... 265E90EB GPR9...... 00000000_265E90EB GPR10..... 8000D5D7 GPR11..... 8000C5D8
GPR12..... 26936BD8 GPR13..... 26938090 GPR14..... A6411BDE GPR15..... 808E6648
FPR0..... 4D000000 00000BD1 FPR2..... 00000000 00000000
FPR4..... 00000000 00000000 FPR6..... 00000000 00000000

GPREG STORAGE:

Storage around GPR0 (00000001)
-0001 00000000 Inaccessible storage.
+001F 00000020 Inaccessible storage.
+003F 00000040 Inaccessible storage.

[7] Traceback:

DSA Entry E Offset Statement Load Mod Program Unit Service Status
1 CEEOPML2 +00000F90 CEEOPLKA CEEOPML2 HLE7770 Call
2 EDDOMP2 +00000F38 CEEDDOM2 Cal
3 thread_func +000000AE 47 CELSAMP CELSAMP I.1.0 Call
4 CEEOPPLM +000000B6 CEEDOMT CEEOPPLM Call

DSA DSA Addr E Addr PU Addr PU Offset Comp Date Compile Attributes
1 26938090 25F5E148 25F5E148 +00000F90 20100319 CEL POSIX
2 26937DE0 26410CA4 2640FAB0 +00000210C 20100319 LIBRARY POSIX
3 26937D06 25E00DAE 265E9090 +000000AE 20070105 C/C++ POSIX EBCDIC HFP
4 2697DFF0 0000C5D8 0000C5D8 +000000B6 20100319 CEL POSIX

Fully Qualified Names

DSA Entry Program Unit Load Module
3 thread_func //POSIX.CRTL.C(CELSAMP).CELSAMP

[9] Parameters, Registers, and Variables for Active Routines:

CEEOPML2 (DSA address 26938090):

UPSTACK DSA
Saved Registers:

thread_func (DSA address 26937D06):

UPSTACK DSA
Parameters:
parm void * 0x25E00ED0
Saved Registers:
Control Blocks for Active Routines:
DSA for CEEOPML2: 26938090
+000000 FLAGS.... 000000 member... CCCC BKC...... 26938090 FMC...... 26938210 R14...... ASF5E76
+000010 R15...... ASF6098E R0...... 25F5F204 R1...... 26738114 R2...... 2671C43C R3...... 26935D78
+000024 R4...... 00000000 R5...... 2660A954 R6...... 265E61A0 R7...... 2660A930 R8...... 25E00ED0

Storage for Active Routines:
DSA frame: 26937DE0
+000000 26938090 10CCCCCC 26937D38 26938090 A6411BDE A5F5E148 25F5F2D4 25E0F158 265E61A0
+000020 26937E00 25E00E52 26937D38 25E00ED0 269378A0 26613128 00000000 00000080 CCCCCCCC

Control Blocks Associated with the Thread:
CAA: 26936BD8
+000000 26936BD8 00000800 00000000 26937D20 00000000 00000000 00000000 00000000
+000020 26936BF8 00000000 00000000 00000000 00000000 00000000 00000000 00000000

Enclave variables:

Thread Synchronization Enclave Latch Table (EPALT): 2671C544
+000000 2671C544 00000000 00000000 00000000 00000000 00000000 00000000 00000000
+000020 2671C564 - +00009F 2671C5E3 same as above
+0000A0 2671C5E4 00000000 00000000 00000000 00000000 00000000 00000000 00000000
+0000B0 2671C5E8 00000000 00000000 00000000 00000000 00000000 00000000 00000000

Chapter 3. Using Language Environment debugging facilities
**DLL Information:**

- **WSA Addr**
- **Module Addr**
- **Thread ID**
- **Use Count**
- **Name**

<table>
<thead>
<tr>
<th>DLL Information</th>
<th>WSA Addr</th>
<th>Module Addr</th>
<th>Thread ID</th>
<th>Use Count</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2660AB50</td>
<td>2699A0000</td>
<td></td>
<td></td>
<td>CELDLL</td>
</tr>
</tbody>
</table>

**HEAPCHK Option Control Block (HCOP):**

```
Address Seg Addr Length Address Seg Addr Length
Table: 265E50D0 +000000 265E50D0 C8C3D6D7 00000048 00000001 00000000 0000000A 0000000A AAAAAA |HCOP............................|
```

**HEAPCHK Element Table (HCEL) for Heapid 269D9F9C:**

```
Header: 269E0028 +000000 269E0028 C8C3C5D3 2699D028 00000026 00000006 00000006 00000000 |HCEL.r.............4............|
```

**Address Seg Addr Length Address Seg Addr Length Table:**

```
+000000 269E0048 269DF020 269DF000 00000050 269A2878 269DF070 269DF000 00000028 269A2BF0 |..0...0....&......0...0.........|
```

**HEAPCHK Element Table (HCEL) for Heapid 26999FCC:**

```
Header: 2699D028 +000000 2699D028 C8C3C5D3 265E6228 2699D028 000001F4 00000001 00000001 00000000 |HCEL.;.......r.....4............|
```

**Address Seg Addr Length Address Seg Addr Length Table:**

```
+000000 2699D048 2699C020 2699C000 000002A8 2698E0E0 00000000 00000000 00000000 00000000 |.r...r.....y.q..................|
```

**HEAPCHK Element Table (HCEL) for Heapid 00000000:**

```
Header: 265E6228 +000000 265E6228 C8C3C5D3 00000000 2699D028 00000000 000001F4 00000005 00000005 00000000 |HCEL.....r.........4............|
```

**Address Seg Addr Length Address Seg Addr Length Table:**

```
+000000 265E6248 26609038 26609018 00001030 265E8190 2660A068 26609018 00000828 265E8258 |.-...-.......;a..-...-.......;b.|
```

**WSA address.................265E6148**

**Heap Storage Diagnostics**

<table>
<thead>
<tr>
<th>Stg Addr</th>
<th>ID</th>
<th>Length</th>
<th>Entry</th>
<th>E Addr</th>
<th>E Offset</th>
<th>Load Mod</th>
</tr>
</thead>
<tbody>
<tr>
<td>269DF020</td>
<td>00000050</td>
<td>CEEVGT5</td>
<td>25FC9358</td>
<td>+00000000</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>CEEVGTST</td>
<td>25FC9328</td>
<td>+000001E3</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>Identify_cu</td>
<td>25FC9328</td>
<td>+000001E3</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>SetDumpYars</td>
<td>263A28C8</td>
<td>+00000000</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>_zdpd</td>
<td>26584CB0</td>
<td>+00000000</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>CEEKDMP</td>
<td>263A28C8</td>
<td>+00000000</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>CEEKDUMP</td>
<td>263A28C8</td>
<td>+00000000</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>dump_n_perc</td>
<td>2699AC0</td>
<td>+0000000E</td>
<td>CELDDL</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>CEEFDINT</td>
<td>2697290</td>
<td>+0000005A</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>CEEKDMP</td>
<td>263A28C8</td>
<td>+00000000</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>CEEKDUMP</td>
<td>263A28C8</td>
<td>+00000000</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>dump_n_perc</td>
<td>2699AC0</td>
<td>+0000001E</td>
<td>CELDDL</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>CEEFDINT</td>
<td>2697290</td>
<td>+0000005A</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>CEEKDMP</td>
<td>263A28C8</td>
<td>+00000000</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>CEEKDUMP</td>
<td>263A28C8</td>
<td>+00000000</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>dump_n_perc</td>
<td>2699AC0</td>
<td>+0000001E</td>
<td>CELDDL</td>
<td></td>
</tr>
<tr>
<td>269DF000</td>
<td>00000000</td>
<td>CEEFDINT</td>
<td>2697290</td>
<td>+0000005A</td>
<td>CEEPLPKA</td>
<td></td>
</tr>
</tbody>
</table>

**Language Environment Trace Table:**

**Most recent trace entry is at displacement: 002980**

```
Displacement Trace Entry in Hexadecimal Trace Entry in EBCDIC
000000 Time 15.25.14.872201 Date 2010.04.07 Thread ID... 2625860000000000
+000010 Member ID.... 03 Flags..... 000000 Entry Type..... 00000001
+000010 94818995 40404040 40404040 40404040 40404040 40404040 40404040 40404040 |main |
+000030 60606D40 40805D50 40979989 40805D50 45404040 45404040 45404040 45404040 |<--(085) printf()|
+000050 45404040 45404040 45404040 45404040 45404040 45404040 45404040 45404040 |
```

```
Displacement Trace Entry in Hexadecimal Trace Entry in EBCDIC
000000 Time 15.25.14.998940 Date 2010.04.07 Thread ID... 2625860000000000
+000010 Member ID.... 03 Flags..... 000000 Entry Type..... 00000002
+000010 4C60604D F0F8F55D 40D9F1F5 00000000 00000009 F0F0F0 40000000 40000000 |
```

**Language Environment Debugging Guide**

54 z/OS V2R1.0 Language Environment Debugging Guide
Enclave Storage:
Initial (User) Heap: 26609018
LE/370 Anywhere Heap: 265E5000
Additional Heap, heapid = 269DF9C: 269DF000

File Status and Attributes:

Chapter 3. Using Language Environment debugging facilities

IBM-supplied default:
- ABPERC(NONE)
- ABTERMENC(ABEND)
- NOAXSLD
- ALL11(ON)
- ANYHEAP(16384,8192,ANYWHERE,FREE)
- NOAUTOTASK
- BELOWHEAP(16384,4096,FREE)
- CBLOPTS(ON)
- CBLSHPFOP(ON)
- CBLOAD(OF1)
- NOFILE
- DEPTHCONDLMT(10)
- DYNLOAD(POSIX,DEBBUG,HLE7770,DYNAMIC)
- ENVAR(**)
- ERRCOUNT(0)
- ERRUNIT(6)
- FILEHIST
- FILETAG(NOAUTOCVT,NOAUTOTAG)
- NOFLOW
- HEAP(32768,32768,ANYWHERE,KEEP,8192,4096)

Last Where SET OPTION

IBM-supplied default:
- ABPERC(NONE)
- ABTERMENC(ABEND)
- NOAXSLD
- ALL11(ON)
- ANYHEAP(16384,8192,ANYWHERE,FREE)
- NOAUTOTASK
- BELOWHEAP(16384,4096,FREE)
- CBLOPTS(ON)
- CBLSHPFOP(ON)
- CBLOAD(OF1)
- NOFILE
- DEPTHCONDLMT(10)
- DYNLOAD(POSIX,DEBBUG,HLE7770,DYNAMIC)
- ENVAR(**)
- ERRCOUNT(0)
- ERRUNIT(6)
- FILEHIST
- FILETAG(NOAUTOCVT,NOAUTOTAG)
- NOFLOW
- HEAP(32768,32768,ANYWHERE,KEEP,8192,4096)
Sections of the Language Environment dump

The sections of the dump listed here appear independently of the Language Environment-conforming languages used. Each conforming language adds language-specific storage and file information to the dump. For a detailed explanation of language-specific dump output:

- For C/C++ routines, see "Finding C/C++ information in a Language Environment dump" on page 191.
- For COBOL routines, see "Finding COBOL information in a dump" on page 236.
- For Fortran routines, see "Finding Fortran information in a Language Environment dump" on page 258.
- For PL/I routines, see "Finding PL/I for MVS & VM information in a dump" on page 277.
Table 19. Contents of the Language Environment dump

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
</table>
| [1] Page Heading           | The page heading section appears on the top of each page of the dump and contains the following information:  
  - CEE3DMP identifier  
  - Title: For dumps generated as a result of an unhandled condition, the title is “Condition processing resulted in the Unhandled condition.”  
  - Product abbreviation of Language Environment  
  - Version number  
  - Release number  
  - Date  
  - Time  
  - Page number  
  The contents of the second line of the page heading vary depending on the environment in which the CEEDUMP is issued.  
  For CEEDUMPs produced under a batch environment, the following items are displayed:  
    - ASID: Describes the address space ID.  
    - Job ID: Describes the JES Job ID.  
    - Job name: Describes the job name.  
    - Step name: Describes the job's step name in which the CEEDUMP was produced.  
    - UserID: Describes the TSO userid who issued the job.  
  For jobs running with POSIX(ON), the following additional items are displayed:  
    - PID: Displays the associated process ID.  
    - Parent PID: Displays the associated parent PID.  
  For CEEDUMPs produced under the z/OS UNIX shell, the following items are displayed:  
    - ASID: Describes the address space ID.  
    - PID: Displays the associated process ID.  
    - Parent PID: Displays the associated parent PID.  
    - User name: Contains the user ID associated to the CEEDUMP.  
  For CEEDUMPs produced under CICS, the following items are displayed:  
    - Transaction ID and task number. |
<p>| [2] CEE3845I CEEDUMP Processing started. | Identifies the start of the Language Environment dump processing. Similarly, message CEE3846I identifies the end of the dump processing. Message number CEE3845I can be used to locate the start of the next CEEDUMP report when scanning forward in a data set that contains several CEEDUMP reports. |
| [3] Caller Program Unit and Offset | Identifies the routine name and offset in the calling routine of the call to the dump service. |</p>
<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>[4] Registers on Entry to CEE3DMP</strong></td>
<td>Shows data at the time of the call to the dump service.</td>
</tr>
<tr>
<td></td>
<td>• Program mask: The program mask contains the bits for the fixed-point overflow mask, decimal overflow mask, exponent underflow mask, and significance mask.</td>
</tr>
<tr>
<td></td>
<td>• General purpose registers (GPRs) 0–15: On entry to CEE3DMP, the GPRs contain:</td>
</tr>
<tr>
<td></td>
<td>GPR 0 Working register</td>
</tr>
<tr>
<td></td>
<td>GPR 1 Pointer to the argument list</td>
</tr>
<tr>
<td></td>
<td>GPR 2–11 Working registers</td>
</tr>
<tr>
<td></td>
<td>GPR 12 Address of CAA</td>
</tr>
<tr>
<td></td>
<td>GPR 13 Pointer to caller's stack frame</td>
</tr>
<tr>
<td></td>
<td>GPR 14 Address of next instruction to run if the ALL31 runtime option is set to ON</td>
</tr>
<tr>
<td></td>
<td>GPR 15 Entry point of CEE3DMP</td>
</tr>
<tr>
<td></td>
<td>• Floating point registers (FPRs) 0 through 15</td>
</tr>
<tr>
<td></td>
<td>• Vector registers (VRs) 0 through 31.</td>
</tr>
<tr>
<td></td>
<td>• Storage pointed to by General Purpose Registers. Treating the contents of each register as an address, 32 bytes before and 64 bytes after the address are shown.</td>
</tr>
</tbody>
</table>

**[5] - [17] Enclave Information** These sections show information that is specific to an enclave. When multiple enclaves are dumped, these sections will appear for each enclave.

<table>
<thead>
<tr>
<th>[5] - [17] Enclave Information</th>
<th>These sections show information that is specific to an enclave. When multiple enclaves are dumped, these sections will appear for each enclave.</th>
</tr>
</thead>
<tbody>
<tr>
<td>If multiple CEEPIPI main-DP environments exist, the dump service generates data and storage information for the most current Main-DP environment, followed by the previous (parent) Main-DP environments in a last-in-first-out (LIFO) order. Sections [5] - [17] will appear for each enclave in the most current Main-DP environment, and sections [5]-[7] will appear for enclaves in the previous (parent) Main-DP environments. When multiple nested Main-DP environments are present in the dump output, a line displaying the CEEPIPI token value for each dumped Main-DP environment will appear before the output for that environment.</td>
<td></td>
</tr>
</tbody>
</table>

**[5] Enclave Identifier** Names the enclave for which information in the dump is provided. If multiple enclaves exist, the dump service generates data and storage information for the most current enclave, followed by previous enclaves in a last-in-first-out (LIFO) order. For more information about dumps for multiple enclaves, see "Multiple enclave dumps" on page 80.

<table>
<thead>
<tr>
<th>[6] - [12] Thread Information</th>
<th>These sections show information that is specific to a thread. When multiple threads are dumped, these sections will appear for each thread.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>[6] Information for thread</strong></td>
<td>Shows the system identifier for the thread. Each thread has a unique identifier.</td>
</tr>
<tr>
<td>Section Number and Heading</td>
<td>Contents</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>[7] Traceback</td>
<td>In a multithread case, the traceback reflects only the current thread. For all active routines, the traceback section shows routine information in three parts. The first part contains:</td>
</tr>
<tr>
<td></td>
<td>• DSA number: A number assigned to the information for this active routine by dump processing. The number is used to associate information from the first part of the traceback with information in the second and third parts of the traceback.</td>
</tr>
<tr>
<td></td>
<td>• Entry: For COBOL, Fortran, PL/I, and Enterprise PL/I for z/OS routines, this is the entry point name. For C/C++ routines, this is the function name. If a function name or entry point was not specified for a particular routine, the string ‘** NoName **’ will appear.</td>
</tr>
<tr>
<td></td>
<td>• Entry point offset</td>
</tr>
<tr>
<td></td>
<td>• Statement number: Refers to the line number in the source code (program unit) in which a call was made or an exception took place (see Status column). The statement number appears only if your routine was compiled with the options required to generate statement numbers.</td>
</tr>
<tr>
<td></td>
<td>• Load module: The load module name displayed can be a partitioned data set member or an UNIX executable file. The load module name is also displayed in the third part of the traceback.</td>
</tr>
<tr>
<td></td>
<td>• Program unit: For COBOL programs, program unit is the PROGRAM-ID name. For C, Fortran, and PL/I routines, program unit is the compile unit name. For Language Environment-conforming assemblers, program unit is either the EPNAME = value on the CEEPPA macro, or a fully qualified path name.</td>
</tr>
<tr>
<td></td>
<td>If the program unit name is available to Language Environment (for example, for C/C++, the routine was compiled with TEST(SYM)), the program unit name will appear under this column, according to the following rules:</td>
</tr>
<tr>
<td></td>
<td>– If your compiled routine is in a partitioned data set, only the member will be output.</td>
</tr>
<tr>
<td></td>
<td>– If your compiled routine is in a sequential data set, only the last qualifier will be shown.</td>
</tr>
<tr>
<td></td>
<td>– If your compiled routine is in an UNIX filename, only what fits of the filename will be displayed in a line.</td>
</tr>
<tr>
<td></td>
<td>• Service level: The latest service level applied to the compile unit (for example, for IBM products, it would be the PTF number).</td>
</tr>
<tr>
<td></td>
<td>• Status: Routine status can be ‘call’ or ‘exception’.</td>
</tr>
</tbody>
</table>
Table 19. Contents of the Language Environment dump (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[7] Traceback (continued)</td>
<td>The second part contains:</td>
</tr>
<tr>
<td></td>
<td>• DSA number: A number assigned to the information for this active routine by dump processing. The number is used to associate information from the first part of the traceback with information in the second and third parts of the traceback.</td>
</tr>
<tr>
<td></td>
<td>• Stack frame (DSA) address</td>
</tr>
<tr>
<td></td>
<td>• Entry point address</td>
</tr>
<tr>
<td></td>
<td>• Program unit address</td>
</tr>
<tr>
<td></td>
<td>• Program unit offset: The offset of the last instruction to run in the routine. If the offset is a negative number, zero, or a very large positive number, the routine associated with the offset probably did not allocate a save area or could have been called using SVC-assisted linkage. Adding the program unit address to the offset gives the location of the current instruction in the routine. This offset is from the starting address of the routine.</td>
</tr>
<tr>
<td></td>
<td>• Compile Date: Contains the year, month and day in which the routine was compiled.</td>
</tr>
<tr>
<td></td>
<td>• Attributes: The available compilation attributes of the compile unit including:</td>
</tr>
<tr>
<td></td>
<td>• A label identifying the LE-supported language such as COBOL, ENT PL/I, C/C++, and so on.</td>
</tr>
<tr>
<td></td>
<td>• Compilation attributes such as EBCDIC, ASCII, IEEE or hexadecimal floating point (HFP). The compilation attributes will only be displayed if there is enough information available.</td>
</tr>
<tr>
<td></td>
<td>• If the CEEDUMP was created under a POSIX environment, POSIX will be displayed.</td>
</tr>
<tr>
<td>The third part of the traceback, which is also referred to as the “Fully Qualified Names” section, contains the following:</td>
<td></td>
</tr>
<tr>
<td>• DSA number</td>
<td></td>
</tr>
<tr>
<td>• Entry</td>
<td></td>
</tr>
<tr>
<td>• Program unit: Similar to the Program Unit column in part 1 except that the server name and the complete program unit (PU) name will be displayed. A PU name will appear here only if it is available to Language Environment.</td>
<td></td>
</tr>
<tr>
<td>• Load Module: The complete pathname of a load module name residing in an UNIX filename will be displayed here if available. The load module’s full pathname will be displayed if the PATH environment variable is set such that the pathname of the load module’s directory appears before the current directory (.). For load modules found in data sets, the same output shown in the traceback part 1 will also be displayed here.</td>
<td></td>
</tr>
</tbody>
</table>
### Table 19. Contents of the Language Environment dump (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
</table>
| [8] Condition Information for Active Routines | Displays the following information for all conditions currently active on the call chain:  
  - Statement showing failing routine and stack frame address of routine  
  - Condition information block (CIB) address  
  - Current condition, in the form of a Language Environment message for the condition raised or a Language Environment abend code, if the condition was caused by an abend  
  - Location: For the failing routine, this is the program unit, entry routine, statement number, and offset.  
  - Machine state, which shows:  
    - Instruction length counter (ILC)  
    - Interruption code  
    - Program status word (PSW)  
    - Contents of 64-bit GPRs 0–15. Note that when the high halves of the registers are not known, they are shown as *******.
    - Storage dump near condition (2 hex-bytes of storage near the PSW)  
    - Storage pointed to by General Purpose Registers  
    - Contents of access registers, if available  
  This information shows the current values at the time the condition was raised. The high halves of the general registers are dumped, in case they are useful for debugging some applications.  
  If the PSW associated with the condition indicates AMODE 24, the register content will be treated as 24-bit address. |
| [9] Parameters, Registers, and Variables for Active Routines | For each active routine, this section shows:  
  - Routine name and stack frame address  
  - Arguments: For C/C++ and Fortran, arguments are shown here rather than with the local variables. For COBOL, arguments are shown as part of local variables. PL/I arguments are not displayed in the Language Environment dump.  
  - Saved registers: This lists the contents of GPRs 0–15 at the time the routine transferred control.  
  - Storage pointed to by the saved registers: Treating the saved contents of each register as an address, 32 bytes before and 64 bytes after the address shown.  
  - Local variables: This section displays the local variables and arguments for the routine. This section also shows the variable type. Variables are displayed only if the symbol tables are available. To generate a symbol table and display variables, use the following compile options:  
    - For C, use TEST(SYM).  
    - For C++, use TEST.  
    - For VS COBOL II, use FDUMP.  
    - For COBOL/370, use TEST(SYM).  
    - For COBOL for OS/390 & VM, use TEST(SYM).  
    - For Enterprise COBOL for z/OS V4R2 and prior releases, use TEST(SYM).  
    - For Enterprise COBOL for z/OS V5R1 and later releases, use TEST(DWARF).  
    - For Fortran, use SDUMP.  
    - For PL/I, arguments and variables are not displayed. |
| [10] Control Blocks for Active Routines | For each active routine controlled by the STACKFRAME option, this section lists contents of related control blocks. The Language Environment-conforming language determines which language-specific control blocks appear. The possible control blocks are:  
  - Stack frame  
  - Condition information block  
  - Language-specific control blocks |
<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[11] Storage for Active Routines</td>
<td>Displays local storage for each active routine. The storage is dumped in hexadecimal, with EBCDIC translations on the right side of the page. There can be other information, depending on the language used. For C/C++ routines, this is the stack frame storage. For COBOL programs, this is language-specific information, WORKING-STORAGE, and LOCAL-STORAGE.</td>
</tr>
<tr>
<td>[12] Control Blocks Associated with the Thread</td>
<td>Lists the contents of the Language Environment common anchor area (CAA), thread synchronization queue element (SQEL), DLL failure data, and dummy stack frame. Other language-specific control blocks can appear in this section. DLL failure data is described in &quot;Using the DLL failure control block&quot; on page 79.</td>
</tr>
<tr>
<td>[13] Enclave variables:</td>
<td>Displays language specific global variables. This section also shows the variable type. Variables are displayed only if the symbol tables are available.</td>
</tr>
</tbody>
</table>
| [14] Enclave Control Blocks | Lists the contents of the Language Environment enclave data block (EDB) and enclave member list (MEML). The information presented may vary depending on which runtime options are set.  
  • If the POSIX runtime option is set to ON, this section lists the contents of the mutex and condition variable control blocks, the enclave level latch table, and the thread synchronization trace block and trace table.  
  • If DLLs have been loaded, this section shows information for each DLL including the DLL name, load address, use count, writeable static area (WSA) address, and the thread id of the thread that loaded the DLL.  
  • If the HEAPCHK runtime option is set to ON, this section shows the contents of the HEAPCHK options control block (HCOP) and the HEAPCHK element tables (HCEL). A HEAPCHK element table contains the location and length of all allocated storage elements for a heap in the order that they were allocated.  
  • When the call-level suboption of the HEAPCHK runtime option is set, any unfreed storage, which would indicate a storage leak, would be displayed in this area. The traceback could then be used to identify the program which did not free the storage.  
  • If the TRACE runtime option is set to ON, this section shows the contents of the Language Environment trace table. Other language-specific control blocks can appear in this section. |
| [15] Enclave Storage | Shows the Language Environment heap storage. For C/C++ and PL/I routines, heap storage is the dynamically allocated storage. For COBOL programs, it is the storage used for WORKING-STORAGE data items. This section also shows the writeable static area (WSA) storage for program objects. Other language-specific storage can appear in this section. |
| [16] File Status and Attributes | Contains additional information about the file. |
| [17] Runtime Options Report | Lists the Language Environment runtime options in effect when the routine was executed. |
| [18] Process Control Blocks | Lists the contents for the Language Environment process control block (PCB), process member list (MEML), and if the POSIX runtime option is set to ON, the process level latch table. Other language-specific control blocks can appear in this section. |
| [19] Additional Language Specific Information | Displays any additional information not included in other sections. For C/C++, it shows the thread ID of the thread that generated the dump and the settings of the errno and errnojr variables for that thread. |
| [20] CEE3846I CEEDUMP Processing completed. | Identifies the end of the Language Environment dump processing. Similarly, message CEE3845I identifies the start of the dump processing. Message CEE3846I can be used to locate the end of the previous CEEDUMP report when scanning backward in a data set that contains several CEEDUMP reports. |
Debugging with specific sections of the Language Environment dump

The following sections describe how you can use particular blocks of the dump to help you debug errors.

Tracebacks, condition information, and data values section
The CEE3DMP call with dump options TRACEBACK, CONDITION, and VARIABLES generates output that contains a traceback, information about any conditions, and a list of arguments, registers, and variables. The traceback, condition, and variable information provided in the Language Environment dump can help you determine the location and context of the error without any additional information. The traceback section includes a sequential list for all active routines and the routine name, statement number, and offset where the exception occurred. The condition information section displays a message describing the condition and the address of the condition information block. The arguments, registers, and variables section shows the values of your arrays, structures, arguments, and data during the sequence of calls in your application. Static data values do not appear. Single quotes indicate character fields. These sections of the dump are shown here.

Upward-growing (non-XPLINK) stack frame section
The stack frame, also called dynamic save area (DSA), for each active routine is listed in the full dump.

A stack frame chain is associated with each thread in the runtime environment and is acquired every time a separately compiled procedure or block is entered. A stack frame is also allocated for each call to a Language Environment service. All stack frames are back-chained with a stopping stack frame (also called a dummy DSA) as the first stack frame on the stack. Register 13 addresses the recently active stack frame or a standard register save area (RSA). The standard save area back chain must be initialized, and it holds the address of the previous save area. Not all Language Environment-conforming compilers set the forward chain; thus, it cannot be guaranteed in all instances. Calling routines establish the member-defined fields.

When a routine makes a call, registers 0–15 contain the following values:
- R1 is a pointer to parameter list or 0 if no parameter list passed.
- R0, R2–R11 is unreferenced by Language Environment. Caller’s values are passed transparently.
- R12 is the pointer to the CAA if entry to an external routine.
- R13 is the pointer to caller’s stack frame.
- R14 is the return address.
- R15 is the address of the called entry point.

With an optimization level other than 0, C/C++ routines save only the registers used during the running of the current routine. Non-Language Environment RSAs can be in the save area chain. The length of the save area and the saved register contents do not always conform to Language Environment conventions. For a detailed description of stack frames Language Environment storage management, see z/OS Language Environment Programming Guide Figure 12 on page 64 shows the format of the upward-growing stack frame.

Note: The Member-defined fields are reserved for the specific higher level language.
Downward-growing (XPLINK) stack frame section

Figure 13 on page 65 shows the format of the downward-growing stack frame. For detailed information about the downward-growing stack, register conventions and parameter passing conventions, see z/OS Language Environment Programming Guide.

---

<table>
<thead>
<tr>
<th>Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Flags</td>
</tr>
<tr>
<td>04</td>
<td>CEEDSBACK - Standard Save Area Back Chain</td>
</tr>
<tr>
<td>08</td>
<td>CEEDSAFE - Standard Save Area Forward Chain</td>
</tr>
<tr>
<td>0C</td>
<td>CEEDSASAVE - GPRs 14, 15, 0-12</td>
</tr>
<tr>
<td>48</td>
<td>Member-defined</td>
</tr>
<tr>
<td>4C</td>
<td>CEEDSANAB - Current Next Available Byte (NAB) in Stack</td>
</tr>
<tr>
<td>50</td>
<td>CEEDSAPNAB - End of Prolog NAB</td>
</tr>
<tr>
<td>54</td>
<td>Member-defined</td>
</tr>
<tr>
<td>58</td>
<td>Member-defined</td>
</tr>
<tr>
<td>5C</td>
<td>Member-defined</td>
</tr>
<tr>
<td>60</td>
<td>Member-defined</td>
</tr>
<tr>
<td>64</td>
<td>Reserved for Debugging</td>
</tr>
<tr>
<td>68</td>
<td>Member-defined</td>
</tr>
<tr>
<td>6C</td>
<td>CEESAMODE - Return Address of the Module That Caused the Last Mode Switch</td>
</tr>
<tr>
<td>70</td>
<td>Member-defined</td>
</tr>
<tr>
<td>74</td>
<td>Member-defined</td>
</tr>
<tr>
<td>78</td>
<td>Reserved for Future Condition Handling</td>
</tr>
<tr>
<td>7C</td>
<td>Reserved for Future Use</td>
</tr>
</tbody>
</table>

Figure 12. Upward-growing (non-XPLINK) stack frame format
Common Anchor Area

Each thread is represented by a common anchor area (CAA), which is the central communication area for Language Environment. All thread- and enclave-related resources are anchored, provided for, or can be obtained through the CAA. The CAA is generated during thread initialization and deleted during thread termination. When calling Language Environment-conforming routines, register 12 points to the address of the CAA.

Use CAA fields as described. Do not modify fields and do not use routine addresses as entry points, except as specified. Fields marked ‘Reserved’ exist for migration of specific languages, or internal use by Language Environment. Language Environment defines their location in the CAA, but not their use. Do not use or reference them except as specified by the language that defines them.

Table 20 on page 66 describes the CAA fields. For more information about the CAA and other structures to which it refers (for example, the DLL failure control block, CEEDLLF), see z/OS Language Environment Vendor Interfaces.
Table 20. Description of CAA fields

<table>
<thead>
<tr>
<th>Hex Offset</th>
<th>Type</th>
<th>Len</th>
<th>CAA Field</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Bit</td>
<td>1</td>
<td>CEEAAFLAG0</td>
<td>CAA flag bits, defined as follows:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0–5 Reserved</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 CEECAAXHDL. A flag used by the condition handler. If the flag is set to 1, the application requires immediate return/percolation to the system on any interrupt or condition handler event.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7 Reserved</td>
</tr>
<tr>
<td>1</td>
<td>Bit</td>
<td>1</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bit</td>
<td>1</td>
<td>CEECAALANGP</td>
<td>PL/I language compatibility flags external to Language Environment. The bits are defined as follows:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0–3 Reserved</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 CEECAATHFN. A flag set by PL/I to indicate a PL/I FINISH ON-unit is active. If the flag is set to 1, no PL/I FINISH ON-unit is active. If the flag is set to 0, a PL/I FINISH ON-unit could be active.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5–7 Reserved</td>
</tr>
<tr>
<td>3</td>
<td>Char</td>
<td>5</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Address</td>
<td>4</td>
<td>CEECAABOS</td>
<td>Start of the current storage segment. This field is initially set during thread initialization. It indicates the start of the current stack storage segment. It is altered when the current stack storage segment is changed.</td>
</tr>
<tr>
<td>C</td>
<td>Address</td>
<td>4</td>
<td>CEECAAEOS</td>
<td>This field is used to determine if a stack overflow routine must be called when allocating storage from the user stack. Normally, the value of this field will represent the end of the current user stack segment. However, its value can also be zero to force the call of a stack overflow routine for every allocation of storage from the user stack. This field is used by function prologs that do not use FASTLINK linkage conventions.</td>
</tr>
<tr>
<td>10</td>
<td>Char</td>
<td>52</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>Signed</td>
<td>2</td>
<td>CEECAATORC</td>
<td>Thread level return code. The thread level return code set by CEESRC callable service.</td>
</tr>
<tr>
<td>46</td>
<td>Signed</td>
<td>2</td>
<td>CEECAATURC</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>Char</td>
<td>44</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>Address</td>
<td>4</td>
<td>CEECAATOVF</td>
<td>Address of stack overflow routine.</td>
</tr>
<tr>
<td>78</td>
<td>Char</td>
<td>168</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>Address</td>
<td>4</td>
<td>CEECAAATTN</td>
<td>Address of the Language Environment attention handling routine. The address of the Language Environment attention handling routine supports common run-time environment’s polling code convention for attention processing.</td>
</tr>
<tr>
<td>124</td>
<td>Char</td>
<td>56</td>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>
Table 20. Description of CAA fields (continued)

<table>
<thead>
<tr>
<th>Hex Offset</th>
<th>Type</th>
<th>Len</th>
<th>CAA Field</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>15C</td>
<td>Address</td>
<td>4</td>
<td>CEECAAHLEXIT</td>
<td>Address of the Exit List Control Block set by the HLL user exit CEEBINT.</td>
</tr>
<tr>
<td>160</td>
<td>Char</td>
<td>56</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>198</td>
<td>Bit (96)</td>
<td>12</td>
<td>CEECAAHOOK</td>
<td>Code to pass control to the debugger.</td>
</tr>
<tr>
<td>1A4</td>
<td>Address</td>
<td>4</td>
<td>CEECAADIMA</td>
<td>(debugger entry)</td>
</tr>
<tr>
<td>1A8</td>
<td>Char</td>
<td>68</td>
<td>CEECAHOOKS</td>
<td>Hook area. This is the start of 18 fullword execute hooks. Language Environment initializes each fullword to X'07000000'. The hooks can be altered to support various debugging hook mechanisms.</td>
</tr>
<tr>
<td>1A8</td>
<td>Char</td>
<td>4</td>
<td>CEECAAALLOC</td>
<td>ALLOCATE descr. built</td>
</tr>
<tr>
<td>1AC</td>
<td>Char</td>
<td>4</td>
<td>CEECAASTATE</td>
<td>New statement begins</td>
</tr>
<tr>
<td>1B0</td>
<td>Char</td>
<td>4</td>
<td>CEECAENTRY</td>
<td>Block entry</td>
</tr>
<tr>
<td>1B4</td>
<td>Char</td>
<td>4</td>
<td>CEECAEXIT</td>
<td>Block exit</td>
</tr>
<tr>
<td>1B8</td>
<td>Char</td>
<td>4</td>
<td>CEECAAMEXIT</td>
<td>Multiple block exit</td>
</tr>
<tr>
<td>1BC</td>
<td>Char</td>
<td>32</td>
<td>CEECAAPATHS</td>
<td>PATH hooks</td>
</tr>
<tr>
<td>1BC</td>
<td>Char</td>
<td>4</td>
<td>CEECAALABEL</td>
<td>At a label constant</td>
</tr>
<tr>
<td>1C0</td>
<td>Char</td>
<td>4</td>
<td>CEECAABCALL</td>
<td>Before CALL</td>
</tr>
<tr>
<td>1C4</td>
<td>Char</td>
<td>4</td>
<td>CEECAAACALL</td>
<td>After CALL</td>
</tr>
<tr>
<td>1C8</td>
<td>Char</td>
<td>4</td>
<td>CEECAADO</td>
<td>DO block starting</td>
</tr>
<tr>
<td>1CC</td>
<td>Char</td>
<td>4</td>
<td>CEECAAIFTRUE</td>
<td>True part of IF</td>
</tr>
<tr>
<td>1D0</td>
<td>Char</td>
<td>4</td>
<td>CEECAIFFFALSE</td>
<td>False part of IF</td>
</tr>
<tr>
<td>1D4</td>
<td>Char</td>
<td>4</td>
<td>CEECAAWHEN</td>
<td>WHEN group starting</td>
</tr>
<tr>
<td>1D8</td>
<td>Char</td>
<td>4</td>
<td>CEECAAOTHER</td>
<td>OTHERWISE group</td>
</tr>
<tr>
<td>1DC</td>
<td>Char</td>
<td>4</td>
<td>CEECAACGOTO</td>
<td>GOTO hook for C</td>
</tr>
<tr>
<td>1E0</td>
<td>Char</td>
<td>4</td>
<td>CEECAARSVDH1</td>
<td>Reserved hook</td>
</tr>
<tr>
<td>1E4</td>
<td>Char</td>
<td>4</td>
<td>CEECAARSVDH2</td>
<td>Reserved hook</td>
</tr>
<tr>
<td>1E8</td>
<td>Char</td>
<td>4</td>
<td>CEECAAMULTEVT</td>
<td>Multiple Event Hook</td>
</tr>
<tr>
<td>1EC</td>
<td>Bit (32)</td>
<td>80</td>
<td>CEECAAMEVMAK</td>
<td>Multiple Event Hook Mask -End of Debug</td>
</tr>
<tr>
<td>1F0</td>
<td>Char</td>
<td>80</td>
<td>CEECAAMEMBER_AREA</td>
<td></td>
</tr>
<tr>
<td>1F0</td>
<td>Address</td>
<td>4</td>
<td>CEECAACGENE</td>
<td>C/370 CGENE</td>
</tr>
<tr>
<td>1F4</td>
<td>Address</td>
<td>4</td>
<td>CEECAACRENT</td>
<td>C/370 writable static</td>
</tr>
<tr>
<td>1F8</td>
<td>Char</td>
<td>8</td>
<td>CEECAACFLTINIT</td>
<td>Used to convert fixed to float cfltini</td>
</tr>
<tr>
<td>200</td>
<td>Address</td>
<td>4</td>
<td>CEECAACPRMS</td>
<td>Address of parameters passed to main module</td>
</tr>
<tr>
<td>204</td>
<td>Signed</td>
<td>4</td>
<td>CEECAACRTL</td>
<td>Combination of 24 unique C/370 trc typ</td>
</tr>
<tr>
<td>208</td>
<td>Address</td>
<td>4</td>
<td>CEECAACTHD</td>
<td></td>
</tr>
<tr>
<td>20C</td>
<td>Address</td>
<td>4</td>
<td>CEECAACURRFECB</td>
<td></td>
</tr>
<tr>
<td>210</td>
<td>Address</td>
<td>4</td>
<td>CEECAAEDCV</td>
<td>C/370 vector table</td>
</tr>
<tr>
<td>214</td>
<td>Address</td>
<td>4</td>
<td>CEECAACPCB</td>
<td>Reserved</td>
</tr>
<tr>
<td>218</td>
<td>Address</td>
<td>4</td>
<td>CEECAACEDB</td>
<td>C/370 CEDB</td>
</tr>
<tr>
<td>21C</td>
<td>Char</td>
<td>3</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>Hex Offset</td>
<td>Type</td>
<td>Len</td>
<td>CAA Field</td>
<td>Explanation</td>
</tr>
<tr>
<td>------------</td>
<td>------</td>
<td>-----</td>
<td>-------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>21F</td>
<td>Char</td>
<td>1</td>
<td>CEECAASPCFLAG3</td>
<td>Used for SPC</td>
</tr>
<tr>
<td>220</td>
<td>Address</td>
<td>4</td>
<td>CEECAACIO</td>
<td>Address of cio</td>
</tr>
<tr>
<td>224</td>
<td>Char</td>
<td>4</td>
<td>CEECAAFDSETFD</td>
<td>Used by FD_* macros</td>
</tr>
<tr>
<td>228</td>
<td>Char</td>
<td>2</td>
<td>CEECAAFCBMUTEXOK</td>
<td></td>
</tr>
<tr>
<td>22A</td>
<td>Char</td>
<td>2</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>22C</td>
<td>Char</td>
<td>4</td>
<td>CEECAATC16</td>
<td></td>
</tr>
<tr>
<td>230</td>
<td>Signed</td>
<td>4</td>
<td>CEECAATC17</td>
<td></td>
</tr>
<tr>
<td>234</td>
<td>Address</td>
<td>4</td>
<td>CEECAEDCOV</td>
<td>C/370 Open Libvec</td>
</tr>
<tr>
<td>238</td>
<td>Signed</td>
<td>4</td>
<td>CEECAACTOFSV</td>
<td></td>
</tr>
<tr>
<td>23C</td>
<td>Address</td>
<td>4</td>
<td>CEECAATRTSPACE</td>
<td>C/370 Open Libvec</td>
</tr>
<tr>
<td>240</td>
<td>Char</td>
<td>24</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>258</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_TCASRV_USERWORD</td>
<td>TCA Service Rtn Vctr</td>
</tr>
<tr>
<td>25C</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_TCASRV_WORKAREA</td>
<td></td>
</tr>
<tr>
<td>260</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_TCASRV_GETMAIN</td>
<td></td>
</tr>
<tr>
<td>264</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_TCASRV_FREEMAIN</td>
<td></td>
</tr>
<tr>
<td>268</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_TCASRV_LOAD</td>
<td></td>
</tr>
<tr>
<td>26C</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_TCASRV_DELETE</td>
<td></td>
</tr>
<tr>
<td>270</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_TCASRV_EXCEPTION</td>
<td></td>
</tr>
<tr>
<td>274</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_TCASRV_ATTENTION</td>
<td></td>
</tr>
<tr>
<td>278</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_TCASRV_MESSAGE</td>
<td></td>
</tr>
<tr>
<td>27C</td>
<td>Char</td>
<td>4</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>280</td>
<td>Address</td>
<td>4</td>
<td>CEECAALWS</td>
<td>Addr of PL/I LWS</td>
</tr>
<tr>
<td>284</td>
<td>Address</td>
<td>4</td>
<td>CEECAASAVR</td>
<td>Register save</td>
</tr>
<tr>
<td>288</td>
<td>Char</td>
<td>36</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>2AC</td>
<td>Bit</td>
<td>1</td>
<td>CEECAASYSTM</td>
<td>Underlying operating system. The value indicates the operating system supporting the active environment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0  Undefined. This value should not appear after Language Environment is initialized.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1  Unsupported</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3  z/OS</td>
</tr>
<tr>
<td>2AD</td>
<td>Bit (8)</td>
<td>1</td>
<td>CEECAAHRDWR</td>
<td>Underlying hardware. This value indicates the type of hardware on which the routine is running.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0  Undefined. This value should not appear after Language Environment is initialized.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1  Unsupported</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2  System/370, non-XA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3  System/370, XA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4  System/370, ESA</td>
</tr>
</tbody>
</table>
Table 20. Description of CAA fields (continued)

<table>
<thead>
<tr>
<th>Hex Offset</th>
<th>Type</th>
<th>Len</th>
<th>CAA Field</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2AE</td>
<td>Bit (8)</td>
<td>1</td>
<td>CEECAASBSYS</td>
<td>Underlying subsystem. This value indicates the subsystem (if any) on which the routine is running.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 Undefined. This value should not occur after Language Environment is initialized.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 Unsupported</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 None. The routine is not running under a Language Environment-recognized subsystem.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 TSO</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 IMS™</td>
</tr>
<tr>
<td>2AF</td>
<td>Bit (8)</td>
<td>1</td>
<td>CEECAAFLAG2</td>
<td>CAA Flag 2, defined as follows:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 Bimodal addressing is available.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 Vector hardware is available.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 Thread terminating.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 Initial thread</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 Library trace is active. The TRACE runtime option was set.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 Reserved</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 CEECAA_ENQ_Wait Interruptible. Thread is in an enqueue wait.</td>
</tr>
<tr>
<td>2B0</td>
<td>Unsign</td>
<td>1</td>
<td>CEECAALEVEL</td>
<td>Language Environment level identifier. This contains a unique value that identifies each release of Language Environment. This number is incremented for each new release of Language Environment.</td>
</tr>
<tr>
<td>2B1</td>
<td>Bit (8)</td>
<td>1</td>
<td>CEECAAPM</td>
<td>Image of current program mask.</td>
</tr>
<tr>
<td>2B2</td>
<td>Bit (16)</td>
<td>2</td>
<td>CEECAAINVAR</td>
<td>Field that is at the same fixed offset in 31-bit and 64-bit CAAs</td>
</tr>
<tr>
<td>2B3</td>
<td>Bit</td>
<td>1</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>2B4</td>
<td>Address</td>
<td>4</td>
<td>CEECAAGETLS</td>
<td>Address of stack overflow for library routines.</td>
</tr>
<tr>
<td>2B8</td>
<td>Address</td>
<td>4</td>
<td>CEECAACELV</td>
<td>Address of the Language Environment library vector. This field is used to locate dynamically loaded Language Environment routines.</td>
</tr>
<tr>
<td>2BC</td>
<td>Address</td>
<td>4</td>
<td>CEECAAGETS</td>
<td>Address of the Language Environment prolog stack overflow routine. The address of the Language Environment get stack storage routine is included in prolog code for fast reference.</td>
</tr>
<tr>
<td>2C0</td>
<td>Address</td>
<td>4</td>
<td>CEECAALBOS</td>
<td>Start of the library stack storage segment. This field is initially set during thread initialization. It indicates the start of the library stack storage segment. It is altered when the library stack storage segment is changed.</td>
</tr>
<tr>
<td>Hex Offset</td>
<td>Type</td>
<td>Len</td>
<td>CAA Field</td>
<td>Explanation</td>
</tr>
<tr>
<td>------------</td>
<td>-------</td>
<td>-----</td>
<td>----------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2C4</td>
<td>Address</td>
<td>4</td>
<td>CEECAALEOS</td>
<td>This field is used to determine if a stack overflow routine must be called when allocating storage from the library stack. Normally, the value of this field will represent the end of the current library stack segment. However, its value can also be zero to force the call of a stack overflow routine for every allocation of storage from the library stack. This field is used by function prologs that do not use FASTLINK linkage conventions.</td>
</tr>
<tr>
<td>2C8</td>
<td>Address</td>
<td>4</td>
<td>CEECAALNAB</td>
<td>Next available library stack storage byte. This contains the address of the next available byte of storage on the library stack. It is modified when library stack storage is obtained or released.</td>
</tr>
<tr>
<td>2CC</td>
<td>Address</td>
<td>4</td>
<td>CEECAADMC</td>
<td>Language Environment shunt routine address. Its value is initially set to 0 during thread initialization. If it is nonzero, this is the address of a routine used in specialized exception processing.</td>
</tr>
<tr>
<td>2D0</td>
<td>Signed</td>
<td>4</td>
<td>CEECAAACD</td>
<td>Most recent CAASHAB abend code.</td>
</tr>
<tr>
<td>2D0</td>
<td>Signed</td>
<td>4</td>
<td>CEEAAABCODE</td>
<td>Most recent abend completion code.</td>
</tr>
<tr>
<td>2D4</td>
<td>Signed</td>
<td>4</td>
<td>CEECAAARS</td>
<td>Most recent CAASHAB reason code.</td>
</tr>
<tr>
<td>2D4</td>
<td>Signed</td>
<td>4</td>
<td>CEECAAARSNCODE</td>
<td>Most recent abend reason code.</td>
</tr>
<tr>
<td>2D8</td>
<td>Address</td>
<td>4</td>
<td>CEECAAERR</td>
<td>Address of the current condition information block. After completion of initialization, this always points to a condition information block. During exception processing, the current condition information block contains information about the current exception being processed. Otherwise, it indicates no exception being processed.</td>
</tr>
<tr>
<td>2DC</td>
<td>Address</td>
<td>4</td>
<td>CEECAAGETSX</td>
<td>Address of the user stack extender routine. This routine is called to extend the current stack frame in the user stack. Its address is in the CEECAA for performance reasons.</td>
</tr>
<tr>
<td>2E0</td>
<td>Address</td>
<td>4</td>
<td>CEECAADDSA</td>
<td>Address of the Language Environment dummy DSA. This address determines whether a stack frame is the dummy DSA, also known as the zeroth DSA.</td>
</tr>
<tr>
<td>2E4</td>
<td>Signed</td>
<td>4</td>
<td>CEECAASECTSIZ</td>
<td>Vector section size. This field is used by the vector math services.</td>
</tr>
<tr>
<td>2E8</td>
<td>Signed</td>
<td>4</td>
<td>CEECAAPARTSUM</td>
<td>Vector partial sum number. This field is used by the vector math services.</td>
</tr>
<tr>
<td>2EC</td>
<td>Signed</td>
<td>4</td>
<td>CEECAASSEXPNT</td>
<td>Log of the vector section size. This field is used by the vector math services.</td>
</tr>
<tr>
<td>2F0</td>
<td>Address</td>
<td>4</td>
<td>CEECAAEDB</td>
<td>Address of the Language Environment EDB. This field points to the encompassing EDB.</td>
</tr>
<tr>
<td>2F4</td>
<td>Address</td>
<td>4</td>
<td>CEECAAPCB</td>
<td>Address of the Language Environment PCB. This field points to the encompassing PCB.</td>
</tr>
<tr>
<td>2F8</td>
<td>Address</td>
<td>4</td>
<td>CEECAEYEPTTR</td>
<td>Address of the CAA eye catcher. The CAA eye catcher is CEECAA. This field can be used for validation of the CAA.</td>
</tr>
<tr>
<td>Hex Offset</td>
<td>Type</td>
<td>Len</td>
<td>CAA Field</td>
<td>Explanation</td>
</tr>
<tr>
<td>------------</td>
<td>---------</td>
<td>-----</td>
<td>---------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2FC</td>
<td>Address</td>
<td>4</td>
<td>CEECAAPTR</td>
<td>Address of the CAA. This field points to the CAA itself and can be used in validation of the CAA.</td>
</tr>
<tr>
<td>300</td>
<td>Address</td>
<td>4</td>
<td>CEECAAGETS1</td>
<td>Non-DSA stack overflow. This field is the address of a stack overflow routine, which cannot guarantee that the current register 13 is pointing at a stack frame. Register 13 must point, at a minimum, to a save area.</td>
</tr>
<tr>
<td>304</td>
<td>Address</td>
<td>4</td>
<td>CEECAASHAB</td>
<td>ABEND shunt routine. Its value is initially set to zero during thread initialization. If it is nonzero, this is the address of a routine used in specialized exception processing for ABENDs that are intercepted in the ESTAE exit.</td>
</tr>
<tr>
<td>308</td>
<td>Address</td>
<td>4</td>
<td>CEECAAPRGCK</td>
<td>Routine interrupt code for CEECAADMC. If CEECAADMC is nonzero, and a routine interrupt occurs, this field is set to the routine interrupt code and control is passed to the address in CEECAAMDC.</td>
</tr>
<tr>
<td>30C</td>
<td>Bit (8)</td>
<td>1</td>
<td>CEECAFLAG1</td>
<td>CAA flag bits, defined as follows:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0   CEECAASORT. A call to DFSORT is active.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1   CEECA_USE_OLD_STK. Use the old stack.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2   CEECA_CICS_EXT_REG. ERTLI CICS extended register interface is in effect</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3   CEECAASHAB_RECOVER_IN_ESTAE_MODE. When on, the Language Environment ESTAE resumes to the abend shunt in the mode and key in which the Language Environment ESTAE was established</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4–7 Reserved.</td>
</tr>
<tr>
<td>30D</td>
<td>Char</td>
<td>1</td>
<td>CEECAASHAB_KEY</td>
<td>IPK result when CEECAASHAB is set.</td>
</tr>
<tr>
<td>30E</td>
<td>Char</td>
<td>2</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>310</td>
<td>Signed</td>
<td>4</td>
<td>CEECAAURC</td>
<td>Thread level return code. This is the common place for members to set the return codes for subroutine-to-subroutine return code processing.</td>
</tr>
<tr>
<td>314</td>
<td>Address</td>
<td>4</td>
<td>CEECAAESS</td>
<td>Determine if a stack overflow routine must be called when allocating storage from the user stack. Normally, the value of this field will represent the end of the current user stack segment. However, its value can also be zero to force the call of a stack overflow routine for every allocation of storage from the user stack. This field is used by function prologs that use FASTLINK linkage conventions.</td>
</tr>
</tbody>
</table>
Table 20. Description of CAA fields (continued)

<table>
<thead>
<tr>
<th>Hex Offset</th>
<th>Type</th>
<th>Len</th>
<th>CAA Field</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>318</td>
<td>Address</td>
<td>4</td>
<td>CEECAALESS</td>
<td>Determine if a stack overflow routine must be called when allocating storage from the library stack. Normally, the value of this field will represent the end of the current library stack segment. However, its value can also be zero to force the call of a stack overflow routine for every allocation of storage from the library stack. This field is used by function prologs that use FASTLINK linkage conventions.</td>
</tr>
<tr>
<td>31C</td>
<td>Address</td>
<td>4</td>
<td>CEECAAOGETS</td>
<td>Overflow from user stack allocations.</td>
</tr>
<tr>
<td>320</td>
<td>Address</td>
<td>4</td>
<td>CEECAAOGETLS</td>
<td>Overflow from library stack allocations.</td>
</tr>
<tr>
<td>324</td>
<td>Address</td>
<td>4</td>
<td>CEECAAPICICB</td>
<td>Address of the preinitialization compatibility control block.</td>
</tr>
<tr>
<td>328</td>
<td>Address</td>
<td>4</td>
<td>CEECAAOGETSX</td>
<td>User DSA exit from OPLINK.</td>
</tr>
<tr>
<td>32C</td>
<td>Signed</td>
<td>2</td>
<td>CEECAAGOSMR</td>
<td>Go some more—Used CEEHTRAV multiple.</td>
</tr>
<tr>
<td>32E</td>
<td>Signed</td>
<td>2</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>330</td>
<td>Address</td>
<td>4</td>
<td>CEECAALEOV</td>
<td>This field is the address of the Language Environment library vector for z/OS UNIX support.</td>
</tr>
<tr>
<td>334</td>
<td>Signed</td>
<td>4</td>
<td>CEECAA_SIGSCTR</td>
<td>SIGSAFE counter.</td>
</tr>
</tbody>
</table>
Table 20. Description of CAA fields (continued)

<table>
<thead>
<tr>
<th>Hex Offset</th>
<th>Type</th>
<th>Len</th>
<th>CAA Field</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>338</td>
<td>Bit (32)</td>
<td>4</td>
<td>CEECAA_SIGFLG</td>
<td>SIGSAFE flags indicate the signal safety of the library and are defined, as follows.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 CEECAA_SIGPUTBACK. The signal cannot be delivered, therefore the signal is put back to the kernel.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 CEECAA_SA_RESTART. Indicates that a signal registered with the SA_RESTART flag interrupted the last kernel call, and the signal catcher returned.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 Reserved</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 CEECAA_SIGSAFE. It is safe to deliver the signal, while in library code.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 CEECAAANCELSAFE. It is safe to deliver the cancel signal, while in library code.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 CEECAA_SIGRESYNCH. CEECAA_sigputsynch flag was on last time CEEOSIGR resolicited a signal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 CEECAA_FRZ_UNSFAE. This thread is in an unsafe state to be frozen.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7 CEECAA_NOAPPREGS. User application registers may be saved in a nonstandard place.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8 CEECAA_EINTR_RSOL. Secondary Signal resolicitation is in progress, after EINTR errno from inner function.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9 CEECAA_EINTR_PUTB. Secondary resolicited signal has been put back.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10 CEECAA_EINTR_REST. User signal catcher returned after catching secondary resolicited signal with SA_RESTART in effect.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11 CEECAA_EINTR_SIGG. Stray signal interrupted CEEOSIGG while secondary signal resolicitation was in progress.</td>
</tr>
<tr>
<td>33A</td>
<td>Bit (16)</td>
<td>2</td>
<td>Reserved</td>
<td>This field is the thread identifier.</td>
</tr>
<tr>
<td>33C</td>
<td>Char</td>
<td>8</td>
<td>CEECAATHIDID</td>
<td>This field is the thread identifier.</td>
</tr>
<tr>
<td>344</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_DCRENT</td>
<td>Reserved</td>
</tr>
<tr>
<td>348</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_DANCHOR</td>
<td>Reserved</td>
</tr>
<tr>
<td>34C</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_CTOC</td>
<td>TOC anchor for CRENT.</td>
</tr>
<tr>
<td>354</td>
<td>Signed</td>
<td>4</td>
<td>CEECAA_CICSRSN</td>
<td>CICS reason code from member language.</td>
</tr>
<tr>
<td>358</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_MEMBR</td>
<td>Address of thread-level member list.</td>
</tr>
<tr>
<td>35C</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_SIGNAL_STATUS</td>
<td>Signal status of the terminating thread member list.</td>
</tr>
<tr>
<td>360</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_HCOM_REG7</td>
<td>HCOM saved R7.</td>
</tr>
<tr>
<td>360</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_HCOM_REG14</td>
<td>HCOM saved R14.</td>
</tr>
<tr>
<td>364</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_STACKFLOOR</td>
<td>Lowest usable address in XP stack.</td>
</tr>
<tr>
<td>Hex Offset</td>
<td>Type</td>
<td>Len</td>
<td>CAA Field</td>
<td>Explanation</td>
</tr>
<tr>
<td>------------</td>
<td>-------</td>
<td>-----</td>
<td>----------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>368</td>
<td>Address</td>
<td>4</td>
<td>CEECAAHPGETS</td>
<td>XP stack extension rtn.</td>
</tr>
<tr>
<td>36C</td>
<td>Address</td>
<td>4</td>
<td>CEECAAECHPXV</td>
<td>C/C++ XPLINK libvec.</td>
</tr>
<tr>
<td>370</td>
<td>Address</td>
<td>4</td>
<td>CEECAAFOR1</td>
<td>Reserved for FORTRAN.</td>
</tr>
<tr>
<td>374</td>
<td>Address</td>
<td>4</td>
<td>CEECAAFOR2</td>
<td>Reserved for FORTRAN.</td>
</tr>
<tr>
<td>378</td>
<td>Address</td>
<td>4</td>
<td>CEECAAPERMID</td>
<td>Thread heap ID.</td>
</tr>
<tr>
<td>37C</td>
<td>Signed</td>
<td>4</td>
<td>CEECA_SYS_RTNCODE</td>
<td>System (kernel) return code.</td>
</tr>
<tr>
<td>380</td>
<td>Signed</td>
<td>4</td>
<td>CEECA_SYS_RSNCODE</td>
<td>System (kernel) reason code.</td>
</tr>
<tr>
<td>384</td>
<td>Address</td>
<td>4</td>
<td>CEECAGETFN</td>
<td>Address of the WSA swap routine.</td>
</tr>
<tr>
<td>388</td>
<td>Address</td>
<td>4</td>
<td>CEECA_JIT1</td>
<td>Reserved.</td>
</tr>
<tr>
<td>38C</td>
<td>Address</td>
<td>4</td>
<td>CEECA_JIT2</td>
<td>Reserved.</td>
</tr>
<tr>
<td>390</td>
<td>Address</td>
<td>4</td>
<td>CEECAASIGNP0TR</td>
<td>Pointer to ‘signam’ external variable in a C application.</td>
</tr>
<tr>
<td>394</td>
<td>Signed</td>
<td>4</td>
<td>CEECAASIGNG</td>
<td>Value of sign of lgamma() -1 - negative sign 0 - zero +1 - positive sign.</td>
</tr>
<tr>
<td>398</td>
<td>Address</td>
<td>4</td>
<td>CEECA_FORDBG</td>
<td>Ptr to AFHDBHIM - FORTRAN hook interface.</td>
</tr>
<tr>
<td>39C</td>
<td>Bit (8)</td>
<td>1</td>
<td>CEECAAB_STATUS</td>
<td>Validity flags.</td>
</tr>
<tr>
<td>39D</td>
<td>Unsign</td>
<td>1</td>
<td>CEECA_STACKDIRECTION</td>
<td>Stack direction.</td>
</tr>
<tr>
<td>39E</td>
<td>Bit</td>
<td>2</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>3A0</td>
<td>Signed</td>
<td>4</td>
<td>CEECAAB_GR0</td>
<td>Reg 0 at the time of abend.</td>
</tr>
<tr>
<td>3A4</td>
<td>Signed</td>
<td>4</td>
<td>CEECAAB_ICD1</td>
<td>SDWAICD1.</td>
</tr>
<tr>
<td>3A8</td>
<td>Signed</td>
<td>4</td>
<td>CEECAAB_ABCC</td>
<td>SDWAABCC.</td>
</tr>
<tr>
<td>3AC</td>
<td>Signed</td>
<td>4</td>
<td>CEECAAB_CRC</td>
<td>SDWACRC.</td>
</tr>
<tr>
<td>3B0</td>
<td>Address</td>
<td>4</td>
<td>CEECAAGTS</td>
<td>Entry point of CEEVAGTS routine.</td>
</tr>
<tr>
<td>3B4</td>
<td>Address</td>
<td>4</td>
<td>CEECA_LER5N1</td>
<td>Reserved.</td>
</tr>
<tr>
<td>3B8</td>
<td>Address</td>
<td>4</td>
<td>CEECAHERP</td>
<td>Address of CEEHERP routine.</td>
</tr>
<tr>
<td>3BC</td>
<td>Address</td>
<td>4</td>
<td>CEECAUSTKBOS</td>
<td>Start of user stack segment.</td>
</tr>
<tr>
<td>3C0</td>
<td>Address</td>
<td>4</td>
<td>CEECAUSTKEOS</td>
<td>End of user stack segment.</td>
</tr>
<tr>
<td>3C4</td>
<td>Address</td>
<td>4</td>
<td>CEECAUSERRTN®</td>
<td>Address of thread start routine. Undefined on IPT or prior to thread init event.</td>
</tr>
<tr>
<td>3C8</td>
<td>Bit</td>
<td>8</td>
<td>CEECAUDHOOK</td>
<td>Hook swapping XPLINK.</td>
</tr>
<tr>
<td>3D0</td>
<td>Address</td>
<td>4</td>
<td>CEECAACEL_HPVX_B</td>
<td>Address of XPLINK compat vector for Base library.</td>
</tr>
<tr>
<td>3D4</td>
<td>Address</td>
<td>4</td>
<td>CEECAACEL_HPVX_M</td>
<td>Address of XPLINK compat vector for Math library.</td>
</tr>
<tr>
<td>3D8</td>
<td>Address</td>
<td>4</td>
<td>CEECAACEL_HPVX_L</td>
<td>Address of XPLINK compat vector for Locale library.</td>
</tr>
<tr>
<td>3DC</td>
<td>Address</td>
<td>4</td>
<td>CEECAACEL_HPVX_O</td>
<td>Address of XPLINK compat vector for Open library.</td>
</tr>
<tr>
<td>3E0</td>
<td>Address</td>
<td>4</td>
<td>CEECAACEL4VEC3</td>
<td>Address of 3rd C-RTL library vector.</td>
</tr>
<tr>
<td>3E4</td>
<td>Address</td>
<td>4</td>
<td>CEECA_CEEDLLF</td>
<td>Address of the newest CEEDLLF control block.</td>
</tr>
<tr>
<td>3E8</td>
<td>Address</td>
<td>4</td>
<td>CEECA_SAVSTACK</td>
<td>Zero or saved stack pointer. This field can be used to save the stack pointer before calling a routine with OS_NOSTACK linkage. After the call returns, this field must be set back to zero.</td>
</tr>
<tr>
<td>3EC</td>
<td>Char</td>
<td>4</td>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>
Table 20. Description of CAA fields (continued)

<table>
<thead>
<tr>
<th>Hex Offset</th>
<th>Type</th>
<th>Len</th>
<th>CAA Field</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3F0</td>
<td>Char</td>
<td>4</td>
<td>CEECAA_USER_WORD</td>
<td>4-byte user field available for application use. In pre-initialization (CEEPIPI) environments, this field is initialized in the IPT CAA from the CEEPIPI set_user_word function. This field is initialized to 0 in non-CEEPIPI environments (including all nested enclaves), and for all non-IPT CAAs in CEEPIPI environments. This field is not otherwise accessed by Language Environment.</td>
</tr>
<tr>
<td>3F4</td>
<td>Address</td>
<td>4</td>
<td>CEECAA_SAVSTACK_ASYNC</td>
<td>Zero or address of field that is zero or saved stack pointer. An application that has large sections of code that do not require access to the Language Environment stack but could benefit from having an additional register available can use this field.</td>
</tr>
</tbody>
</table>

**Condition information block**

Figure 14 on page 76 shows the condition information block. The Language Environment condition manager creates a condition information block (CIB) for each condition encountered in the Language Environment environment. The CIB holds data required by the condition handling facilities and pointers to locations of other data. The address of the current CIB is located in the CAA.

For COBOL, Fortran, and PL/I applications, Language Environment provides macros (in the SCEESAMP data set) that map the CIB. For C/C++ applications, the macros are in leawi.h.
### Figure 14. Condition information block (Part A)

<table>
<thead>
<tr>
<th>Offset</th>
<th>Field Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+0</td>
<td>Condition Information Block Eye catcher</td>
</tr>
<tr>
<td>+4</td>
<td>Previous Condition Information Block</td>
</tr>
<tr>
<td>+8</td>
<td>Most Recent Condition Information Block</td>
</tr>
<tr>
<td>+C</td>
<td>Size of Condition Information Block</td>
</tr>
<tr>
<td>+10</td>
<td>Platform Identifier 3 = Language Environment</td>
</tr>
<tr>
<td>+18</td>
<td>Current Language Environment Condition</td>
</tr>
<tr>
<td>+24</td>
<td>Address of Machine State Time of Interrupt</td>
</tr>
<tr>
<td>+28</td>
<td>Previous Language Environment Condition</td>
</tr>
<tr>
<td>+37</td>
<td>Condition Flags</td>
</tr>
<tr>
<td>+38</td>
<td>Handle Cursor</td>
</tr>
<tr>
<td>+44</td>
<td>Resume Cursor</td>
</tr>
<tr>
<td>+54</td>
<td>Physical Callee Stack Frame Pointer (handle cursor)</td>
</tr>
<tr>
<td>+58</td>
<td>DSA format for Stack frame in the Handle Cursor 0 = non-XPLINK 1 = XPLINK</td>
</tr>
<tr>
<td>+59</td>
<td>DSA format for Physical CalleeStack frame (handle cursor) (reserved)</td>
</tr>
<tr>
<td>+5A</td>
<td>(reserved)</td>
</tr>
<tr>
<td>+5B</td>
<td>Most Recent Condition Information Block</td>
</tr>
<tr>
<td>+B0</td>
<td>Previous Condition Information Block</td>
</tr>
<tr>
<td>+B1</td>
<td>Status Flag 5 64 = An SDWA is Associated with the Condition</td>
</tr>
<tr>
<td>+B2</td>
<td>Status Flag 6 128 = Storage Condition</td>
</tr>
<tr>
<td>+B3</td>
<td>Status Flag 7</td>
</tr>
<tr>
<td>+B4</td>
<td>Abend Code Word</td>
</tr>
</tbody>
</table>

The figure provides a detailed breakdown of the fields within a condition information block, illustrating how various components are mapped to specific offsets within the block.
The flags for Condition Flag 4:
2 The resume cursor has been moved
4 Message service has processed the condition
8 The resume cursor has been moved explicitly

The flags for Status Flag 5, Language Environment events:
1 Caused by an attention interrupt
2 Caused by a signaled condition
4 Caused by a promoted condition
8 Caused by a condition management raised TIU
32 Caused by a condition signaled via CEEOKILL The signaled-via-CEEOKILL flag is always set with the signaled flag; thus, a signaled
condition can have a value of either 2 or 34. (The value is 2 if the signaled condition does not come through CEEOKILL. If it comes through CEEOKILL, its value is 2+32=34.)

- **64** Caused by a program check
- **128** Caused by an abend

The flags for Status Flag 6, Language Environment actions:

- **2** Doing stack frame zero scan
- **4** H-cursor pointing to owning SF
- **8** Enable only pass (no condition pass)
- **16** MRC type 1
- **32** Resume allowed
- **64** Math service condition
- **128** Abend reason code valid

The language-specific function codes for the CIB:

- **X'1'** For condition procedure
- **X'2'** For enablement
- **X'3'** For stack frame zero conditions

**Using the machine state information block**

The Language Environment machine state information block contains condition information pertaining to the hardware state at the time of the error. Figure 16 on page 79 shows the machine state information block.
Using the DLL failure control block

The CEEDLLF control block contains error diagnostics corresponding to an implicit or explicit DLL failure. Diagnostics describing up to 10 of the most recent DLL failures are available in a circular list of CEEDLLF control blocks. When viewing a dump, the in-use CEEDLLF control blocks are displayed from newest to oldest. See "Understanding the Language Environment IPCS VERBEXIT LEDATA output" on page 90 for the contents of CEEDLLF fields.
Multiple enclave dumps

[Figure 17 on page 81] illustrates the information available in the Language Environment dump and the order of information for multiple enclaves. If multiple enclaves are used, the dump service generates data and storage information for the most current enclave and moves up the chain of enclaves to the starting enclave in a LIFO order. For example, if two enclaves are used, the dump service first generates output for the most current enclave. Then the service creates output for the previous enclave. A thread terminating in a non-POSIX environment is analogous to an enclave terminating because Language Environment Version 1 supports only single threads.
If multiple nested CEEPIPI Main-DP environments are present, the dump service generates data and storage information for the most current Main-DP environment and moves up the chain of Main-DP environments to the starting Main-DP environment in LIFO order.

Figure 17. Language Environment dump of multiple enclaves

<table>
<thead>
<tr>
<th>Enclave 1</th>
<th>Enclave 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thread 1</td>
<td>Thread 2</td>
</tr>
<tr>
<td>Main 1</td>
<td>Main 2</td>
</tr>
<tr>
<td>subroutine</td>
<td>subroutine</td>
</tr>
<tr>
<td>subroutine</td>
<td>subroutine</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Entry Information (CEE3DMP calls only)

Information for Enclave 1

Traceback:
Call chain of routines

Condition Information for Active Routine:
Failing routine information

Arguments, Registers, and Variables for Active Routines:
Symbolic dump for routines

Control Blocks for Active Routines:
DSAs for routines
CIBs for routines
Language-specific control blocks

Storage for Active Routines:
Language-specific information
Variables for routines

Control Blocks Associated with the Thread:
Common anchor area (CAA)
Dummy DSA

Enclave Control Blocks:
Enclave data block (EDB)
Enclave-level member list (MEML)

Enclave Storage:
Heap storage for routines

Process Control Blocks:
Process control block (PCB)
Process-level member list (MEML)
Language-specific control blocks
When multiple nested CEEPIPI Main-DP environments are present in the dump output, the information in Figure 17 on page 81 appears for the most current Main-DP environment. For the other chained Main-DP environments, only the traceback section appears. The following is an example:

**** Information for CEEPIPI token xxxxxxxx ****
information for newest enclave
information for next older enclave
information for oldest enclave
Other information

**** Information for CEEPIPI token xxxxxxxx ****
traceback for newest enclave
traceback for next older enclave
traceback for next older enclave
traceback for oldest enclave

**** Information for CEEPIPI token xxxxxxxx ****
traceback for newest enclave
traceback for next older enclave
traceback for next older enclave
traceback for oldest enclave

**** Information for CEEPIPI token xxxxxxxx ****
traceback for newest enclave
traceback for next older enclave
traceback for next older enclave
traceback for oldest enclave

---

**Generating a system dump**

A system dump contains the storage information needed to diagnose errors. You can use Language Environment to generate a system dump through any of the following methods:

**DYNDUMP(hilq,DYNAMIC,TDUMP)**
You can use the DYNDUMP runtime option to obtain IPCS-readable dumps of user applications that would ordinarily be lost due to the absence of a SYSMDUMP, SYSUDUMP, or SYSABEND DD statement.

**TERMTHDACT(UAONLY, UATRACE, or UADUMP)**
You can use these runtime options, with TRAP(ON), to generate a system dump if an unhandled condition of severity 2 or greater occurs. For more details about the level of dump information produced by each of the TERMTHDACT suboptions, see "Generating a Language Environment dump with TERMTHDACT" on page 40.

**TRAP(ON,NOSPIE) TERMTHDACT(UAIMM)**
TRAP(ON,NOSPIE) TERMTHDACT(UAIMM) generates a system dump of the user address space of the original abend or program interrupt prior to the Language Environment condition manager processing the condition.

**ABPERC(abcode)**
The ABPERC runtime option specifies one abend code that is exempt from the Language Environment condition handler. The Language Environment condition handler percolates the specified abend code to the operating system. The operating system handles the abend and generates a system dump. ABPERC is ignored under CICS.

**Abend Codes in Initialization Assembler User Exit**
Abend codes listed in the initialization assembler user exit are passed to the operating system. The operating system can then generate a system dump.
You can use the CEE3ABD callable service to cause the operating system to handle an abend.

See system or subsystem documentation for detailed system dump information.

The method for generating a system dump varies for each of the Language Environment runtime environments. The following sections describe the recommended steps needed to generate a system dump in a batch, IMS, CICS, and z/OS UNIX shell runtime environments. Other methods may exist, but these are the recommended steps for generating a system dump.

For details on setting Language Environment runtime options, see z/OS Language Environment Programming Guide.

**Steps for generating a system dump in a batch runtime environment**

Perform the following steps to generate a system dump in a batch runtime environment. When you are done, you will have generated a system dump in a batch runtime environment.

1. Specify runtime options TERMTHDACT(UAONLY, UADUMP, UATRACE, or UAIMM), and TRAP(ON). If you specify the suboption UAIMM then you must set TRAP(ON,NOSPIE). The TERMTHDACT suboption determines the level of detail of the Language Environment formatted dump. For further details on the TERMTHDACT suboptions, see "Generating a Language Environment dump with TERMTHDACT" on page 40.

2. Decide whether to include a SYSMDUMP DD card or use the DYNDUMP runtime option.
   - Include a SYSMDUMP DD card with the desired data set name and DCB information:
     
     LRECL=4160, BLKSIZE=4160, and RECFM=FBS.
   - Specify the DYNDUMP runtime option with the following information:
     
     DYNDUMP (hlq,DYNAMIC,TDUMP)

3. Rerun the program.

**Steps for generating a system dump in an IMS runtime environment**

Perform the following steps to generate a system dump in an IMS runtime environment. When you are done, you will have generated system dump in an IMS runtime environment.

1. Specify runtime options TERMTHDACT(UAONLY, UADUMP, UATRACE, or UAIMM), ABTERM(ABEND), and TRAP(ON). If you specify the suboption UAIMM, then you must set TRAP(ON,NOSPIE). The TERMTHDACT suboption determines the level of detail of the Language Environment formatted dump. For further details on the TERMTHDACT suboptions, see "Generating a Language Environment dump with TERMTHDACT" on page 40.
2. Decide whether to include a SYSMDUMP DD card or use the DYNDUMP runtime option.
   - Include a SYSMDUMP DD card with the desired data set name and DCB information:
     
     ```
     LRECL=4160, BLKSIZE=4160, and RECFM=FBS.
     ```
   - Specify the DYNDUMP runtime option with the following information:
     
     ```
     DYNDUMP (hlq,DYNAMIC,TDUMP)
     ```

3. Rerun the program.

### Steps for generating a system dump in a CICS runtime environment

**Before you begin:** Under CICS, a system dump provides the most useful information for diagnosing problems. However, if you have a Language Environment U4038 abend, CICS will not generate a system dump. To generate diagnostic information for a CICS runtime environment with a Language Environment U4038 abend, you must create a Language Environment U4039 abend. For instructions on how to create a Language Environment U4039 abend, see "Steps for generating a Language Environment U4039 abend."

**Note:** DYNDUMP is ignored in a CICS environment.

Perform the following steps to generate a system dump in a CICS runtime environment. When you are done, you will have generated a system dump in a CICS runtime environment.

1. Specify runtime options TERMTHDACT(UAONLY, UADUMP, or UATRACE), ABTERM(ABEND), and TRAP(ON). The TERMTHDACT suboption determines the level of detail of the Language Environment formatted dump. For more details on the TERMTHDACT suboptions, see "Generating a Language Environment dump with TERMTHDACT" on page 40.

2. Update the transaction dump table with the CICS-supplied CEMT command:

   ```
   CEMT SET TRD(40XX) SYS ADD
   ```

   **Result** You will see CEMT output.

   **Example**
   
   ```
   STATUS: RESULTS - OVERTYPE TO MODIFY
   Trd(4088) Sys Loc Max(999) Cur(0000)
   ```

3. Rerun the program.

### Steps for generating a Language Environment U4039 abend

If you have a Language Environment U4038 abend, CICS will not generate a system dump. To generate diagnostic information, you must create a Language
Environment U4039 abend by performing the following steps. By setting these runtime options, a Language Environment U4039 abend occurs which generates a system dump.

1. Specify DUMP=YES in CICS DFHSIT.
2. Specify runtime options TERMTTHDACT(UAONLY, UATRACE, or UADUMP), ABTERM(ABEND), and TRAP(ON)
3. Rerun the program.

Steps for generating a system dump in a z/OS UNIX shell

Perform the following steps to generate a system dump from a z/OS UNIX shell:

- Using `_BPXK_MDUMP`
  1. Specify where to write the system dump
     - To write the system dump to a z/OS data set, issue the following command, where `filename` is a fully qualified data set name with DCB information: LRECL=4160, BLKSIZE=4160, and RECFM=FBS.

     ```
     export _BPXK_MDUMP=filename
     ```

     **Example**
     ```
     export _BPXK_MDUMP=hlq.mydump
     ```
     - To write the system dump to an HFS file, issue the following command, where `filename` is a fully qualified HFS filename.

     ```
     export _BPXK_MDUMP=filename
     ```

     **Example**
     ```
     export _BPXK_MDUMP=/tmp/mydump.dmp
     ```

  2. Specify Language Environment runtime options, where `suboption` is UAONLY, UADUMP, UATRACE, or UAIMM.

     ```
     export _CEE_RUNOPTS="termthdact(suboption)"
     ```

     If UAIMM is set, TRAP(ON,NOSPIE) must also be set. The TERMTTHDACT suboption determines the level of detail of the Language Environment formatted dump. For more details about the TERMTTHDACT suboptions, see “Generating a Language Environment dump with TERMTTHDACT” on page 40.

  3. Rerun the program.

When you are done, the system dump is written to the data set name or HFS file name specified. For additional _BPXK_MDUMP information see `z/OS UNIX System Services Planning` and `z/OS UNIX System Services Programming: Assembler Callable Services Reference`.

- Using DYNDUMP
  1. Specify Language Environment runtime options:

     ```
     export _CEE_RUNOPTS="termthdact(suboption),DYNDUMP(hlq,DYNAMIC,TDUMP)"
     ```

     `suboption` is UAONLY, UADUMP, UATRACE, or UAIMM. If UAIMM is set,
TRAP(ON,NOSPIE) must also be set. The TERMTHDACT suboption determines the level of detail of the Language Environment formatted dump. For more details about the TERMTHDACT suboptions, see "Generating a Language Environment dump with TERMTHDACT" on page 40.

hlq the high level qualifier for the dump data set to be created.

2. Rerun the program.

When you are done, the system dump is written to the name generated by the DYNDUMP runtime option. For additional DYNDUMP information see z/OS Language Environment Programming Reference.

Note: You can also specify the signal SIGDUMP on the kill command to generate a system dump of the user address space. For more information regarding the SIGDUMP signal, see z/OS UNIX System Services Command Reference.

Formatting and analyzing system dumps

You can use the interactive problem control system (IPCS) to format and analyze system dumps. Language Environment provides an IPCS VERBEXIT LEDATA that can be used to format Language Environment control blocks. For more information on using IPCS, see z/OS MVS IPCS User’s Guide.

Preparing to use the Language Environment support for IPCS

Use the following guidelines before you use IPCS to format Language Environment control blocks:

• Ensure that your IPCS job can find the CEEIPCSP member.

IPCS provides an exit control table with imbed statements to enable other products to supply exit control information. The IPCS default table, BLSCECT, normally in the SYS1.PARMLIB library, has the following entry for Language Environment:

```
IMBED MEMBER(CEEIPCSP) ENVIRONMENT(IPCS)
```

The Language Environment-supplied CEEIPCSP member, installed in the SYS1.PARMLIB library, contains the Language Environment-specific entries for the IPCS exit control table.

• Provide an IPCSPARM DD statement to specify the libraries containing the IPCS control tables.

Example

```
//IPCSPARM DD DSN=SYS1.PARMLIB,DISP=SHR
```

• Ensure that your IPCS job can find the Language Environment-supplied ANALYZE exit routines installed in the SYS1.MIGLIB library.

• To aid in debugging system or address space hang situations, Language Environment mutexes, latches and condition variables can be displayed if the CEEIPCSP member you are using is updated to identify the Language Environment ANALYZE exit, by including the following statement:

```
EXIT EP(CEEEANLZ) ANALYZE
```
Understanding Language Environment IPCS VERBEXIT – LEDATA

Purpose

Use the LEDATA verb exit to format data for Language Environment. This VERBEXIT provides information about the following topics:

- A summary of Language Environment at the time of the dump
- Runtime Options
- Storage Management Control Blocks
- Condition Management Control Blocks
- Message Handler Control Blocks
- C/C++ Control Blocks
- COBOL Control Blocks

Format

```
VERBEXIT LEDATA ['parameter[,parameter]...']
```

Report Type Parameters:
```
[ SUM ]
[ HEAP | STACK | SM ]
[ HPT(number) [ HPTTCB(address) ] [ HPTCELL(address) ] [ HPTLOC(location) ] ]
[ CM ]
[ MH ]
[ CEDUMP ]
[ COMP(value) ]
[ PTBL(value) ]
[ ALL ]
```

Data Selection Parameters:
```
[ DETAIL | EXCEPTION ]
```

Control Block Selection Parameters:
```
[ CAA(caa-address) ]
[ DSA(dsa-address) ]
[ TCB(tc-b-address) ]
[ ASID(address-space-id) ]
[ NTHREADS(value) ]
```

Parameters

The following sections describe the different types of supported parameters. Note that only hexadecimal characters can be specified as addresses provided in LEDATA parameters. Special characters cause the formatter to fail. Therefore, to specify a 64-bit address as a parameter, it must be in the form like 123456789 instead of 1_23456789.

Report type parameters

Use the following parameters to select the type of report. You can specify as many reports as you wish. If you omit these parameters, the default is SUMMARY.

SUMmary

Requests a summary of the Language Environment at the time of the dump.

The following information is included:

- TCB address
- Address Space Identifier
- Language Environment Release
- Active members
- Formatted CAA, PCB, RCB, EDB and PMCB
- Runtime Options in effect

**HEAP | STACK | SM**

**HEAP**
Requests a report on Storage Management control blocks pertaining to HEAP storage, as well as a detailed report on heap segments. The detailed report includes information about the free storage tree in the heap segment, and information about each allocated storage element. It also specifies a heap pools report with information useful to find potential damaged cells. Note that Language Environment does not provide support for alternative Vendor Heap Manager (VHM) data.

**STACK**
Requests a report on Storage Management control blocks pertaining to STACK storage.

**SM**
Requests a report on Storage Management control blocks. This is the same as specifying both HEAP and STACK.

**HPT(number) [ HPTTCB(address) ] [ HPTCELL(address) ] [ HPTLOC(location) ]**

**HPT(number)**
Requests that the HEAPPOOLS trace, if available, be formatted. If the value is 0 or *, the trace for every HEAPPOOLS pool id is formatted. If the value is a single number (1-12), the trace for the specific HEAPPOOLS pool id is formatted. If only the HPT keyword is specified with no value, the trace behaves similar to when the value is *. If no filter is specified, all of the entries are formatted for the specific pool id.

**HPTTCB(address)**
Filters the HEAPPOOLS trace table, if available, printing only those entries for a given TCB address (address).

**HPTCELL(address)**
Filters the HEAPPOOLS trace table, if available, printing only those entries for a given cell address (address).

**HPTLOC(location)**
Filters the HEAPPOOLS trace table, if available, printing only those entries for a given virtual storage location (location). The following values are valid:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>Display entries located in virtual storage below the bar.</td>
</tr>
<tr>
<td>64</td>
<td>Display entries located in virtual storage above the bar.</td>
</tr>
<tr>
<td>ALL</td>
<td>Display entries located in virtual storage below or above the bar.</td>
</tr>
</tbody>
</table>

**Note:**
1. Filter options without specifying HPT implies HPT(*).
2. You can specify multiple options together, like HPTTCB and HPTCELL. All pieces of information must match the trace entry for it to be formatted. If location and cell contradict each other, such as HPTLOC(31) and HPTCELL(64bit addr), an error will be displayed.

**CM**
Requests a report on Condition Management control blocks.

**MH**
Requests a report on Message Handler control blocks.
**CEEDump**
Requests a CEEDUMP-like report. Currently this includes the traceback, the Language Environment trace, and thread synchronization control blocks at process, enclave and thread levels.

If the dump output has multiple nested enclaves or multiple nested CEEPIPI Main-DP environments, tracebacks will appear for each enclave in each Main-DP environment. This is similar to how the tracebacks appear in the CEEDUMP output. See the section “Multiple enclave dumps” on page 80 for a description of CEEDUMP output when multiple enclave and Main-DP environments are present.

**PTBL(value)**
Requests that PreInit tables be formatted according to the following values:

- **CURRENT**
  If current is specified, the PreInit table associated with the current or specified TCB is displayed.

- **address**
  If an address is specified, the PreInit table at that address is specified.

- `*` All active and dormant PreInit tables within the current address space are displayed; this option is time-consuming.

- **ACTIVE**
  The PreInit tables for all TCBs in the address space are displayed.

**COMP(value)**
Requests component control blocks to be formatted according to the following values:

- **C** Requests a report on C/C++ runtime control blocks.

- **CIO**
  Requests a report on C/C++ I/O control blocks.

- **COBOL**
  Requests a report on COBOL-specific control blocks.

- **PLI**
  Requests a report on PL/I-specific control blocks.

- **ALL**
  Requests a report on all the preceding control blocks.

If the value specified in COMP is not one of the values (C, CIO, COBOL, PLI, or ALL), a message is displayed and it continues executing as if COMP(ALL) was specified.

**Note:** The ALL parameter for LEDATA also generates a report that includes all the component control blocks.

**ALL**
Requests all above reports, as well as C/C++, COBOL, and PL/I reports.

### Data selection parameters

Data selection parameters limit the scope of the data in the report. If no data selection parameter is selected, the default is DETAIL.

**DETail**
Requests formatting all control blocks for the selected components. Only
significant fields in each control block are formatted. For the Heap and Storage Management Reports, the DETAIL parameter will provide a detailed heap segment report for each heap segment in the dump. The detailed heap segment report includes information on the free storage tree in the heap segments, and all allocated storage elements. This report will also identify problems detected in the heap management data structures. For more information about the Heap Reports, see “Understanding the HEAP LEDATA output” on page 111.

EXCeption
Requests validating all control blocks for the selected components. Output is only produced naming the control block and its address for the first control block in a chain that is invalid. Validation consists of control block header verification at the very least.

For the Summary, CEEDUMP, C/C++, COBOL, and PL/I reports, the EXCEPTION parameter has not been implemented. For these reports, DETAIL output is always produced.

Control block selection parameters
Use these parameters to select the control blocks used as the starting points for formatting.

CAA(caa-address)
  specifies the address of the CAA. If not specified, the CAA address is obtained from the TCB.

DSAdsa-address
  specifies the address of the DSA. If not specified, the DSA address is assumed to be the register 13 value for the TCB.

TCB(tcb-address)
  specifies the address of the TCB. If not specified, the TCB address of the current TCB from the CVT is used.

ASID(address-space-id)
  specifies the hexadecimal address space ID. If not specified, the IPCS default address space ID is used. This parameter is not needed when the dump only has one address space.

NTHREADS(value)
  specifies the number of TCBs for which the traceback will be displayed. If NTHREADS is not specified, value will default to (1). If value is specified as asterisk (*), all TCBs will be displayed.

Examples
For examples of the output produced by LEDATA and explanation of the content, refer to “Understanding the Language Environment IPCS VERBEXIT LEDATA output.”

Understanding the Language Environment IPCS VERBEXIT LEDATA output
The Language Environment IPCS VERBEXIT LEDATA generates formatted output of the Language Environment runtime environment control blocks from a system dump. The following example illustrates the output produced when the LEDATA VERBEXIT is invoked with the ALL parameter. (Ellipses are used to summarize some sections of the dump.) The system dump being formatted was obtained by
specifying the TERMTHDACT(UADUMP) runtime option when running the program CELSAMP in Figure 8 on page 45.

“Sections of the Language Environment LEDATA VERBEXIT formatted output” on page 106 describes the information contained in the formatted output. For reference, the sections of the sample dump are numbered to correspond with the descriptions of the formatted output.

Figure 18. Example of formatted output from LEDATA VERBEXIT (Part 1 of 18)
Figure 19. Example of formatted output from LEDATA VERBEXIT (Part 2 of 18)
Figure 20. Example of formatted output from LEDATA VERBEXIT (Part 3 of 18)
LAST WHERE SET Override OPTIONS

<table>
<thead>
<tr>
<th>Language Environment Runtime Options in effect.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAST WHERE SET Override OPTIONS</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR ABPERC(NONE)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR ABTERMNC(ABEND)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR NOAIXBLD</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR ALL3I(ON)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR ANYHEAP(0000016384,0000008192,ANY ,FREE)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR NOAUTOTASK</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR BELOWHEAP(00008192,000004096,FREE)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR CBLOPTS(ON)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR CBLYSHPOP(ON)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR CBLODA(OFF)</td>
</tr>
<tr>
<td>DD:CEEPTS OVR CEEDUMP(0000000000,SYSOUT=*,FREE=END,SPIN=UNALLOC)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR CHECK(ON)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR COUNTRY(US)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR NODEBUG</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR DEPTHCLUDMUT(0000000010)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR ENVAR(*** )</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR ERRCOUNT(0000000000)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR ERROR(0000000000)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR ERROR(0000000000)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR FILELIST</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR FILETAG(NOAUTOCVT,NOAUTOTAG)</td>
</tr>
<tr>
<td>DEFAULT SETTING OVR NOFLOW</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR HEAP(0000032768,0000032768,ANY ,KEEP,0000524288,0000131072)</td>
</tr>
<tr>
<td>DD:CEEPTS OVR HEAPCHK(ON,0000000001,0000000001,0000000010,0000000010,0000131072,0000131072)</td>
</tr>
<tr>
<td>DD:CEEPTS OVR HEAPPOOLS(ON,0000000000,0000000001,0000000001,0000000001,0000000001,0000000001,0000000001)</td>
</tr>
<tr>
<td>DD:CEEPTS OVR HEAPZONES(0000,ABEND,0000,ABEND)</td>
</tr>
<tr>
<td>DD:CEEPTS OVR INFMESFILTER(ON)</td>
</tr>
<tr>
<td>DD:CEEPTS OVR INQPCOPN</td>
</tr>
<tr>
<td>DD:CEEPTS OVR INTERRUPT(OFF)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR LIBSTACK(0000000000,0000000000,0000000000,0000000000,0000000000,0000000000,0000000000)</td>
</tr>
<tr>
<td>DD:CEEPTS OVR MSGFILE(SYSOUT,FBA,00000121,00000000,NOENQ)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR MSGQ(0000000000)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR NATLANG(EN)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR NONONIPTSTACK(See THREADSTACK)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR OCSTATUS</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR PAGEFRAMESIZE(4K,4K,4K)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR PLITASKCOUNT(0000000020)</td>
</tr>
<tr>
<td>PROGRAMMER DEFAULT OVR POSIX(ON)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR PROFILE(9,9,9)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR PRUN(0000000000)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR PRUN(0000000000)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR RCH(0000000000)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR RCH(0000000000)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR RRPOPT(ON)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR RPSTG(ON)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR NORTEREUS</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR NOSIMVRD</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR STACK(0000131072,0000131072,ANY ,KEEP,000524288,0000131072)</td>
</tr>
<tr>
<td>DD:CEEPTS OVR STORAGE(AA,BB,CC,0000000000)</td>
</tr>
<tr>
<td>DD:CEEPTS OVR TERMTHDACT(UADUMP,CESE,0000000000)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR NOTEST(ALL,* ,PROMPT,INSPPREF)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR THREADHEAP(0000000000,0000000000,0000000000,0000000000)</td>
</tr>
<tr>
<td>IBM-SUPPLIED DEFAULT OVR THREADSTACK(OFF,0000000000,0000000000,0000000000,0000000000,0000000000)</td>
</tr>
</tbody>
</table>

Figure 21. Example of formatted output from LEDATA VERBEXIT (Part 4 of 18)
Figure 22. Example of formatted output from LEDATA VERBEXIT (Part 5 of 18)
Free Storage Tree for Heap Segment 21D91018

<table>
<thead>
<tr>
<th>Depth</th>
<th>Address</th>
<th>Length</th>
<th>Node</th>
<th>Node</th>
<th>Parent</th>
<th>Left</th>
<th>Right</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>21D96260</td>
<td>00002DB8</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Map of Heap Segment 21D91018

To display entire segment: IP LIST 21D91018 LEN(X'00008000') ASID(X'01A9')

21D91038: Allocated storage element, length=00001030. To display: IP LIST 21D91038 LEN(X'00001030') ASID(X'01A9')

21D92068: Allocated storage element, length=0000828. To display: IP LIST 21D92068 LEN(X'0000828') ASID(X'01A9')

21D92098: Allocated storage element, length=0000CD0. To display: IP LIST 21D92098 LEN(X'0000CD0') ASID(X'01A9')

21D93580: Allocated storage element, length=00002030. To display: IP LIST 21D93580 LEN(X'00002030') ASID(X'01A9')

21D95598: Allocated storage element, length=0000CD0. To display: IP LIST 21D95598 LEN(X'0000CD0') ASID(X'01A9')

21D96260: Free storage element, length=00002DB8. To display: IP LIST 21D96260 LEN(X'00002DB8') ASID(X'01A9')

Summary of analysis for Heap Segment 21D91018:
Amounts of identified storage: Free: 00002DB8 Allocated: 00005228 Total: 00007FE0
Number of identified areas: Free: 1 Allocated: 5 Total: 6
00000000 bytes of storage were not accounted for.
No errors were found while processing this heap segment.
This is the last heap segment in the current heap.

Anywhere Heap Control Blocks
HPCB: 21615D20
+000000 EYE_CATCHER:HPCB FIRST:21D6D000 LAST:22177000

HPSB: 21615E04
+000000 HPSB EYE_CATCHER:21D9A000 BYTES_ALLOC:0037B788 CURR_ALLOC:0031EE68
+000000 GET_REQ:00000DCA FREE_REQ:00000D75
+000010 GETMAINS:00000013 FREEMAINS:00000005

HANC: 21D6D000
+000000 EYE_CATCHER:HANC NEXT:21D9A000 PREV:21615D20
+000000 HEAP_ID:21615D20 SEG_ADDR:A1D6D000 ROOT_ADDR:21D70620
+000000 SEG_LEN:00004000 ROOT_LEN:00000000

Free Storage Tree for Heap Segment 21D6D000

<table>
<thead>
<tr>
<th>Depth</th>
<th>Address</th>
<th>Length</th>
<th>Node</th>
<th>Node</th>
<th>Parent</th>
<th>Left</th>
<th>Right</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>21D70620</td>
<td>00009E00</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Figure 23. Example of formatted output from LEDATA VERBEXIT (Part 6 of 18)
Map of Heap Segment 21D6D000

To display entire segment: IP LIST 21D6D000 LEN(X'00004000') ASID(X'01A9')

21D6D020: Allocated storage element, length=00000018. To display: IP LIST 21D6D020 LEN(X'00000018') ASID(X'01A9')

Below Heap Control Blocks

HPCB: 21615D50
+000000 EYE_CATCHER:HPCB FIRST:21615D50 LAST:21615D50

** NO SEGMENTS ALLOCATED **

HPSB: 21615E1C
+000000 BYTES_ALLOC:00000000 CURR_ALLOC:00000000
+000008 GET_REQ:00000000 FREE_REQ:00000000
+000010 GETMAINS:00000000 FREEMAINS:00000000

Additional Heap Control Blocks

HPSB: 21615E34
+000000 BYTES_ALLOC:00000908 CURR_ALLOC:00000908
+000008 GET_REQ:00000007 FREE_REQ:00000000
+000010 GETMAINS:00000003 FREEMAINS:00000002

ADHP: 22118238
+000000 EYE_CATCHER:ADHP NEXT:FOF00000 HEAPID:22118244

HPCB: 22118244
+000000 EYE_CATCHER:HPCB FIRST:2212B000 LAST:2212B000

HANC: 2212B000
+000000 EYE_CATCHER:HANC NEXT:22118244 PREV:22118244
+000000 HEAPID:22118244 SEG_ADDR:2212B000 ROOT_ADDR:2212B2C8
+000008 SEG_LEN:00001000 ROOT_LEN:00000D38

This is the last heap segment in the current heap.

Free Storage Tree for Heap Segment 2212B000

Node | Node | Parent | Left | Left | Right | Right
Depth | Address | Length | Node | Node | Node | Length | Length
0 2212B2C8 00000038 08000000 00000000 00000000 00000000 00000000

Map of Heap Segment 2212B000

To display entire segment: IP LIST 2212B000 LEN(X'00001000') ASID(X'01A9')

2212B020: Allocated storage element, length=000002A8. To display: IP LIST 2212B020 LEN(X'000002A8') ASID(X'01A9')

2212B028: D7C3C9C2 00000000 00000000 00000000 00000000 00000000 00000000 00000000 |PCIB............................|

2212B2C8: Free storage element, length=00000D38. To display: IP LIST 2212B2C8 LEN(X'00000D38') ASID(X'01A9')

Summary of analysis for Heap Segment 2212B000:

Amounts of identified storage: Free: 00000D38 Allocated: 000002A8 Total: 00000FE0

Number of identified areas: Free: 1 Allocated: 1 Total: 2

00000000 bytes of storage were not accounted for.

No errors were found while processing this heap segment.

This is the last heap segment in the current heap.

Figure 24. Example of formatted output from LEDATA VERBEXIT (Part 7 of 18)
Heap Pool Report

QPCB: 21D6DA00
+000000 EYECATCHER:QPCB LENGTH:00000800 NUMPOOLS:000006
+00000C LARGEST_CELL_SIZE:00000800 BIG_REQUESTS:000001
+00014 STORAGE_HITS_ADDR:21F00028 FLAGS:E400 NUMGETARRAYS:00
+0001B NUMCELLSIZES:06 GET_POOLINFO_ARRAYS_PTR:21D6DA28

Data for pool 1:

POOLDATA: 21D60000
+000000 POOLDATA:00000001 INPUT_CELL_SIZE:00000800
+000008 CELL_SIZE:00000010 INPUT_PERCENT:0000000A
+000010 CELL_POOL_SIZE:000000CA CELL_POOL_NUM:00000051
+000018 POOL_LATCH_ADDR:21EA4DC8 POOL_EXTENTS:00000000
+000020 LAST_CELL:21D90000 NEXT_CELL:21D90000
+000028 Q_CONTROL_INFO:00000000 Q_FIRST_CELL:00000000
+000030 POOL_NUM_GET_TOTAL:00000001 POOL_INDEX_SAME_SIZE:01
+000033 POOL_INDEX_SIZE:01 POOL_INDEX_SAME_SIZE:01
+000034 POOL_TRACE_TABLE:21EAF070

Heap Pool Extent Mapping
EXTENT: 21D90000
+000000 POOLDATA:000000001 INPUT_CELL_SIZE:00000800
+000008 CELL_SIZE:00000010 INPUT_PERCENT:0000000A
+000010 CELL_POOL_SIZE:000000CA CELL_POOL_NUM:00000051
+000018 POOL_LATCH_ADDR:21EA4DC8 POOL_EXTENTS:00000000
+000020 LAST_CELL:21D90000 NEXT_CELL:21D90000
+000028 Q_CONTROL_INFO:00000000 Q_FIRST_CELL:00000000
+000030 POOL_NUM_GET_TOTAL:00000001 POOL_INDEX_SAME_SIZE:01
+000033 POOL_INDEX_SIZE:01 POOL_INDEX_SAME_SIZE:01
+000034 POOL_TRACE_TABLE:21EAF070

To display entire pool extent: IP LIST 21D90000 LEN(X'00000CC8') ASID(X'01A9')

Summary of analysis for Pool 1:

Number of cells: Unused: 202 Free: 0 Allocated: 2 Total Used: 204
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Data for pool 2:

POOLDATA: 21D60000
+000000 POOLDATA:00000002 INPUT_CELL_SIZE:00000200
+000008 CELL_SIZE:00000028 INPUT_PERCENT:0000000A
+000010 CELL_POOL_SIZE:000000CA CELL_POOL_NUM:00000051
+000018 POOL_LATCH_ADDR:21EA4DC8 POOL_EXTENTS:00000000
+000020 LAST_CELL:00000000 NEXT_CELL:00000000
+000028 Q_CONTROL_INFO:00000000 Q_FIRST_CELL:00000000
+000030 POOL_NUM_GET_TOTAL:00000000 POOL_INDEX_SAME_SIZE:01
+000033 POOL_INDEX_SIZE:02 POOL_INDEX_SAME_SIZE:01
+000034 POOL_TRACE_TABLE:21EAF070

Heap Pool Extent Mapping
EXTENT: 21D90000
+000000 POOLDATA:000000002 INPUT_CELL_SIZE:00000200
+000008 CELL_SIZE:00000028 INPUT_PERCENT:0000000A
+000010 CELL_POOL_SIZE:000000CA CELL_POOL_NUM:00000051
+000018 POOL_LATCH_ADDR:21EA4DC8 POOL_EXTENTS:00000000
+000020 LAST_CELL:00000000 NEXT_CELL:00000000
+000028 Q_CONTROL_INFO:00000000 Q_FIRST_CELL:00000000
+000030 POOL_NUM_GET_TOTAL:00000000 POOL_INDEX_SAME_SIZE:01
+000033 POOL_INDEX_SIZE:02 POOL_INDEX_SAME_SIZE:01
+000034 POOL_TRACE_TABLE:21EAF070

There are no extents for this pool.

Data for pool 6:

POOLDATA: 21D60000
+000000 POOLDATA:00000006 INPUT_CELL_SIZE:00000800
+000008 CELL_SIZE:000000A0 INPUT_PERCENT:0000000A
+000010 CELL_POOL_SIZE:00002020 CELL_POOL_NUM:00000041
+000018 POOL_LATCH_ADDR:21EA4D68 POOL_EXTENTS:00000001
+000020 LAST_CELL:21D93568 NEXT_CELL:21D93576
+000028 Q_CONTROL_INFO:00000000 Q_FIRST_CELL:00000000
+000030 POOL_NUM_GET_TOTAL:00000001 POOL_INDEX_SAME_SIZE:01
+000033 POOL_INDEX_SIZE:06 POOL_INDEX_SAME_SIZE:01
+000034 POOL_TRACE_TABLE:21EAF070

Heap Pool Extent Mapping
EXTENT: 21D90000
+000000 POOLDATA:00000006 INPUT_CELL_SIZE:00000800
+000008 CELL_SIZE:000000A0 INPUT_PERCENT:0000000A
+000010 CELL_POOL_SIZE:00002020 CELL_POOL_NUM:00000041
+000018 POOL_LATCH_ADDR:21EA4D68 POOL_EXTENTS:00000001
+000020 LAST_CELL:21D93568 NEXT_CELL:21D93576
+000028 Q_CONTROL_INFO:00000000 Q_FIRST_CELL:00000000
+000030 POOL_NUM_GET_TOTAL:00000001 POOL_INDEX_SAME_SIZE:01
+000033 POOL_INDEX_SIZE:06 POOL_INDEX_SAME_SIZE:01
+000034 POOL_TRACE_TABLE:21EAF070

To display entire pool extent: IP LIST 21D90000 LEN(X'00002028') ASID(X'01A9')

Summary of analysis for Pool 6:

Number of cells: Unused: 3 Free: 0 Allocated: 1 Total Used: 4
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Figure 25. Example of formatted output from LEDATA VERBEXIT (Part 8 of 18)
Figure 26. Example of formatted output from LEDATA VERBEXIT (Part 11 of 18)
To display entire DSA: IP LIST 21D712D0 LEN(X’0000030F8’) ASID(X’01A9’)

DSA: 21D71248
+000000 FLAGS:10CC MEMD:CCCC BKC:21D71130 FWC:21D7132B
+000000C R4:169030A R5:21604328 R0:21601570
+000030 R7:21601570 R8:00000003 R9:80000000
+00003C R10:A1692F48 R11:A1692F48 R12:21616BB8
+000048 LWS:00000000 NAB:21D7132B PNAB:CCCCCCCC
+000064 RENT:CCCCCCCC CILC:CCCCCCCC MODE:CCCCCCCC
+000078 HMR:CCCCCCCC

Contents of DSA at location 21D71248:

To display entire DSA: IP LIST 21D71130 LEN(X’00000118’) ASID(X’01A9’)

DSA: 21D71130
+000000 FLAGS:10CC MEMD:CCCC BKC:21D71030 FWC:21D7124B
+000000C R4:169030A R5:21601570 R0:21D7124B
+000030 R7:21604330 R8:00000003 R9:80000000
+00003C R10:A1692F48 R11:A1692F48 R12:21616BB8
+000048 LWS:00000000 NAB:21D71130 PNAB:CCCCCCCC
+000064 RENT:CCCCCCCC CILC:CCCCCCCC MODE:CCCCCCCC
+000078 HMR:CCCCCCCC

Contents of DSA at location 21D71030:

To display entire DSA: IP LIST 21D71030 LEN(X’00000118’) ASID(X’01A9’)

DSA: 21D71030
+000000 FLAGS:0000 MEMD:CCCC BKC:21617660 FWC:CCCCCCCC
+000000C R4:169030A R5:21604328 R0:21601570
+000030 R7:21604330 R8:00000003 R9:80000000
+00003C R10:A1692F48 R11:A1692F48 R12:21616BB8
+000048 LWS:00000000 NAB:21D71130 PNAB:CCCCCCCC
+000064 RENT:CCCCCCCC CILC:CCCCCCCC MODE:CCCCCCCC
+000078 HMR:CCCCCCCC

User Stack Control Blocks

STKH: 21D71018
+000000 EYE_CATCHER:STKU NEXT:2161742C PREV:2161742C
+00000C SEGMENT_LEN:00000000

Figure 27. Example of formatted output from LEDATA VERBEXIT (Part 12 of 18)
Figure 28. Example of formatted output from LEDATA VERBEXIT (Part 13 of 18)
Figure 29. Example of formatted output from LEDATA VERBEXIT (Part 14 of 18)
Figure 30. Example of formatted output from LEDATA VERBEXIT (Part 15 of 18)
Message Processing Control Blocks

CMXB: 216151A0
+000000 EYE:CMXB SIZE:0148 FLAGS:0000 DHEAD1:00016000
+00000C DHEAD2:00012000

MDST forward chain from CMXBHEAD(1)

MDST: 00016000
+000000 EYE:MDST SIZE:0100 CTL:00 CEEDUMPLOC:00
+000008 NEXT:00012000 PREV:00000000 DDNAM:CEEDUMP
+00000C DHEAD2:00012000
MDST: 00012000
+000000 EYE:MDST SIZE:0100 CTL:00 CEEDUMPLOC:00
+000008 NEXT:00000000 PREV:00016000 DDNAM:SYSOUT

MDST back chain from CMXBHEAD(2)

MDST: 00016000
+000000 EYE:MDST SIZE:0100 CTL:00 CEEDUMPLOC:00
+000008 NEXT:00012000 PREV:00000000 DDNAM:CEEDUMP
+00000C DHEAD2:00012000
MDST: 00012000
+000000 EYE:MDST SIZE:0100 CTL:00 CEEDUMPLOC:00
+000008 NEXT:00000000 PREV:00016000 DDNAM:SYSOUT

TMXB: 2160F048
+000000 EYE:TMXB MIB_CHAIN_PTR:22167028

MGF: 22167028
+000000 EYE:CMIB PREV:22131780 NEXT:22118380 SEQ:00000005
+000010 CTOK:00000BF7 41C3C5C5 (CEE3063I)
MGF: 22118380
+000000 EYE:CMIB PREV:22167028 NEXT:2160F080 SEQ:00000002
+000010 CTOK:00030C89 59C3C5C5 (CEE3209S)
MGF: 2160F080
+000000 EYE:CMIB PREV:22118380 NEXT:221315C0 SEQ:00000001
+000010 CTOK:00000DF6 41C3C5C5 (CEE3574I)
MGF: 221315C0
+000000 EYE:CMIB PREV:2160F080 NEXT:22131780 SEQ:00000003
+000010 CTOK:000301CE 59C3C5C5 (CEE0462S)
MGF: 22131780
+000000 EYE:CMIB PREV:221315C0 NEXT:22167028 SEQ:00000004
+000010 CTOK:000101C7 49C3C5C5 (CEE0455W)

Information for enclave main

Information for thread 27AC0D0800000000
PCB Address: 21615320
TCB Address: 008E6968

Registers and PSW:

GPR0..... 00000000_84000000 GPR1..... 00000000_84000000 GPR2..... 00000000_21D72618 GPR3..... 00000000_00020009
GPR4..... 00000000_216CEB88 GPR5..... 00000000_216E9C32 GPR6..... 00000000_21615320 GPR7..... 00000000_21604E30
GPR8..... 00000000_21D72618 GPR9..... 00000000_21D721AC GPR10.... 00000000_21D7201F GPR11.... 00000000_A1609B58
GPR12.... 00000000_21616888 GPR13.... 00000000_21D74E18 GPR14.... 00000000_A1609B58 GPR15.... 00000000_00000000
PSW..... 078D1400 A16D9C32

Figure 31. Example of formatted output from LEDATA VERBEXIT (Part 16 of 18)
Figure 32. Example of formatted output from LEDATA VERBEXIT (Part 17 of 18)
Sections of the Language Environment LEDATA VERBEXIT formatted output

The sections of the output listed in Table 21 appear independently of the Language Environment-conforming languages used.

Table 21. Contents of the Language Environment LEDATA VERBEXIT formatted output

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] - [9] <strong>Summary</strong></td>
<td>The following sections are included when the SUMMARY parameter is specified on the LEDATA invocation.</td>
</tr>
<tr>
<td>Section Number and Heading</td>
<td>Contents</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------</td>
</tr>
</tbody>
</table>
| [1] Summary Header        | Contains the following information:  
|                           | • Address of Thread control block (TCB)  
|                           | • Release number  
|                           | • Address Space ID (ASID) |
| [2] Active Members List   | List of active members is extracted from the enclave member list (MEML) |
| [4] CEEDLLF               | Formats the contents of all Language Environment CEEDLLF (DLLF) control blocks that are in use. See The CEEDLLF DLL Failure Control Block in z/OS Language Environment Vendor Interfaces for more information about the CEEDLLF control block chain. |
| [5] CEEPCB                | Formats the contents of the Language Environment process control block (PCB), and the process level member list. |
| [7] CEEEDB                | Formats the contents of the Language Environment enclave data block (EDB), and the enclave level member list. |
| [8] PMCB                  | Formats the contents of the Language Environment program management control block (PMCB). |
| [9] Runtime Options       | Lists the runtime options in effect at the time of the dump, and indicates where they were set. |
| [10] Heap Storage Control Blocks | This section is included when the HEAP or SM parameter is specified on the LEDATA invocation. It formats the Enclave-level storage management control block (ENSM) and for each different type of heap storage:  
|                           | • Heap control block (HPCB)  
|                           | • Chain of heap anchor blocks (HANC). A HANC immediately precedes each segment of heap storage.  
|                           | This section includes a detailed heap segment report for each segment in the dump. For more information about the detailed heap segment report, see “Understanding the HEAP LEDATA output” on page 111.  
|                           | When HEAPPOOLS is ON, this section also includes a detailed heap pools report. For more information about the detailed heap pools report, see “Understanding the heap pools LEDATA output” on page 116. |
| [11] Stack Storage Control Blocks | This section is included when the STACK or SM parameter is specified on the LEDATA invocation; it formats:  
|                           | • Storage management control block (SMCB)  
|                           | • Chain of dynamic save areas (DSA). See “Upward-growing (non-XPLINK) stack frame section” on page 63 or “Downward-growing (XPLINK) stack frame section” on page 64 for a description of the fields in the DSA.  
|                           | • Chain of stack segment headers (STKH). An STKH immediately precedes each segment of stack storage. |
| [12] Condition Management Control Blocks | This section is included when the CM parameter is specified on the LEDATA invocation; it formats the chain of Condition Information Block Headers (CIBH) and Condition Information Blocks. The Machine State Information Block is contained with the CIBH starting with the field labeled MCH_EYE. See “Condition information block” on page 73 for a description of fields in these control blocks. |
| [13] Message Processing Control Blocks | This section is included when the MH parameter is specified on the LEDATA invocation. |
Table 21. Contents of the Language Environment LEDATA VERBEXIT formatted output (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[14]-[17] NTHREADS information:</td>
<td>One or more instances of these sections are included when the NTHREADS() parameter is specified on the LEDATA invocation. For a description of NTHREADS, see &quot;Report type parameters&quot; on page 87.</td>
</tr>
<tr>
<td>[14] - [21] CEEDUMP Formatted Control Blocks:</td>
<td>These sections are included when the CEEDUMP parameter is specified on the LEDATA invocation.</td>
</tr>
<tr>
<td>[14] Enclave Identifier</td>
<td>Names the enclave for which information is provided.</td>
</tr>
<tr>
<td>[15] Information for thread</td>
<td>Shows the system identifier for the thread. Each thread has a unique identifier.</td>
</tr>
<tr>
<td>[16] Registers and PSW</td>
<td>Displays the register and program status word (PSW) values that were used to create the traceback. These values may come from the TCB, the RTM2 work area, a linkage stack entry or output from the BPXGMSTA service. This section is not displayed when the DSA() parameter is specified on the LEDATA invocation.</td>
</tr>
</tbody>
</table>
Table 21. Contents of the Language Environment LEDATA VERBEXIT formatted output (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[17] Traceback</td>
<td>For all active routines in a particular thread, the traceback section shows routine information in two parts. The first part contains the following items:</td>
</tr>
<tr>
<td></td>
<td>• DSA number: A number assigned to the information for this active routine by dump processing. The number is used to associate information from the first part of the traceback with information in the second part of the traceback.</td>
</tr>
<tr>
<td></td>
<td>• Entry: For COBOL, Fortran, and PL/1 routines, this is the entry point name. For C/C++ routines, this is the function name. If a function name or entry point was not specified for a particular routine, the string &quot;** NoName **&quot; will appear.</td>
</tr>
<tr>
<td></td>
<td>• Entry point offset</td>
</tr>
<tr>
<td></td>
<td>• Statement number: This field contains no Language Environment data.</td>
</tr>
<tr>
<td></td>
<td>• Load module</td>
</tr>
<tr>
<td></td>
<td>• Program unit: The primary entry point of the external procedure. For COBOL programs, this is the PROGRAM-ID name. For C, Fortran, and PL/1 routines, this is the compile unit name. For Language Environment-conforming assemblers, this is the EPNAME = value on the CEEPPA macro.</td>
</tr>
<tr>
<td></td>
<td>• Service level: The latest service level applied to the compile unit (for example, for IBM products, it would be the PTF number).</td>
</tr>
<tr>
<td></td>
<td>• Status: Routine status can be call, exception, or running.</td>
</tr>
<tr>
<td></td>
<td>The second part contains the following items:</td>
</tr>
<tr>
<td></td>
<td>• DSA number</td>
</tr>
<tr>
<td></td>
<td>A number assigned to the information for this active routine by dump processing. The number is used to associate information from the first part of the traceback with information in the second part of the traceback.</td>
</tr>
<tr>
<td></td>
<td>• Stack frame (DSA) address</td>
</tr>
<tr>
<td></td>
<td>• Entry point address</td>
</tr>
<tr>
<td></td>
<td>• Program unit address</td>
</tr>
<tr>
<td></td>
<td>• Program unit offset: The offset of the last instruction to run in the routine. If the offset is a negative number, zero, or a very large positive number, the routine associated with the offset probably did not allocate a save area, or the routine could have been called using SVC-assisted linkage. Adding the program unit address to the offset gives you the location of the current instruction in the routine. This offset is from the starting address of the routine.</td>
</tr>
<tr>
<td></td>
<td>• Compile Date: Contains the year, month and day in which the routine was compiled.</td>
</tr>
<tr>
<td></td>
<td>• Attributes: The available compilation attributes of the compile unit include:</td>
</tr>
<tr>
<td></td>
<td>– A label identifying the LE-supported language such as COBOL, ENT PL/I, C/C++, and so on.</td>
</tr>
<tr>
<td></td>
<td>– Compilation attributes such as EBCDIC, ASCII, IEEE, or hexadecimal floating point (HFP). The compilation attributes will only be displayed if there is enough information available.</td>
</tr>
<tr>
<td></td>
<td>– POSIX, If the CEEDUMP was created under a POSIX environment.</td>
</tr>
<tr>
<td>[18] Control Blocks Associated with the Thread</td>
<td>Lists the contents of the thread synchronization queue element (SQEL).</td>
</tr>
<tr>
<td>[19] Enclave Control Blocks</td>
<td>If the POSIX runtime option was set to ON, this section lists the contents of the mutex and condition variable control blocks, the enclave level latch table, and the thread synchronization trace block and trace table. If the HEAPCHK runtime option is set to ON, this section lists the contents of the HEAPCHK options control block (HCOP) and the HEAPCHK element tables (HCEL). A HEAPCHK element table contains the location and length of all allocated storage elements for a heap in the order that they were allocated.</td>
</tr>
<tr>
<td>Section Number and Heading</td>
<td>Contents</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>[20] Language Environment Trace Table</td>
<td>If the TRACE runtime option was set to ON, this section shows the contents of the Language Environment trace table.</td>
</tr>
<tr>
<td>[21] Process Control Blocks</td>
<td>If the POSIX runtime option was set to ON, this section lists the contents of the process level latch table.</td>
</tr>
<tr>
<td>[22] Preinitialization Information</td>
<td>This section is included when the PTBL parameter is specified on the LEDATA invocation. This section formats information related to preinitialization. See PTBL LEDATA output for more information. If the preinitialization service CEEPIPI was not used to initialize this environment, the message: No PIPICB associated with CAA is displayed instead.</td>
</tr>
</tbody>
</table>

**PTBL LEDATA output:** The VERBEXIT LEDATA command generates formatted output of Preinit tables when the PTBL or ALL parameter are specified. If ALL is specified, PTBL defaults to CURRENT value. The following sample illustrates the output produced when the VERBEXIT LEDATA command is invoked with the PTBL parameter.

```
PTBL(CURRENT)
********************************************************************************
LANGUAGE ENVIRONMENT DATA
********************************************************************************
Language Environment Product 04 V01 R09.00

PreInitialization Programming Interface Trace Data
CEEPIPI Environment Table Entry and Trace Entry:
Active CEEPIPI Environment (Address 20905C00)
Eyecatcher: CEEXIPTB
TCB address: 008D6E88

CEEPIPI Environment:
Non-XPLINK Environment
Environment Type: MAIN
Sequence of Calls not active
Exits not established
Signal Interrupt Routines not registered
Service Routines not active

CEEPIPI Environment Enclave Initialized
Number of CEEPIPI Table Entries = 3

CEEPIPI Table Entry Information:
CEEPIPI Table Index 0 (Entry 1)
Routine Name = ISJPPCA3
Routine Type = C/C++
Routine Entry Point = A0910530
Routine Function Pointer = A0910620
Routine Entry is Non-XPLINK
Routine was loaded by Language Environment
Routine Address was resolved
Routine Function Descriptor was valid
Routine Return Code = 0
Routine Reason Code = 0

Entry of routine in CEEPIPI Table for Index 0 (20905DB8)
+000000 20905DB8 A0910620 20919B30 80000000 00000000 00000000 00000000 00000000 00000000 |.j..........................|
+000020 20905DD8 00000000 00000000 00000000 A0910530 00000003 209197D8 00000003 20910530 |.............j.......jpQ.....j..|
+000040 20905DF8 A0910530 00009AD0 C9E2D1D7 D7C3C1F3 00000000 00000000 00000000 00000000 |.j......ISJPPCA3................|

CEEPIPI Table Index 1 (Entry 2) not in use.
CEEPIPI Table Index 2 (Entry 3) not in use.

CEEPIPI Trace Table Entries:
Call Type = INIT_MAIN
PIPI Driver Address = A090068A
Load Service Return Code = 0
Load Service Reason Code = 0
Most Recent Return Code = 0
Most Recent Reason Code = 0
An ABEND will be issued if storage cannot be obtained
Preinit Environment will not allow EXEC CICS commands
Service RC = 0: A new environment was initialized.
```
Exiting Language Environment Data

When nested CEEPIPI main-DP environments are present, two new items will appear after the TCB address:

- Address of the CEEPIPI environment (PTBL) that called the currently displayed CEEPIPI environment.
- Saved register 13 value. This is the address of the DSA for the Language Environment routine called from the assembler CEEPIPI driver.

The following is an example:

```
EYECATCHER : CEEXPITB
TCB ADDRESS : XXXXXXXX
CALLER PTBL : XXXXXXXX
SAVED R13 : XXXXXXXX
```

Understanding the HEAP LEDATA output

The Language Environment IPCS VERBEXIT LEDATA generates a detailed heap segment report when the HEAP option is used with the DETAIL option, or when the SM,DETAIL option is specified. The detailed heap segment report is useful when trying to pinpoint damage because it provides very specific information. The report describes the nature of the damage, and specifies where the actual damage occurred. The report can also be used to diagnose storage leaks, and to identify heap fragmentation. The following example illustrates the output produced by specifying the HEAP option. "Heap report sections of the LEDATA output" on page 115 describes the information contained in the formatted output. For easy reference, the sections of the dump are numbered to correspond with the description of each section that follows in Table 22 on page 115. Ellipses are used to summarize some sections of the dump.

Note: Language Environment does not provide support for alternative Vendor Heap Manager (VHM) data. LEDATA verb exit will state that an alternative VHM is in use.
Heap Storage Control Blocks

ENSM: 00014D30
  +0000A8  ENSM_ADDL_HEAPS:259B1120

User Heap Control Blocks

HPCB: 00014D48
  +000000  EYE_CATCHER:HPCB FIRST:25995000 LAST:25995000

  HANC: 25995000
  +000000  EYE_CATCHER:HANC NEXT:00014D48 PREV:00014D48
  +00000C  HEAPID:00000000  SEG_ADDR:25995000  ROOT_ADDR:259950B0
  +000018  SEG_LEN:00008000  ROOT_LEN:00007F50

This is the last heap segment in the current heap.

Free Storage Tree for Heap Segment 25995000

<table>
<thead>
<tr>
<th>Depth</th>
<th>Address</th>
<th>Length</th>
<th>Node</th>
<th>Parent</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>259950B0</td>
<td>00007F50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Map of Heap Segment 25995000

To display entire segment: IP LIST 25995000 LEN(X'00008000') ASID(X'0021')

Summary of analysis for Heap Segment 25995000:

Amounts of identified storage:
- Free: 00007F50
- Allocated: 00000090
- Total: 00007FE0

Number of identified areas:
- Free: 1
- Allocated: 4
- Total: 5

0000000 bytes of storage were not accounted for.
No errors were found while processing this heap segment.
This is the last heap segment in the current heap.

Anywhere Heap Control Blocks

HPCB: 00014D78
  +000000  EYE_CATCHER:HPCB FIRST:24A91000 LAST:259C2000

  HANC: 24A91000
  +000000  EYE_CATCHER:HANC NEXT:25993000 PREV:00014D78
  +00000C  HEAPID:00014D78  SEG_ADDR:24A91000  ROOT_ADDR:00000000
  +000018  SEG_LEN:00000028  ROOT_LEN:00000000

Free Storage Tree for Heap Segment 24A91000

The free storage tree is empty.

Map of Heap Segment 24A91000

To display entire segment: IP LIST 24A91000 LEN(X'00F00028') ASID(X'0021')

Summary of analysis for Heap Segment 24A91000:
Amounts of identified storage: Free:00000000 Allocated:00000008 Total:00000008
Number of identified areas: Free: 0 Allocated: 1 Total: 1
00000000 bytes of storage were not accounted for.
No errors were found while processing this heap segment.

HANC: 259AC000
+000000 EYE_CATCHER:HANC NEXT:259AF000 PREV:2599D000
+00000C HEAPID:00014D78 SEG_ADDR:259AC000 ROOT_ADDR:259AC020
+000018 SEG_LEN:00002000 ROOT_LEN:00000003

Free Storage Tree for Heap Segment 259AC000

Node Node Parent Left Right Left Right
Depth Address Length Node Node Node Length Length
0 259AC020 000000C30 00000000 00000000 259ADC48 00000000 000003B8
1 259ADC48 000003B8 259AC020 00000000 00000000 00000000 00000000

Map of Heap Segment 259AC000
To display entire segment: IP LIST 259AC000 LEN(X'00002000') ASID(X'0021')

Chapter 3. Using Language Environment debugging facilities
Summary of analysis for Heap Segment 00044000:
Amounts of identified storage: Free:00000368 Allocated:00000368 Total:00001FE0
Number of identified areas: Free: 1 Allocated: 5 Total: 6
00000000 bytes of storage were not accounted for.
No errors were found while processing this heap segment.
This is the last heap segment in the current heap.

Additional Heap Control Blocks
ADHP: 259B1120
+000000 EYE_CATCHER:ADHP NEXT:259B24A8 HEAPID:259B112C
HPCB: 259B112C
+000000 EYE_CATCHER:hpcb FIRST:259B112C LAST:259B112C
ADHP: 259B24A8
+000000 EYE_CATCHER:ADHP NEXT:259ADCO8 HEAPID:259B24B4
HPCB: 259B24B4
+000000 EYE_CATCHER:hpcb FIRST:259B24B4 LAST:259B24B4
ADHP: 259ADCO8
+000000 EYE_CATCHER:ADHP NEXT:259AE000 HEAPID:259AD14
HPCB: 259AD14
+000000 EYE_CATCHER:HPCB FIRST:259AE000 LAST:259AE000
HANC: 259AE000
+000000 EYE_CATCHER:HANC NEXT:259AD14 PREV:259AD14
+000000 HEAPID:259AD14 SEG_ADDR:259AE000 ROOT_ADDR:259AE1B
+000000 SEG_LEN:00000100 ROOT_LEN:00000058
This is the last heap segment in the current heap.

Free Storage Tree for Heap Segment 259AE000

Map of Heap Segment 259AE000
To display entire segment: IP LIST 259AE000 LEN(X'00000100') ASID(X'0021')

Summary of analysis for Heap Segment 259AE000:
Amounts of identified storage: Free:000000E8 Allocated:000000CB Total:00000FE0
Number of identified areas: Free: 1 Allocated: 1 Total: 2
00000000 bytes of storage were not accounted for.
No errors were found while processing this heap segment.
This is the last heap segment in the current heap.

Exiting Language Environment Data
Heap report sections of the LEDATA output

The Heap Report sections of the LEDATA output provide information for each heap segment in the dump. The detailed heap segment reports include information on the free storage tree in the heap segments, the allocated storage elements, and the cause of heap management data structure problems.

Table 22. Contents of the Heap report sections of LEDATA output

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
</table>
| [1] Free Storage Tree Report | Within each heap segment, Language Environment keeps track of unallocated storage areas by chaining them together into a tree. Each free area represents a node in the tree. Each node contains a header, which points to its left and right child nodes. The header also contains the length of each child.  

The LEDATA HEAP option formats the free storage tree within each heap, and validates all node addresses and lengths within each node. Each node address is validated to ensure that it:  
  • Falls on a doubleword boundary  
  • Falls within the current heap segment  
  • Does not point to itself  
  • Does not point to a node that was previously traversed  

Each node length is validated to ensure that it:  
  • Is a multiple of 8  
  • Is not larger than the heap segment length  
  • Does not cause the end of the node to fall outside of the current heap segment  
  • Does not cause the node to overlap another node  

If the formatter finds a problem, then it will place an error message describing the problem directly after the formatted line of the node that failed validation |

| [2] Heap Segment Map Report | The LEDATA HEAP option produces a report that lists all of the storage areas within each heap segment, and identifies the area as either allocated or freed. For each allocated area the contents of the first X'20' bytes of the area are displayed in order to help identify the reason for the storage allocation.  

Each allocated storage element has an 8 byte prefix used by Language Environment to manage the area. The first fullword contains a pointer to the start of the heap segment. The second fullword contains the length of the allocated storage element. The formatter validates this header to ensure that its heap segment pointer is valid. The length is also validated to ensure that it:  
  • Is a multiple of 8  
  • Is not zero  
  • Is not larger than the heap segment length  
  • Does not cause the end of the element to fall outside of the current heap segment  
  • Does not cause the element to overlap a free storage node  

If the heap_free_value of the STORAGE runtime option was specified, then the formatter also checks that the free storage within each free storage element is set to the requested heap_free_value. If a problem is found, then an error message describing the problem is placed after the formatted line of the storage element that failed validation |

Diagnosing heap damage problems

Heap storage errors can occur when an application allocates a heap storage element that is too small for it to use, and therefore, accidently overlays heap storage. If this situation occurs then some of the typical error messages generated are:  
  • The node address does not represent a valid node within the heap segment  
  • The length of the segment is not valid, or  
  • The heap segment pointer is not valid.
If one of the above error messages is generated by one of the reports, then examine the storage element that immediately precedes the damaged node to determine if this storage element is owned by the application program. Check the size of the storage element and ensure that it is sufficient for the program’s use. If the size of the storage element is not sufficient then adjust the allocation size.

If an error occurs indicating that the node's pointers form a circular loop within the free storage tree, then check the Free Storage Tree Report to see if such a loop exists. If a loop exists, then contact the IBM support center for assistance because this may be a problem in the Language Environment heap management routines.

Additional diagnostic information regarding heap damage can be obtained by using the HEAPCHK runtime option. This option provides a more accurate time perspective on when the heap damage actually occurred, which could help to determine the program that caused the damage. For more information on HEAPCHK, see z/OS Language Environment Programming Reference.

**Diagnosing storage leak problems**

A storage leak occurs when a program does not return storage back to the heap after it has finished using it. To determine if this problem exists, do one of the following:

- The call-level suboption of the HEAPCHK runtime option causes a report to be produced in the CEEDUMP. Any still-allocated (that is, not freed) storage identified by HEAPCHK is listed in the report, along with the corresponding traceback. This shows any storage that wasn’t freed, as well as all the calls that were involved in allocating the storage. For more information about the HEAPCHK runtime option, see z/OS Language Environment Programming Reference.

- Examine the Heap Segment Map report to see if any data areas, within the allocated storage elements, appear more frequently than expected. If they do, then check to see if these data areas are still being used by the application program. If the data areas are not being used, then change the program to free the storage element after it is done with it.

**Diagnosing heap fragmentation problems**

Heap fragmentation occurs when allocated storage is interlaced with many free storage areas that are too small for the application to use. Heap fragmentation could indicate that the application is not making efficient use of its heap storage. Check the Heap Segment Map report for frequent free storage elements that are interspersed with the allocated storage elements.

**Understanding the heap pools LEDATA output**

The Language Environment IPCS VERBEXIT LEDATA generates a detailed heap pools report when HEAPPOOLS is ON. The detailed heap pools report is useful when trying to find potential damaged cells because it provides very specific information. The following sample shows an example of a report and “Heap pools report sections of the LEDATA output” on page 120 describes the information contained in the formatted output.

```
Heap Pool Report
  QPCB: 25C1EA00
  +000000 EYECATCHER:QPCB LENGTH:00000F00 NUMPOOLS:0000000A
  +0000C LARGEST_CELL_SIZE:00000800 BIG_REQUESTS:00000000
  +00014 STORAGE_HITS_ADDR:00000000 FLAGS:0400 NUMGETARRAYS:05
  +00018 NUMCELLSIZES:06 GET_POOLINFO ARRAYS_PTR:25C1EB00

Data for pool 1:
  POOLDATA: 25C1EE00
  +000000 POOL_INDEX:00000001 INPUT_CELL_SIZE:00000008
```
Heap Pool Extent Mapping

EXTENT: 25C45A80
+000000 EYE_CATCHER: EX31 NEXT_EXTENT: 00000000
To display entire pool extent: IP LIST 25C45A80 LEN(X'00000148') ASID(X'0020')
25C45B00: Free storage cell. To display: IP LIST 25C45B00 LEN(X'00000010') ASID(X'0020')

[1] Verifying free chain for pool: 1...
No errors were found while processing free chain.
Summary of analysis for Pool 1:
Number of cells: Unused: 19 Free: 1 Allocated: 0 Total Used: 20
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Data for pool 2:
POOLDATA: 25C1EF00
+000000 POOL_INDEX: 00000002 INPUT_CELL_SIZE: 00000020
+000008 CELL_SIZE: 00000008 INPUT_PERCENT: 00000001
+000010 CELL_POOL_SIZE: 00000008 CELL_POOL_NUM: 00000008
+000018 POOL_LATCH_ADDR: 25C54B48 POOL_EXTENTS: 00000001
+000020 LAST_CELL: 25C456B8 NEXT_CELL: 25C45C78
+000028 Q_CONTROL_INFO: 0000031F Q_FIRST_CELL: 25C45C50
+000030 POOL_NUM_GET_TOTAL: 00000190 POOL_NUM_FREE: 00000001
+000038 POOL_EXTENTS_ANCHOR: 25C45C48 POOL_INDEX_SAME_SIZE: 01
+00003D POOL_INDEX_SIZE: 01 POOL_NUM_SAME_SIZE: 01
+000040 POOL_TRACE_TABLE: 25C16080

EXTENT: 25C45C00
+000000 EYE_CATCHER: EX31 NEXT_EXTENT: 00000000
To display entire pool extent: IP LIST 25C45C00 LEN(X'00000148') ASID(X'0020')
25C45C50: Free storage cell. To display: IP LIST 25C45C50 LEN(X'00000028') ASID(X'0020')

[1] Verifying free chain for pool: 2...
No errors were found while processing free chain.
Summary of analysis for Pool 2:
Number of cells: Unused: 7 Free: 1 Allocated: 0 Total Used: 8
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Data for pool 3:
POOLDATA: 25C1F000
+000000 POOL_INDEX: 00000003 INPUT_CELL_SIZE: 00000080
+000008 CELL_SIZE: 00000088 INPUT_PERCENT: 00000001
+000010 CELL_POOL_SIZE: 00000008 CELL_POOL_NUM: 00000004
+000018 POOL_LATCH_ADDR: 25C548FC POOL_EXTENTS: 00000002
+000020 LAST_CELL: 25C45F38 NEXT_CELL: 25C45F38
+000028 Q_CONTROL_INFO: 0000095D Q_FIRST_CELL: 25C45DA0
+000030 POOL_NUM_GET_TOTAL: 000004B4 POOL_NUM_FREE: 00000003
+000038 POOL_EXTENTS_ANCHOR: 25C45D98 POOL_INDEX_SAME_SIZE: 01
+00003D POOL_INDEX_SIZE: 03 POOL_NUM_SAME_SIZE: 01
+000040 POOL_TRACE_TABLE: 25CB60A0

EXTENT: 25C45D00
+000000 EYE_CATCHER: EX31 NEXT_EXTENT: 00000000
To display entire pool extent: IP LIST 25C45D00 LEN(X'00000228') ASID(X'0020')
25C45E28: Free storage cell. To display: IP LIST 25C45E28 LEN(X'00000088') ASID(X'0020')
25C45EB0: Free storage cell. To display: IP LIST 25C45EB0 LEN(X'00000088') ASID(X'0020')

[1] Verifying free chain for pool: 3...
No errors were found while processing free chain.
Summary of analysis for Pool 3:
Number of cells: Unused: 1 Free: 3 Allocated: 4 Total Used: 8

00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Data for pool 4:

**POOLDATA:** 25C1F100
+000000 Pool_INDEX:00000004 INPUT_CELL_SIZE:00000100
+000008 Cell_SIZE:00000108 INPUT_PERCENT:00000001
+000010 Cell_POOL_SIZE:00000420 CELL_POOL_NUM:00000004
+000018 Pool_LATCH_ADDR:25C54C10 Pool_EXTENTS:00000001
+000020 Last_Cell:25C462E8 Next_Cell:25C461E0
+000028 Q_CONTROL_INFO:0000063E Q_FIRST_CELL:25C45FD0
+000030 Pool_NUM_GET_TOTAL:00000320 Pool_NUM_FREE:00000002
+000038 Pool_EXTENTS_ANCHOR:25C45FC8 Pool_INDEX_SAME_SIZE:01
+00003D Pool_INDEX_SIZE:04 Pool_NUM_SAME_SIZE:01
+000040 Pool_TRACE_TABLE:25CE60C0

**[2]Heap Pool Extent Mapping**

EXTENT: 25C45FCB
+000000 EYE_CATCHER:EX31 NEXT_EXTENT:00000000
To display entire pool extent: IP LIST 25C45FCB LEN(X'00000428') ASID(X'0020')
25C45FD0: Free storage cell. To display: IP LIST 25C45FD0 LEN(X'00000108') ASID(X'0020')
25C460D8: Free storage cell. To display: IP LIST 25C460D8 LEN(X'00000108') ASID(X'0020')

Summary of analysis for Pool 4:

Number of cells: Unused: 2 Free: 2 Allocated: 0 Total Used: 4
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Data for pool 5.1:

**POOLDATA:** 25C3F200
+000000 Pool_INDEX:00000005 INPUT_CELL_SIZE:00000400
+000008 Cell_SIZE:00000408 INPUT_PERCENT:00000001
+000010 Cell_POOL_SIZE:0001020 CELL_POOL_NUM:00000004
+000018 Pool_LATCH_ADDR:25C54C24 Pool_EXTENTS:00000002
+000020 Last_Cell:25E48438 Next_Cell:25C42040
+000028 Q_CONTROL_INFO:000001DD Q_FIRST_CELL:25C42858
+000030 Pool_NUM_GET_TOTAL:000000F2 Pool_NUM_FREE:00000003
+000038 Pool_EXTENTS_ANCHOR:25E48028 Pool_INDEX_SAME_SIZE:01
+00003D Pool_INDEX_SIZE:05 Pool_NUM_SAME_SIZE:05
+000040 Pool_TRACE_TABLE:25D160E0

**[2]Heap Pool Extent Mapping**

EXTENT: 25E48028
+000000 EYE_CATCHER:EX31 NEXT_EXTENT:00000000
To display entire pool extent: IP LIST 25E48028 LEN(X'00001028') ASID(X'0020')
25E48030: Free storage cell. To display: IP LIST 25E48030 LEN(X'00000408') ASID(X'0020')
EXTENT: 25C42040
+000000 EYE_CATCHER:EX31 NEXT_EXTENT:00000000
To display entire pool extent: IP LIST 25C42040 LEN(X'00001028') ASID(X'0020')
25C42048: Allocated storage cell. To display: IP LIST 25C42048 LEN(X'00000408') ASID(X'0020')
25C42050: Allocated storage cell. To display: IP LIST 25C42050 LEN(X'00000408') ASID(X'0020')
25C42058: Allocated storage cell. To display: IP LIST 25C42058 LEN(X'00000408') ASID(X'0020')
25C42450: Allocated storage cell. To display: IP LIST 25C42450 LEN(X'00000408') ASID(X'0020')
25C42458: Allocated storage cell. To display: IP LIST 25C42458 LEN(X'00000408') ASID(X'0020')
25C42460: Free storage cell. To display: IP LIST 25C42460 LEN(X'00000408') ASID(X'0020')

Summary of analysis for Pool 5.1:

Number of cells: Unused: 3 Free: 3 Allocated: 2 Total Used: 8
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Data for pool 5.2:

**POOLDATA:** 25C1F300
+000000 Pool_INDEX:00000006 INPUT_CELL_SIZE:00000400
+000008 Cell_SIZE:00000408 INPUT_PERCENT:00000001
+000010 Cell_POOL_SIZE:00001020 CELL_POOL_NUM:00000004
+000018 Pool_LATCH_ADDR:25C54C24 Pool_EXTENTS:00000001
+000020 Last_Cell:25C47018 Next_Cell:25C47018
+000028 Q_CONTROL_INFO:000001DD Q_FIRST_CELL:25C46400
+000030 Pool_NUM_GET_TOTAL:000000F0 Pool_NUM_FREE:00000003
+000038 Pool_EXTENTS_ANCHOR:25C463F8 Pool_INDEX_SAME_SIZE:02
+00003D Pool_INDEX_SIZE:05 Pool_NUM_SAME_SIZE:05
+000040 Pool_TRACE_TABLE:25D46100

**[2]Heap Pool Extent Mapping**

EXTENT: 25C463F8
+000000 EYE_CATCHER:EX31 NEXT_EXTENT:00000000
To display entire pool extent: IP LIST 25C463F8 LEN(X'00001028') ASID(X'0020')
25C46400: Free storage cell. To display: IP LIST 25C46400 LEN(X'00000408') ASID(X'0020')
25C46808: Free storage cell. To display: IP LIST 25C46808 LEN(X'00000408') ASID(X'0020')
25C46C10: Free storage cell. To display: IP LIST 25C46C10 LEN(X'00000408') ASID(X'0020')

[1] Verifying free chain for pool: 5.2...
No errors were found while processing free chain.
Summary of analysis for Pool 5.2:
Number of cells: Unused: 1 Free: 3 Allocated: 0 Total Used: 4
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Data for pool 5.3:
POOLDATA: 25C1F400
+000000 POOLDATA: 25C46400 INPUT_CELL_SIZE:00000400
+000008 CELL_SIZE:00000408 INPUT_PERCENT:00000001
+000010 CELL_POOL_SIZE:000001020 CELL_POOL_NUM:00000004
+000018 POOL_LATCH_ADDR:25C54C24 POOL_EXTENTS:00000001
+000020 LAST_CELL:25E49C78 NEXT_CELL:25E49C78
+000028 Q_CONTROL_INFO:00000000 Q_FIRST_CELL:25E49060
+000030 POOL_NUM_GET_TOTAL:00000000 POOL_NUM_FREE:00000003
+000038 POOL_EXTENTS_ANCHOR:25E49058 POOL_INDEX_SAME_SIZE:04
+00003D POOL_INDEX_SIZE:05 POOL_NUM_SAME_SIZE:05
+000040 POOL_TRACE_TABLE:25D76120

EXTENT: 25E49058
+000000 EYE_CATCHER:EX31 NEXT_EXTENT:00000000
To display entire pool extent: IP LIST 25E49058 LEN(X'00001028') ASID(X'0020')
25E49060: Free storage cell. To display: IP LIST 25E49060 LEN(X'00000408') ASID(X'0020')
25E49068: Free storage cell. To display: IP LIST 25E49068 LEN(X'00000408') ASID(X'0020')

[1] Verifying free chain for pool: 5.3...
No errors were found while processing free chain.
Summary of analysis for Pool 5.3:
Number of cells: Unused: 1 Free: 3 Allocated: 0 Total Used: 4
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Data for pool 5.4:
POOLDATA: 25C1F500
+000000 POOLDATA: 25C46400 INPUT_CELL_SIZE:00000400
+000008 CELL_SIZE:00000408 INPUT_PERCENT:00000001
+000010 CELL_POOL_SIZE:000001020 CELL_POOL_NUM:00000004
+000018 POOL_LATCH_ADDR:25C54C24 POOL_EXTENTS:00000001
+000020 LAST_CELL:25C47430 NEXT_CELL:25C47430
+000028 Q_CONTROL_INFO:00000000 Q_FIRST_CELL:25C47430
+000030 POOL_NUM_GET_TOTAL:00000000 POOL_NUM_FREE:00000003
+000038 POOL_EXTENTS_ANCHOR:25C47428 POOL_INDEX_SAME_SIZE:04
+00003D POOL_INDEX_SIZE:05 POOL_NUM_SAME_SIZE:05
+000040 POOL_TRACE_TABLE:25D76120

EXTENT: 25C47428
+000000 EYE_CATCHER:EX31 NEXT_EXTENT:00000000
To display entire pool extent: IP LIST 25C47428 LEN(X'00001028') ASID(X'0020')
25C47430: Free storage cell. To display: IP LIST 25C47430 LEN(X'00000408') ASID(X'0020')
25C47438: Free storage cell. To display: IP LIST 25C47438 LEN(X'00000408') ASID(X'0020')
25C47440: Free storage cell. To display: IP LIST 25C47440 LEN(X'00000408') ASID(X'0020')

[1] Verifying free chain for pool: 5.4...
No errors were found while processing free chain.
Summary of analysis for Pool 5.4:
Number of cells: Unused: 1 Free: 3 Allocated: 0 Total Used: 4
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Data for pool 5.5:
POOLDATA: 25C1F600
+000000 POOLDATA: 25C46400 INPUT_CELL_SIZE:00000400
+000008 CELL_SIZE:00000408 INPUT_PERCENT:00000001
+000010 CELL_POOL_SIZE:000001020 CELL_POOL_NUM:00000004
+000018 POOL_LATCH_ADDR:25C54C24 POOL_EXTENTS:00000001
+000020 LAST_CELL:25C49078 NEXT_CELL:25C49078
+000028 Q_CONTROL_INFO:00000000 Q_FIRST_CELL:25C49078
+000030 POOL_NUM_GET_TOTAL:00000000 POOL_NUM_FREE:00000003
+000038 POOL_EXTENTS_ANCHOR:25C49060 POOL_INDEX_SAME_SIZE:05
+00003D POOL_INDEX_SIZE:05 POOL_NUM_SAME_SIZE:05
+000040 POOL_TRACE_TABLE:25D76120

EXTENT: 25C49060
+000000 EYE_CATCHER:EX31 NEXT_EXTENT:00000000
To display entire pool extent: IP LIST 25C49060 LEN(X'00001028') ASID(X'0020')
25C49068: Free storage cell. To display: IP LIST 25C49068 LEN(X'00000408') ASID(X'0020')
25C49078: Free storage cell. To display: IP LIST 25C49078 LEN(X'00000408') ASID(X'0020')
25C49080: Free storage cell. To display: IP LIST 25C49080 LEN(X'00000408') ASID(X'0020')
25C49088: Free storage cell. To display: IP LIST 25C49088 LEN(X'00000408') ASID(X'0020')

[1] Verifying free chain for pool: 5.5...
No errors were found while processing free chain.
Summary of analysis for Pool 5.5:
Number of cells: Unused: 1 Free: 3 Allocated: 0 Total Used: 4
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Chapter 3. Using Language Environment debugging facilities
Summary of analysis for Pool 5.5:
Number of cells: Unused: 1 Free: 3 Allocated: 0 Total Used: 4
00000000 free cells were not accounted for.
No errors were found while processing this Pool.

Data for pool 6:
POOLDATA: 25C1F700
+000000 POOL_INDEX:00000000 INPUT_CELL_SIZE:00000800
+000008 CELL_SIZE:00000800 INPUT_PERCENT:00000001
+000010 CELL_POOL_SIZE:00000802 CELL_POOL_NUM:00000004
+000018 POOL_LATCH_ADDR:25C54C38 POOL_EXTENTS:00000001
+000020 LAST_CELL:25C452E8 NEXT_CELL:25C452E8
+000028 Q_CONTROL_INFO:0000063E Q_FIRST_CELL:25C452E8
+000030 POOL_NUM_GET_TOTAL:00000321 POOL_NUM_FREE:00000002
+000038 POOL_EXTENTS_ANCHOR:25C43AC8 POOL_INDEX_SIZE:06 POOL_NUM_SAME_SIZE:01
+00003D POOL_INDEX.same_SIZE:06 POOL_INDEX.SAME_SIZE:01
+000040 POOL_TRACE_TABLE:25E06180

Heap pool Extent Mapping
EXTENT: 25C43AC8
+000000 EYE_CATCHER:EX31 NEXT_EXTENT:00000000
To display entire pool extent: IP LIST 25C43AC8 LEN(X'00002028') ASID(X'0020')

Heap pools report sections of the LEDATA output
The heap pools report provides information about the following items:
• Each cell pool.
• The free chain associated with every qpcb pool data area, and all the free and
  allocated cells in the extent chain.
• Errors found when the cells are validated.

Table 23. Contents of heap pools report sections of LEDATA output

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
</table>
| [1] Free Chain Validation  | Within each cell pool, Language Environment keeps track of unallocated cells by
|                            | chaining them together. The LEDATA HEAP option validates the free chain within
|                            | each cell pool. It verifies that the cell pointer is within a valid extent and that
|                            | the cell pool number is valid. If the formatter finds a problem, it will place an
|                            | error message describing the problem directly after the formatted line of the cell
|                            | that failed validation. |
| [2] Heap Pool Extent Mapping Report | The LEDATA HEAP option produces a report that lists all of the cells within each
|                                      | pool extent, and identifies the cells as either allocated or freed. For each
|                                      | allocated cell, the contents of the first X'20' bytes of the area are displayed to
|                                      | identify the reason for the storage allocation. The formatter validates if cell
|                                      | pool number in header is correct. |

Understanding the heap pools trace LEDATA output
The Language Environment IPCS VERBEXIT LEDATA generates a detailed heap
pools trace report when the HPT option is used. The argument value is the ID of
the pool to be formatted in the report. Table 24 on page 123 describes the contents
of the report.
HEAPPOOLS Trace Table

POOLID: 3 ASID: 0024 AVAILABLE ENTRIES: 12 OF 12

Timestamp: 2008/03/14 14:10:22.614088
Type: FREE Cell Address: 25E91AC0 Cpid: 01 Tcb: 008AFCF0

<table>
<thead>
<tr>
<th>CALL NAME</th>
<th>CALL ADDRESS</th>
<th>CALL OFFSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>GetStorage:~GetStorage()</td>
<td>25E53360</td>
<td>00000008</td>
</tr>
<tr>
<td>foo8()</td>
<td>25E53598</td>
<td>00000006</td>
</tr>
<tr>
<td>foo7()</td>
<td>25E53678</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo6()</td>
<td>25E536F0</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo5()</td>
<td>25E53768</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo4()</td>
<td>25E537E0</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo3()</td>
<td>25E53858</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo2()</td>
<td>25E53800</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo1()</td>
<td>25E53948</td>
<td>00000005A</td>
</tr>
<tr>
<td>thread</td>
<td>25E53A50</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Timestamp: 2008/03/14 14:10:22.614087
Type: FREE Cell Address: 25E91B48 Cpid: 01 Tcb: 008AFCF0

<table>
<thead>
<tr>
<th>CALL NAME</th>
<th>CALL ADDRESS</th>
<th>CALL OFFSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>GetStorage:~GetStorage()</td>
<td>25E53360</td>
<td>00000008</td>
</tr>
<tr>
<td>foo9()</td>
<td>25E53430</td>
<td>00000006</td>
</tr>
<tr>
<td>foo8()</td>
<td>25E53598</td>
<td>00000009A</td>
</tr>
<tr>
<td>foo7()</td>
<td>25E53678</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo6()</td>
<td>25E536F0</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo5()</td>
<td>25E53768</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo4()</td>
<td>25E537E0</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo3()</td>
<td>25E53858</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo2()</td>
<td>25E53800</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo1()</td>
<td>25E53948</td>
<td>00000005A</td>
</tr>
<tr>
<td>thread</td>
<td>25E53A50</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Timestamp: 2008/03/14 14:10:22.614034
Type: FREE Cell Address: 25E91C58 Cpid: 01 Tcb: 008AFA60

<table>
<thead>
<tr>
<th>CALL NAME</th>
<th>CALL ADDRESS</th>
<th>CALL OFFSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>GetStorage:~GetStorage()</td>
<td>25E53360</td>
<td>00000008</td>
</tr>
<tr>
<td>foo9()</td>
<td>25E53430</td>
<td>00000006</td>
</tr>
<tr>
<td>foo8()</td>
<td>25E53598</td>
<td>00000009A</td>
</tr>
<tr>
<td>foo7()</td>
<td>25E53678</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo6()</td>
<td>25E536F0</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo5()</td>
<td>25E53768</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo4()</td>
<td>25E537E0</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo3()</td>
<td>25E53858</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo2()</td>
<td>25E53800</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo1()</td>
<td>25E53948</td>
<td>00000005A</td>
</tr>
<tr>
<td>thread</td>
<td>25E53A50</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Timestamp: 2008/03/14 14:10:22.614032
Type: FREE Cell Address: 25E91D58 Cpid: 01 Tcb: 008AFA60

<table>
<thead>
<tr>
<th>CALL NAME</th>
<th>CALL ADDRESS</th>
<th>CALL OFFSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>GetStorage:~GetStorage()</td>
<td>25E53360</td>
<td>00000008</td>
</tr>
<tr>
<td>foo9()</td>
<td>25E53430</td>
<td>00000006</td>
</tr>
<tr>
<td>foo8()</td>
<td>25E53598</td>
<td>00000009A</td>
</tr>
<tr>
<td>foo7()</td>
<td>25E53678</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo6()</td>
<td>25E536F0</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo5()</td>
<td>25E53768</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo4()</td>
<td>25E537E0</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo3()</td>
<td>25E53858</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo2()</td>
<td>25E53800</td>
<td>00000005A</td>
</tr>
<tr>
<td>foo1()</td>
<td>25E53948</td>
<td>00000005A</td>
</tr>
<tr>
<td>thread</td>
<td>25E53A50</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Timestamp: 2008/03/14 14:10:22.614030
Understanding the C/C++-specific LEDATA output

The Language Environment IPCS VERBEXIT LEDATA generates formatted output of C/C++-specific control blocks from a system dump when the COMP(C), COMP(ALL), or ALL parameter is specified and C/C++ is active in the dump. The following example illustrates the C/C++-specific output produced. Figure 8 on page 45 and Table 25 on page 141 describe the information contained in the formatted output. Ellipses are used to summarize some sections of the dump. For easy reference, the sections of the dump are numbered to correspond with the description of each section that follows.
Chapter 3. Using Language Environment debugging facilities
Exiting CRTL Environment Data

************************************************************************************

CRTL I/O CONTROL BLOCKS

************************************************************************************

CIO: 2OC0E098
+000000 EYE:CIO SIZE:00000090 PTR:00000000 FLG1:09
+0000D0 FLG2:0D FLG3:00 FLG4:00 DUMMY:2OC0E128
+00014C EDCZ24:00000000 FCBSTART:2135A040 DUMMYFCB:2OC0E148
+000200 MFCBSTART:2135A470 IOANYLIST:2135A000
+0002B8 IOBELOWLIST:00014000 FCBDBLIST:00000000
+000330 PERRORBUF:20C0DF60 TMPCOUNTER:00000000
+000338 TEMPMEM:00000000 PROMPTBUF:00000000
+00044C IOEXITS:0000127C8 TERMINALCHAIN:00000000
+00049C IOANCHOR:00000000 XT1:00000000 ENWPI24:20F484A0
+000530 MAXNUMDESCRPS:00000000 DESCARRAY:00000000
+00064D TEMPFILENUM:00000000 CSS:00000000 DUMMY_NAME:........
+00074A HOSTNAME_CACHE:00000000 HOSTADDR_CACHE:00000000
+00077C FD1:20E62508 LAST_FD_CLOSE:00000000 00000000
+00088B IOGET64:2132448E IOFREE64:21323D80

126 z/OS V2R1.0 Language Environment Debugging Guide
Chapter 3. Using Language Environment debugging facilities

File name: /u/charum/b235/in.txt

File name: CHARUM.A.B

File name: CHARUM.A.B
Chapter 3. Using Language Environment debugging facilities

File name: CHARUM.D.E
OSFS: 2135AE64
+00000 OSFS_EYE:OSFS READ:20F8C258 WRITE:20F89A10
+00000C REPOS:20F8F590 GETPOS:20F8070 CLOSE:20F862D
+000018 FLUSH:20F86D50 UTILITY:20F85D60 EXITFTELL:00000000
+000024 EXITUNGETC:00000000 OSIOBLK:2135AF38 NEWLINEPTR:35AFE021
+00002C JFCB:00012908 CURMBUF:000129C0 MBUFCOUNT:00000001
+000034 MBUFPTR:00000000 COUNTIN:00000000 COUNTOUT:00000000
+00003C DECB:7F000000 80800000 000129F8 2135AFE0 00006AF8 00000000 00000000 00000000
+00004E FFIL: 2135B080
+00000 MARKER1:ACCB FILE:00000000 __FP:2135B0A0
+00000C MARKER2:ACCB __FP:2135B0A0
+000014 FCMBUF:00000000 CHECKRESULT:00000000
+000010 DECB:7F000000 80800000 000129F8 2135AFE0 00006AF8 00000000 00000000 00000000

File name: CHARUM.E.F

130  z/OS V2R1.0 Language Environment Debugging Guide
FFIL: 2135B620
+000000 MARKER1:AFCB FILE:00000000 _FP:2135B640
+00000C MARKER2:AFCAFCB FP_FLAGS:01000000 _FP:2135B640
+00014 FCBMUTEX:00000000 THREADID:00000000 00000000

File name: CHARUM.G.H

FCB: 2135B640
+000000 BUFPTR:00000000 COUNTIN:00000000 COUNTOUT:00000000
+00000C READFUNC:2135B710 WRITEFUNC:2135B730 FLAGS1:8000
+000016 DEPTH:0000 NAME:2135B7FC _LENGTH:00000000
+000020 BUFSIZE:00000000 BUF:00000000
+000028 CURSOR:00000000 ENDOFDATA:00000000 SAVEDBUF:00000000
+000030 REALCOUNTIN:00000000 REALCOUNTOUT:00000000
+000038 POSMAJOR:00000000 SAVEMAJOR:00000000
+000040 POSMINOR:00000000 SAVEMINOR:00000000 STATE:0000
+000048 SAVESTATE:0000 EXITFTELL:20F482A8 EXITUNGETC:20F481E8
+000080 DBSTART:00000000 USERBUF:00000000 LRECL:0000050
+000088 BLKSIZE:0000050 REALBUFPTR:00000000
+000090 UNGETBUFF:00000000 BUFSIZE:0000051 BUF:00000000
+000098 CURSOR:00000000 ENDOFDATA:00000000 SAVEDBUF:00000000
+0000A0 REALCOUNTIN:00000000 REALCOUNTOUT:00000000
+0000B0 POSMAJOR:00000000 SAVEMAJOR:00000000
+0000B8 POSMINOR:00000000 SAVEMINOR:00000000 STATE:0000
+0000C0 SAVESTATE:0000 EXITFTELL:20F482A8 EXITUNGETC:20F481E8

OSNS: 2135B774
+000000 OSNS EYE:OSNS READ:20F48580 WRITE:20FB8D88
+00000C REPOS:20F5F588 GETPOS:20F48330 CLOSE:20FB8930
+000018 FLUSH:20FB8CC0 UTILITY:20FB8600 EXITFTELL:20F482A8
+000024 EXITUNGETC:20F481E8 OSIOBLK:2135B848
+000030 NEWLINEPTR:00000000 RECLENGTH:00000050 FLAGS:81000000

OSIO: 2135B848
+000000 OSIO EYE:OSIO DCBW:00012CA0 DCBRU:00000000
+00000C JFCB:00012D08 CURRBUFF:00000000 MBUFCOUNT:00000001
+000010 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000014 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000018 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000020 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000024 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000028 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000030 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000034 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000038 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000040 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000044 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000050 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000058 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000060 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000068 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000070 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000078 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000080 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000088 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000090 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+000098 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0
+0000A0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0 DCBFDAD:2135B8B0

Chapter 3. Using Language Environment debugging facilities 133
Chapter 3. Using Language Environment debugging facilities 135
File name: CHARUM.J.K

FCB: 2135BE90
  BUFPTR:00000000 COUNTIN:00000000 COUNTOUT:00000000
  READFUNC:2135BF80 WRITEFUNC:2135BFA0 FLAGS1:8000
  DEPTH:0000 NAME:2135BE90 _LENGTH:0000000A
  BUFSIZE:00000044 MEMBER:........ NEXT:2135C1B0
  BUFSIZE:00001800 BUF:00000000 CURSOR:00000000 ENDOFDATA:00000000

OSUT: 2135BEF4
  OSUT_EYE:OSUT READ:20F48580 WRITE:20FBB8E0
  REPOS:20FBCA0 GETPOS:20FBDEC8 CLOSE:00000000
  NEWLINEPTR:00000000 MAXFTELLBLK:0007FFFF
  RECBITS:0000000D FLAGS:E0000000

OSIO: 2135C0B8
  OSIO_EYE:OSIO DCBW:00014020 DCBRU:00000000
  JFCB:00012F48 DCBRELAD:2135C120 DCBFDAD:00000000
  DCBRECFM:C0 DCBMACR1:65 DCBMACR2:B8 DCBRECFM:C0

OSIO_VOLSEQ:0000 OSIO_NEWVOLSEQ:0000 OSIO_EXT:00000000
OSIO_HIGHVOL:0000 APPENDEDLASTVOLSEQ:0000
OSIO: 2135C0B8
  OSIO_EYE:OSIO DCBW:00014020 DCBRU:00000000
  JFCB:00012F48 DCBRELAD:2135C120 DCBFDAD:00000000
  DCBRECFM:C0 DCBMACR1:65 DCBMACR2:B8 DCBRECFM:C0

DCB: 00014020
  DCBRELAD:2135C120 DCBFDAD:00000000 DCBRECFM:C0
  DCBRECFM:C0 DCBMACR1:65 DCBMACR2:B8 DCBRECFM:C0

DCE: 2135C120
  DCELEN:0038 RESERVOID:0000
  DCBRECFM:C0 DCBRECFM:C0

DCB: 2135BE90
  BUFPTR:00000000 COUNTIN:00000000 COUNTOUT:00000000
  READFUNC:2135BF80 WRITEFUNC:2135BFA0 FLAGS1:8000
  DEPTH:0000 NAME:2135BE90 _LENGTH:0000000A
  BUFSIZE:00000044 MEMBER:........ NEXT:2135C1B0
  BUFSIZE:00001800 BUF:00000000 CURSOR:00000000 ENDOFDATA:00000000

OSUT: 2135BEF4
  OSUT_EYE:OSUT READ:20F48580 WRITE:20FBB8E0
  REPOS:20FBCA0 GETPOS:20FBDEC8 CLOSE:00000000
  NEWLINEPTR:00000000 MAXFTELLBLK:0007FFFF
  RECBITS:0000000D FLAGS:E0000000

OSIO: 2135C0B8
  OSIO_EYE:OSIO DCBW:00014020 DCBRU:00000000
  JFCB:00012F48 DCBRELAD:2135C120 DCBFDAD:00000000
  DCBRECFM:C0 DCBMACR1:65 DCBMACR2:B8 DCBRECFM:C0

DCB: 00014020
  DCBRELAD:2135C120 DCBFDAD:00000000 DCBRECFM:C0
  DCBRECFM:C0 DCBMACR1:65 DCBMACR2:B8 DCBRECFM:C0

DCE: 2135C120
  DCELEN:0038 RESERVOID:0000
  DCBRECFM:C0 DCBRECFM:C0

DCB: 2135BE90
  BUFPTR:00000000 COUNTIN:00000000 COUNTOUT:00000000
  READFUNC:2135BF80 WRITEFUNC:2135BFA0 FLAGS1:8000
  DEPTH:0000 NAME:2135BE90 _LENGTH:0000000A
  BUFSIZE:00000044 MEMBER:........ NEXT:2135C1B0
  BUFSIZE:00001800 BUF:00000000 CURSOR:00000000 ENDOFDATA:00000000

OSUT: 2135BEF4
  OSUT_EYE:OSUT READ:20F48580 WRITE:20FBB8E0
  REPOS:20FBCA0 GETPOS:20FBDEC8 CLOSE:00000000
  NEWLINEPTR:00000000 MAXFTELLBLK:0007FFFF
  RECBITS:0000000D FLAGS:E0000000

OSIO: 2135C0B8
  OSIO_EYE:OSIO DCBW:00014020 DCBRU:00000000
  JFCB:00012F48 DCBRELAD:2135C120 DCBFDAD:00000000
  DCBRECFM:C0 DCBMACR1:65 DCBMACR2:B8 DCBRECFM:C0

DCB: 00014020
  DCBRELAD:2135C120 DCBFDAD:00000000 DCBRECFM:C0
  DCBRECFM:C0 DCBMACR1:65 DCBMACR2:B8 DCBRECFM:C0
Chapter 3. Using Language Environment debugging facilities

137
FILE: 2135C430

MARKER1: AFCB FILE: 00000000 __FP: 2135C450

MARKER2: AFCBAFCB FF_FLAGS: 01000000

FCBMUTEX: 00000000 THREADID: 00000000 00000000

File name: CHARUM.L.M

FCB: 2135C450

BUFPTR: 00000000 COUNTIN: 00000000 COUNTOUT: 00000000
READFUNC: 2135C520 WRITEFUNC: 2135C540
DEPTH: 000000 NAME: 2135C60C _LENGTH: 0000000A
_BUFSIZE: 00000044 MEMBER: ........ NEXT: 2135C720
PREV: 2135C180 PARENT: 2135C450 CHILD: 00000000
DDNAME: SYS00020 FD: 00000000 DEVTYPE: 00 FCBTYPE: 0046
FSCE: 2135C584 UNGETBUF: 2135C584 REPOS: 20FD0D10
GETPOS: 20FD1240 CLOSE: 20FCD070 FLUSH: 20FD0CB0
UTILITY: 20FD0780 USERBUF: 00000000 LRECL: 00000050
UNGETCOUNT: 00000000 BUFSIZE: 00000050 BUF: 00000000
CURSOR: 00000000 ENDOFDATA: 00000000 SAVEDBUF: 00000000
REALCOUNTIN: 00000000 REALCOUNTOUT: 00000000
POSMAJOR: 00000000 SAVEMAJOR: 00000000
SAVEMINOR: 00000000 STATE: 0000
SAVESTATE: 0000 EXITFTELL: 00000000 EXITUNGETC: 20F481E8
DBSTART: 0000000000000000 UTILITYAREA: 00000000
INTERCEPT: 0000000000000000
OSFS: 2135C450
OSFS_EYE: OSFS READ: 20F48580 WRITE: 20FCFA28
REPOS: 20FCDB38 GETPOS: 20FCFA08 CLOSE: 00000000
UTILITY: 21312EAD EXITFTELL: 00000000
OSIO: 2135C450
OSIO_EYE: OSIO DCBW: 00014260 DCBRU: 00000000
OSIO_ACCESS_METHOD: 01 FIRSTPOS: 00000010
NEWPOS: 00000000 ENDOPBLOCK: 00000000
RELRECNAM: 00000000
OSIO_EXT: 00000000 APPENDEDLASTVOLSEQ: 0000
OSIO_VOLSEQ: 00000000 OSIO_NEWVOLSEQ: 0000
OSIO_HIGHVOL: 00000000 OSIO_JFCBX: 00000000
OSIO: 2135C450
OSIO_EYE: OSIO DCBW: 00014260 DCBRU: 00000000
OSIO_ACCESS_METHOD: 01 FIRSTPOS: 00000010
NEWPOS: 00000000 ENDOPBLOCK: 00000000
RELRECNAM: 00000000
OSIO_EXT: 00000000 APPENDEDLASTVOLSEQ: 0000
OSIO_VOLSEQ: 00000000 OSIO_NEWVOLSEQ: 0000
OSIO_HIGHVOL: 00000000 OSIO_JFCBX: 00000000
DCB: 00014260
DCBRELAD: 2135C6C0 DCBFRAD: 00000000 22000100
DCBUFNO: 00 DCBSRG1: 40 DCBEQAD: 00000000 DCBRECFM: 80
DCBRECFM: 80 DBCSFAD: 00000000 DCBEQAD: 00000000
DCBEQAD: 00000000 DCBRECFM: 80 DBCSFAD: 00000000
DCBMACR2: 88 DCBSYNAD: 00000000 DCBLKDS: 0050 DCBSTQD: 00000000
DCBE: 2135C6C0
DCBE: 2135C6C0
DCBID: DCBE DCBELEN: 0038 RESERVED: 0000

138  z/OS V2R1.0 Language Environment Debugging Guide
Chapter 3. Using Language Environment debugging facilities

139
Table 25. Contents of C/C++-specific sections of LEDATA output

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] CGEN</td>
<td>Formats the C/C++-specific portion of the Language Environment common anchor area (CAA).</td>
</tr>
<tr>
<td>[2] CGENE</td>
<td>Formats the extension to the C/C++-specific portion of the Language Environment common anchor area (CAA).</td>
</tr>
</tbody>
</table>
Table 25. Contents of C/C++-specific sections of LEDATA output (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[7] File Control Blocks</td>
<td>Formats the C/C++ file control block (FCB). The FCB and its related control blocks represent the information needed by each open stream. The following related control blocks are included.</td>
</tr>
<tr>
<td>FFIL</td>
<td>Formats the header of the C/C++ file control block (FCB).</td>
</tr>
<tr>
<td>FSCE</td>
<td>The file specific category extension control block (FSCE), which represents the specific type of IO being performed. The following is a list of FSCEs that may be formatted; other FSCEs will be displayed using a generic overlay.</td>
</tr>
<tr>
<td>HFSF</td>
<td>UNIX file system file</td>
</tr>
<tr>
<td>HSPF</td>
<td>Hiper-Space file</td>
</tr>
<tr>
<td>INTC</td>
<td>Intercept file</td>
</tr>
<tr>
<td>MEMF</td>
<td>Memory file</td>
</tr>
<tr>
<td>OSNS</td>
<td>OS no seek</td>
</tr>
<tr>
<td>OSFS</td>
<td>OS fixed text</td>
</tr>
<tr>
<td>OSVF</td>
<td>OS variable text</td>
</tr>
<tr>
<td>OSUT</td>
<td>OS undefined format text</td>
</tr>
<tr>
<td>TDQF</td>
<td>CICS Transient Data Queue file</td>
</tr>
<tr>
<td>TERM</td>
<td>Terminal file</td>
</tr>
<tr>
<td>VSAM</td>
<td>VSAM file</td>
</tr>
<tr>
<td>OSIO</td>
<td>The OS IO interface control block.</td>
</tr>
<tr>
<td>OSIOE</td>
<td>The OS IO extended interface control block.</td>
</tr>
<tr>
<td>DCB</td>
<td>The data control block. For more information about the DCB, see <a href="http://www.ibm.com/systems/z/OS/zos/bkserv/">z/OS DFSMS Macro Instructions for Data Sets</a>.</td>
</tr>
<tr>
<td>DCBE</td>
<td>The data control block extension. For more information about the DCBE, see <a href="http://www.ibm.com/systems/z/OS/zos/bkserv/">z/OS DFSMS Macro Instructions for Data Sets</a>.</td>
</tr>
<tr>
<td>JFCB</td>
<td>The job file control block (JFCB). For more information about the JFCB, see <a href="http://www.ibm.com/systems/z/OS/zos/bkserv/">z/OS MVS Data Areas in z/OS Internet Library at http://www.ibm.com/systems/z/OS/zos/bkserv/</a>.</td>
</tr>
<tr>
<td>JFCBX</td>
<td>The job file control block extension (JFCBX).</td>
</tr>
<tr>
<td>MBUF</td>
<td>The message buffer control block (MBUF).</td>
</tr>
<tr>
<td>[8] Memory File Control Blocks</td>
<td>This section formats the C/C++ memory file control block (MFCB).</td>
</tr>
</tbody>
</table>

Understanding the COBOL-specific LEDATA output

The Language Environment IPCS VERBEXIT LEDATA generates formatted output of COBOL-specific control blocks from a system dump when the COMP(COBOL), COMP(ALL) or ALL parameter is specified and COBOL is active in the dump. The following example illustrates the COBOL-specific output produced. The system dump being formatted was obtained by specifying the TERMTHDACT(UADUMP) runtime option. [Table 26 on page 144](#) describes the information contained in the formatted output. For easy reference, the sections of the dump are numbered to correspond with the description of each section that follows.
Table 26. Contents of COBOL-specific sections of LEDATA Output

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] RUNCOM</td>
<td>Formats the COBOL enclave-level control block (RUNCOM).</td>
</tr>
</tbody>
</table>

The names of the control blocks have changed in Enterprise COBOL V5.1. Table 27 shows the correspondence with COBOL V4R2 and prior releases.

Table 27. Contents of COBOL-specific sections of LEDATA Output (Enterprise COBOL V5.1 and later releases)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] COBDB</td>
<td>Corresponds to RUNCOM, formats the COBOL enclave-level control block.</td>
</tr>
<tr>
<td>[2] COBPCB</td>
<td>Corresponds to THDCOM, formats the COBOL process-level control block.</td>
</tr>
<tr>
<td>[3] COBRCB</td>
<td>Corresponds to COBCOM, formats the COBOL region-level control block.</td>
</tr>
<tr>
<td>[4] CLLE</td>
<td>Formats the COBOL loaded program control block (same name).</td>
</tr>
<tr>
<td>[5] COBDSACB</td>
<td>Corresponds to TGT, program-level control block.</td>
</tr>
</tbody>
</table>

Understanding the PL/I-specific LEDATA output

The Language Environment IPCS VERBEXIT LEDATA generates formatted output of PL/I-specific control blocks from a system dump when the COMP(PLI), COMP(ALL) or ALL parameter is specified and PL/I is active in the dump. The following example illustrates the PL/I-specific output produced. The system dump being formatted was obtained by specifying the TERMTHDACT(UADUMP)
runtime option. Table 28 on page 150 describes the information contained in the formatted output. For easy reference, the sections of the dump are numbered to correspond with the description of each section that follows.

********************************************************************************

<table>
<thead>
<tr>
<th>PL/I FOR MVS &amp; VM ENVIRONMENT DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] RXRCB: 00021000</td>
</tr>
<tr>
<td>+000000 ID:ZRCB</td>
</tr>
<tr>
<td>LIBVEC:0001303B RSAP:00000000</td>
</tr>
<tr>
<td>+000010 PSM:00000000</td>
</tr>
<tr>
<td>PSLA:00000000</td>
</tr>
<tr>
<td>+000000 ID:ZPRB</td>
</tr>
<tr>
<td>RCB:00021000 SYSP_FCB:00063004</td>
</tr>
<tr>
<td>+000010 MSG_FCB:00000000</td>
</tr>
<tr>
<td>PRY_INIT:001683B</td>
</tr>
<tr>
<td>+00001C ENT_FCO:00000000</td>
</tr>
<tr>
<td>MSSFLGS:00 FLAGS:86000000</td>
</tr>
<tr>
<td>+000030 DCL_LIST:00000000</td>
</tr>
<tr>
<td>DBG_STG:00000000</td>
</tr>
<tr>
<td>+00003B DCL_LIST_LEN:00000000</td>
</tr>
<tr>
<td>[3] TIA: 00056298</td>
</tr>
<tr>
<td>+000000 TISA:00000000</td>
</tr>
<tr>
<td>TAPC:00000000 TERA:00000000</td>
</tr>
<tr>
<td>TIM:00000000</td>
</tr>
<tr>
<td>+00000E TFL:00300000</td>
</tr>
<tr>
<td>TWT:00000000</td>
</tr>
<tr>
<td>+000020 TDB:00056450</td>
</tr>
<tr>
<td>TDDS:00000000 TLWR:00000000</td>
</tr>
<tr>
<td>+00002C TAP:00000000</td>
</tr>
<tr>
<td>TSN:00000000 TARD:00000000</td>
</tr>
<tr>
<td>+000030 TETF:000571C8</td>
</tr>
<tr>
<td>TAST:00000000 TXB:00000000</td>
</tr>
<tr>
<td>+00003C TXHIC:00000000</td>
</tr>
<tr>
<td>TXBOC:00000000</td>
</tr>
<tr>
<td>+00007B TLF:00000000</td>
</tr>
<tr>
<td>TERN:00000000 FCB:00000000</td>
</tr>
<tr>
<td>+000084 RC:00000000</td>
</tr>
<tr>
<td>REASON:00000000 ADBG:00000000</td>
</tr>
<tr>
<td>+000090 PAR:00000000</td>
</tr>
<tr>
<td>PADFR:00000000 PLIST:00000000</td>
</tr>
<tr>
<td>+00009C STRLOC:00000000</td>
</tr>
<tr>
<td>STRLEN:00000000 STRVAR:00000000</td>
</tr>
<tr>
<td>+0000AC ZEROSTR:00000000</td>
</tr>
<tr>
<td>PARM:00000000 PRECALL:00000000</td>
</tr>
<tr>
<td>+0000BC PRETERM:00000000</td>
</tr>
<tr>
<td>PIRPARM:00000000 CHECK:00000000</td>
</tr>
<tr>
<td>+0000CC USERD:00000000</td>
</tr>
<tr>
<td>CCPRM:00000000 MAINLAR:00000000</td>
</tr>
<tr>
<td>+0000CC MSG_LRECL:00000000</td>
</tr>
<tr>
<td>MSG_RTN:00000000 TMY:00000000</td>
</tr>
<tr>
<td>+0000DC TMX:00000000 USERCODE:00000000</td>
</tr>
<tr>
<td>PREREINT:151016F0</td>
</tr>
<tr>
<td>+0000DC SYSP_DCL:00000000</td>
</tr>
<tr>
<td>PRVLEN:00000000 PG_ADDR:00000000</td>
</tr>
<tr>
<td>+0000ED PNUM:7FFFFFFF</td>
</tr>
<tr>
<td>00000000 4K:00000000 BILC:00000000</td>
</tr>
<tr>
<td>00000000 00000000 00000000 00000000</td>
</tr>
<tr>
<td>+00011C SYSPRINT_OPCODE:15A3C04C</td>
</tr>
<tr>
<td>4K_HID:00000000</td>
</tr>
<tr>
<td>[4] FECB: 000571C8</td>
</tr>
<tr>
<td>+000000 CHAIN:00000000</td>
</tr>
<tr>
<td>PRV:00000000 NAME:IEFBR14</td>
</tr>
<tr>
<td>+000010 CODE:50E0D068</td>
</tr>
<tr>
<td>58FF0014 41C0C000 0CEF58E0 D0680B0E</td>
</tr>
<tr>
<td>+000024 EPA:00E730000</td>
</tr>
<tr>
<td>SAVE:00000000 END:00000008</td>
</tr>
<tr>
<td>+000034 FLAGS:00000000</td>
</tr>
<tr>
<td>MENTRY:00000000 LOADPTR:00000000</td>
</tr>
<tr>
<td>+------------------- start of data for file 1 ------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>+000000 FCB:00000000</td>
</tr>
<tr>
<td>+000000 ENV:15101770</td>
</tr>
<tr>
<td>+000000 ATT:02010400</td>
</tr>
<tr>
<td>OPA:01861800</td>
</tr>
<tr>
<td>+000000 NMO:0014 FNLEN:0007</td>
</tr>
<tr>
<td>+000000 FFST:00020100</td>
</tr>
<tr>
<td>00000000 FAIS:0001A1A8 FATHM:00046402</td>
</tr>
<tr>
<td>+000010 FADL:15101750</td>
</tr>
<tr>
<td>FACB/FAD8:0057484 FAFO:00057314</td>
</tr>
<tr>
<td>+00001C Fail:00000000</td>
</tr>
<tr>
<td>FERR:00000000 FCOM:00000000</td>
</tr>
<tr>
<td>FATA:02210400</td>
</tr>
<tr>
<td>+00003C TRFA:00000000</td>
</tr>
<tr>
<td>00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000</td>
</tr>
<tr>
<td>+000040 FNG:00000000</td>
</tr>
<tr>
<td>FBIF:00000000 FST:00000000</td>
</tr>
<tr>
<td>FST:00000000</td>
</tr>
<tr>
<td>+000050 FRC:00000000</td>
</tr>
<tr>
<td>FRET:00000000 FRTB:00000000</td>
</tr>
<tr>
<td>FERM:0001A20 FGAM:00082</td>
</tr>
<tr>
<td>+000066 FKL:00000000</td>
</tr>
<tr>
<td>FCCT:00000000 FAKY:00000000</td>
</tr>
<tr>
<td>+000070 FTO/FREL:00000000</td>
</tr>
<tr>
<td>FXBA:00000000 FRTB:00000000</td>
</tr>
<tr>
<td>+00007C FQ:02910000</td>
</tr>
<tr>
<td>FABM:0A10040C</td>
</tr>
<tr>
<td>+----------------- start of data for file 1 ------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>[7] IOB: 000574D8</td>
</tr>
<tr>
<td>+000000 FFST:00020100</td>
</tr>
<tr>
<td>00000000 FAIS:0001A1A8 FATHM:00046402</td>
</tr>
<tr>
<td>+000010 FAFO:00057314</td>
</tr>
<tr>
<td>+00001C Fail:00000000</td>
</tr>
<tr>
<td>FERR:00000000 FCOM:00000000</td>
</tr>
<tr>
<td>FATA:02210500</td>
</tr>
<tr>
<td>+000034 TRFA:00000000</td>
</tr>
<tr>
<td>00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000</td>
</tr>
<tr>
<td>+000040 FNG:00000000</td>
</tr>
<tr>
<td>FBIF:00000000 FST:00000000</td>
</tr>
<tr>
<td>FST:00000000</td>
</tr>
<tr>
<td>+000050 FRC:00000000</td>
</tr>
<tr>
<td>FRET:00000000 FRTB:00000000</td>
</tr>
<tr>
<td>FERM:0001A20 FGAM:00082</td>
</tr>
<tr>
<td>+000066 FKL:00000000</td>
</tr>
<tr>
<td>FCCT:00000000 FAKY:00000000</td>
</tr>
<tr>
<td>+000070 FTO/FREL:00000000</td>
</tr>
<tr>
<td>FXBA:00000000 FRTB:00000000</td>
</tr>
<tr>
<td>+00007C FQ:02910000</td>
</tr>
<tr>
<td>FABM:0A10040C</td>
</tr>
<tr>
<td>+----------------- start of data for file 1 ------------------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Chapter 3. Using Language Environment debugging facilities 145
Exiting PL/I for MVS & VM Environment Data

********************************************************************
ENTERPRISE PL/I ENVIRONMENT DATA
********************************************************************

[8] RCB: 15A3A000
+000000 ID:VRCB LIBVEC:00022038 DTPMTRN:00000000
+000010 CICSFS:00000001

[9] PCB: 15A3B000
+000000 ID:IBMPLPCB RCB:00000000 FCO:15A3B054
+000010 INITMETHOD:15A3B286 METHODLEN:00000068 FLAGS:06800000
+00001C ORG_TCA:00033B88 IO_MOD:800283A0 IO_OPEN:000283F4
+000028 IO_CLOSE:000284D4 IO_GET:00028592 IO_PUT:000285DA
+000034 IO_PUTX:00028622 IO_WR_DM:0002866C
+00003C IO_WR_DI:00028818 IO_WR_SF:0002889E
+000044 IO_RD_DI:00028938 IO_RD_SF:000289BE
+00004C IO_TPUT:00028A2C IO_GTSIZE:00028A78

[10] TCA: 000568F0
+000000 PREV:00000000 FLAGS:00000000 APPTYPE:00000000
+000014 INITADDR:15A40CC8 INITSTOR:00000000
+000020 BEL_HEAPID:00000000 MAXPATHLEN:00000000
+00002C TABTAB:15479F08 DDMDLL:00000000 IOFLGS:00000000
+000038 DDT:00000000 TWC:00000000 PFO_ANC:00000000
+000044 DDB:00000000 CONV_FCO:00000000 SCB_PTR:00000000
+000050 DMY_OCA:00056AF8 LAST_OCA:00056BC8 DEF_BIF_STR:0000
+00005A DEF_ONCHR:40 ASEM_HAND:00000000 DSEM_HAND:00000000
+000064 OSEM_HAND:00000000 FSEM_HAND:00000000
+00006C XML_CHAIN:00000000 XML_EXIT:00000000
+000078 CTL_LIST:00000000 SYSPRT_FCO:00000000
+000080 FLUSH_RTN:153D6228 STDOUT_HAND:00000000
+000094 IO_MOD:000283A0 BTRV_RTN:00000000
+0000A0 CONV_RTN:00000000 DEC_VALID:00000000
+0000A8 HEX_TRANS:00000000 NLS_BLOCK:00000000
+0000B0 RAND_SEED:00000001 RETCODE:00000000
+0000C0 DBG_TERM:00000000 DBG_FETCH:00000000
+0000C8 DBG_EXCP:00000000 SIM_HAND:00000000
+0000D0 DBG_FRAME1:00000000 STMT_HOOK:00000000
+0000D8 ENTRY_HOOK:00000000 CALL_PLITEST:00000000
+0000E0 IBMPEACH:00000000 CICSPPMB:00000000
+0000E8 ENCL_REC_CNT:00000000 ENCL_CNT:00000000
+0000F0 DEF_LIB_HP:00000000 DEF_USR_HP:00000000
+0000F8 CUR_USR_HP:00000000 ADMS_GOTO:00000000
+000108 THD_SPEC_USE:00000000 STG_TAB:15A41150 SYSTEM:00000002
+000114 ANCH_BASE:00000000 API_ADDR:00000000
+00011C PBAS_ADDR:00000000 PBG_STD:00000000 SNAP_ID:0000
+00012E SNAP_FLGS:00000000 FETCH_WSA:00000000
+000138 MUTEX_ATTRIB:00000000 1D_OPEN:000283F4
+000140 IO_CLOSE:000284D4 IO_GET:00028592 IO_PUT:000285DA
+00014C IO_PUTX:00028622 ASIM_MUTEX:00000000
+000154 DSM_MUTEX:00000000 DSM_MUTEX:00000000
+00015C FSM_MUTEX:00000000 FILES_AREA:15A445E8
+000164 IO_WRMDY:0002866C IO_WRD:00028818
+00016C IO_WSF:0002889E IO_RD:00028938
+000174 IO_RSOF:000289BE Amode_Glue:00000000
+00017C FCB_AREA:15A418B8

+000000 CHAIN:15A41888 HANDLE:00056CF0 LDHANDLE:00054000
+00000C COUNT:000000001 FLAGS:00000000 MODMSZ:00000000
+000018 MODNAME:HELP AMODESTG:00056CF0 PTKEN:15A3C0DC
+000000 CHAIN:15A41888 HANDLE:00056CC8 LDHANDLE:00059E98
+00000C COUNT:000000001 FLAGS:00000000 MODMSZ:00000000
+000018 MODNAME:DELETE AMODESTG:00056CC8 PTKEN:15A3C0DC
+000000 CHAIN:15A418B8 HANDLE:00056CA0 LDHANDLE:00073000
+00000C COUNT:000000001 FLAGS:00000000 MODMSZ:00000000

146 z/OS V2R1.0 Language Environment Debugging Guide
Chapter 3. Using Language Environment debugging facilities
Chapter 3. Using Language Environment debugging facilities

FILENAME: SYSPRINT
FNAME: 15A3B30A
NAMELEN: 0008
ANCHOR: 15A3B306 DECLARED: 00444042 INVALIDS: 00A3AE01
NAMEPTR: 15A3B30A ENVPTR: 00000000 INT_TAG: 00000000
ATTRS: PRINT EXT OUTPUT SYSPRINT STREAM
INVLD: KEYED UNBUF BUF INPUT UPDATE SEQ DIR TRANS RECORD
FCO: 15A3B054
SELF: 15A3B054 CHAIN: 00000000 ANCESTOR: 00000000
INV_STMT_METH: 1541FD48 STMT_ERR_METH: 1541FCF0
DIAGNOSE_METH: 1541FD48 DONE_METH: 1541FCF0
OPEN_METH: 1541FD48 CLOSE_METH: 1541F7B0
WRITE_METH: 1541FD48 REWRITE_METH: 1541FD48
DELETE_METH: 1541FD48 READ_METH: 1541FD48
UNLOCK_METH: 1541FCF0 WAIT_METH: 1541FCF0
PUT_METH: 15467018 GET_METH: 1541FD48
FLUSH_METH: 1541F650 FINDUSE_METH: 1541EE00
SETTYPE_METH: 1541ED78 QRYTYPE_METH: 1541ED10
PFO: 15A3B2EE
EHB: 00000000 LENGTH: 00000232
DCB_ACB: 00060004 IO_BUF: 00061F7C BLKSIZE: 00000081
BLKXFER: 00000000 BUF_OBJ: 00000000
BUF_LEFT: 00000000 PRIOR_REC_L: 00000000
RECSIZE: 00000079 BUFSIZE: 00000000
BIG_IO_BUF: 00000000 DCBE: 15A4C000 ERR_TYPE: 00
DD_ACCESS: 00000001 DD_BLKSIZE: 0000 DD_LRECL: 0000
DD_RETCODE: 0000 DD_DDNAME: SYSPRINT DD_RECFM: 00
DD_DISP: 0081 DD_FLAGS: 20
DD_DSNAME: A374585.IPCSPLI2.J0005155.D0000119.?
PATHNAME: A374585.IPCSPLI2.J0005155.D0000119.?
ENV: CONSECUTIVEDEF CTLASA UNSET V B
Table 28. Contents of PL/I-specific sections of LEDATA output

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[10] TCA</td>
<td>Formats the Enterprise PL/I task communication control block (TCA).</td>
</tr>
<tr>
<td>[12] OCA</td>
<td>Formats the Enterprise PL/I ON communications control block (OCA).</td>
</tr>
</tbody>
</table>

Formatting individual control blocks

In addition to the full LEDATA output, which contains many formatted control blocks, the IPCS Control block formatter can format individual Language Environment control blocks. The IPCS CBF command can be invoked from the "IPCS Subcommand Entry" screen, option 6 of the "IPCS PRIMARY OPTION MENU".

Syntax

```
 CBF—address—STRUCTure—(—cbname—)
```

address
Address of the control block in the dump, which is determined by browsing the dump or running the LEDATA verb exit.

cbname
The name of the control block to be formatted. The control blocks that can be individually formatted are listed in Table 29 on page 151. In general, the name of each control block is similar to that used by the LEDATA verb exit and is generally found in the control block’s eyecatcher field. However, all control
block names are prefixed with “CEE” to uniquely define the Language Environment control block names to IPCS.

For example, the following command produces the output shown in Figure 34.

```
CBF 213F6B48 struct(CEECAA)
```

Figure 34. CAA formatted by the CBFORMAT IPCS command

For more information on using the IPCS CBF command, refer to the "CBFORMAT subcommand" section in z/OS MVS IPCS Commands, SA23-1382.

Table 29. Language Environment Control blocks that can be individually formatted

<table>
<thead>
<tr>
<th>Control Block</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEEADHP</td>
<td>Additional Heap Control Block</td>
</tr>
<tr>
<td>CEECAA</td>
<td>Common Anchor Area</td>
</tr>
</tbody>
</table>
### Table 29. Language Environment Control blocks that can be individually formatted (continued)

<table>
<thead>
<tr>
<th>Control Block</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEECIB</td>
<td>Condition Information Block</td>
</tr>
<tr>
<td>CEECIBH</td>
<td>Condition Information Block Header</td>
</tr>
<tr>
<td>CEECMXB</td>
<td>Message Services Block</td>
</tr>
<tr>
<td>CEEDSA</td>
<td>Dynamic Storage Area</td>
</tr>
<tr>
<td>CEEDLLF</td>
<td>DLL Failure Control Block</td>
</tr>
<tr>
<td>CEEDSAATR</td>
<td>XPLINK Transition Area</td>
</tr>
<tr>
<td>CEEEDSAX</td>
<td>Dynamic Storage Area (XPLINK style)</td>
</tr>
<tr>
<td>CEEEDB</td>
<td>Enclave Data Block</td>
</tr>
<tr>
<td>CEEENSM</td>
<td>Enclave Level Storage Management</td>
</tr>
<tr>
<td>CEEHANC</td>
<td>Heap Anchor Node</td>
</tr>
<tr>
<td>CEEHCOM</td>
<td>CEL Exception Manager Communications Area</td>
</tr>
<tr>
<td>CEEHPJB</td>
<td>Thread Level Heap Control Block</td>
</tr>
<tr>
<td>CEEHPSB</td>
<td>Heap Statistics Block</td>
</tr>
<tr>
<td>CEEMDST</td>
<td>Message Destination</td>
</tr>
<tr>
<td>CEEMGF</td>
<td>Mapping of the Message Formatter (IBM1MGF)</td>
</tr>
<tr>
<td>CEEPCB</td>
<td>Process Control Block</td>
</tr>
<tr>
<td>CEEPMBB</td>
<td>Program Management Control Block</td>
</tr>
<tr>
<td>CEERCBB</td>
<td>Region Control Block</td>
</tr>
<tr>
<td>CEESKSBB</td>
<td>Stack Statistics Block</td>
</tr>
<tr>
<td>CEESMCB</td>
<td>Storage Management Control Block</td>
</tr>
<tr>
<td>CEESTKH</td>
<td>Stack Header Block</td>
</tr>
<tr>
<td>CEESTKHX</td>
<td>Stack Header Block (xplink style)</td>
</tr>
<tr>
<td>CEESTSB</td>
<td>Storage Report Statistics Block</td>
</tr>
<tr>
<td>CEETMXB</td>
<td>Thread Level Messages Extension Block</td>
</tr>
</tbody>
</table>

### Requesting a Language Environment trace for debugging

Language Environment provides an in-storage, wrapping trace facility that can reconstruct the events leading to the point where a dump is taken. The trace facility can record two types of events: entry and exit library calls and, if the POSIX runtime option is set to ON, user mutex and condition variable activity such as init, lock/unlock, and wait. Language Environment produces a trace table in its dump report under the following conditions:

- The CEE3DMP callable service is invoked with the BLOCKS option and the TRACE runtime option is set to ON.
- The TRACE runtime option is set to NODUMP and the TERMTHDACT runtime option is set to DUMP, UADUMP, TRACE, or UATRACE.
- The TRACE runtime option is set to DUMP (the default).

For more information about the CEE3DMP callable service, the TERMTHDACT runtime option, or the TRACE runtime option, see [z/OS Language Environment Programming Reference](https://www.ibm.com/support/docview/doc?rs=4426&context=SSL000000&cc=us&lang=en&cp=1521&docnumber=SSL000000).
The TRACE runtime option activates Language Environment runtime library tracing and controls the size of the trace buffer, the type of trace events to record, and it determines whether a dump containing only the trace table should be unconditionally taken when the application (enclave) terminates. The trace table contents can be written out either upon demand or at the termination of an enclave.

The contents of the Language Environment dump depend on the values set in the TERMTHDACT runtime option. Table 30 summarizes the dump contents that are generated under abnormal termination.

Table 30. TERMTHDACT runtime option settings and dump contents produced

<table>
<thead>
<tr>
<th>TERMTHDACT value</th>
<th>Type of dump generated</th>
</tr>
</thead>
<tbody>
<tr>
<td>TERMTHDACT(QUIET)</td>
<td>Language Environment dump containing the trace table only</td>
</tr>
<tr>
<td>TERMTHDACT(MSG)</td>
<td>Language Environment dump containing the trace table only</td>
</tr>
<tr>
<td>TERMTHDACT(TRACE)</td>
<td>Language Environment dump containing the trace table and the traceback</td>
</tr>
<tr>
<td>TERMTHDACT(DUMP)</td>
<td>Language Environment dump containing thread/enclave/process storage and control blocks (the trace table is included as an enclave control block)</td>
</tr>
<tr>
<td>TERMTHDACT(UAONLY)</td>
<td>System dump of the user address space and a Language Environment dump that contains the trace table</td>
</tr>
<tr>
<td>TERMTHDACT(UATRACE)</td>
<td>Language Environment dump that contains traceback information, and a system dump of the user address space</td>
</tr>
<tr>
<td>TERMTHDACT(UADUMP)</td>
<td>Language Environment dump containing thread/enclave/process storage and control blocks (the trace table is included as an enclave control block), and a user address space dump</td>
</tr>
<tr>
<td>TERMTHDACT(UAIMM)</td>
<td>System dump of the user address space of the original abend or program interrupt that occurred before the Language Environment condition manager processing the condition. Also contains a Language Environment dump, which contains the trace table. Under CICS, UAIMM yields UAONLY behavior. Under non-CICS, TRAP(ON,NOSPIE) must be in effect. When TRAP(ON,PIE) is in effect, UAIMM yields UAONLY behavior. For software raised conditions or signals, UAIMM behaves the same as UAONLY.</td>
</tr>
</tbody>
</table>

Under normal termination, independent of the TERMTHDACT setting, Language Environment generates a dump containing the trace table only based on the TRACE runtime option.

Language Environment quiesces all threads that are currently running except for the thread that issued the call to CEE3DMP. When you call CEE3DMP in a multithread environment, only the current thread is dumped. Enclave- and process-related storage could have changed from the time the dump request was issued.

**Locating the trace dump**

If your application calls CEE3DMP, the Language Environment dump is written to the file specified in the FNAME parameter of CEE3DMP (the default is CEEDUMP).
If your application is running under TSO or batch, and a CEEDUMP DD is not specified, Language Environment writes the CEEDUMP to the batch log (SYSOUT=* by default). You can change the SYSOUT class by specifying a CEEDUMP DD, or by setting the environment variable, _CEE_DMPTARG=SYSOUT(x), where x is the preferred SYSOUT class.

If your application is running under z/OS UNIX and is either running in an address space you issued a fork() to, or if it is invoked by one of the exec family of functions, the dump is written to the hierarchical file system (HFS). Language Environment writes the CEEDUMP to one of the following directories in the specified order:
1. The directory found in environment variable _CEE_DMPTARG, if found
2. The current working directory, if the directory is not the root directory (/), the directory is writable, and the CEEDUMP path name does not exceed 1024 characters
3. The directory found in environment variable TMPDIR (an environment variable that indicates the location of a temporary directory if it is not /tmp)
4. The /tmp directory

The name of this file changes with each dump and uses the following format:

```
/path/Fname.Date.Time.Pid
```

- **path** Path determined from the above algorithm.
- **Fname** Name specified in the FNAME parameter on the call to CEE3DMP (default is CEEDUMP).
- **Date** Date the dump is taken, appearing in the format YYYYMMDD (such as 20090307 for March 7, 2009).
- **Time** Time the dump is taken, appearing in the format HHMMSS (such as 175501 for 05:55:01 p.m.).
- **Pid** Process ID the application is running in when the dump is taken.

**Using the Language Environment trace table format in a dump report**

The Language Environment trace table is established unconditionally at enclave initialization time if the TRACE runtime option is set to ON. All threads in the enclave share the trace table; there is no thread-specific table, nor can the table be dynamically extended or enlarged.

**Understanding the trace table entry (TTE)**

Each trace table entry is a fixed-length record consisting of a fixed-format portion (containing such items as the timestamp, thread ID, and member ID) and a member-specific portion. The member-specific portion has a fixed length, of which some (or all) can be unused. For information about how participating products use the trace table entry, see the product-specific documentation. The format of the trace table entry is as follows:
Time
The 64-bit value obtained from a store clock (STCK).

Thread ID
The 8-byte thread ID of the thread that is adding the trace table entry.

Member ID and Flags
Contains 2 fields:

Member ID
The 1-byte member ID of the member making the trace table entry, as follows:

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>CEL</td>
</tr>
<tr>
<td>03</td>
<td>C/C++</td>
</tr>
<tr>
<td>04</td>
<td>COBOL V5 (and later releases)</td>
</tr>
<tr>
<td>05</td>
<td>COBOL</td>
</tr>
<tr>
<td>07</td>
<td>Fortran</td>
</tr>
<tr>
<td>08</td>
<td>Reserved</td>
</tr>
<tr>
<td>10</td>
<td>PL/I</td>
</tr>
<tr>
<td>11</td>
<td>Enterprise PL/I</td>
</tr>
<tr>
<td>12</td>
<td>Sockets</td>
</tr>
</tbody>
</table>

Flags
24 flags reserved for internal use.

Member Entry Type
A number that indicates the type of the member-specific trace information that follows the field. To uniquely identify the information contained in a specific TTE, you must consider Member ID as well as Member Entry Type.

Member-Specific Information
Based on the member ID and the member entry type, this field contains the specific information for the entry, up to 104 bytes. For C/C++, the entry type of 1 is a record that records an invocation of a base C runtime library function. The entry consists of the name of the invoking function and the name of the invoked function. Entry type 2 is a record that records the return from the base library function. It contains the returned value and the value of errno.

Member-specific information in the trace table entry
Global tracing is activated by using the LE=n suboption of the TRACE runtime option. This requests all Language Environment members to generate trace records in the trace table. The settings for the global trace events are:

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No global trace</td>
</tr>
<tr>
<td>1</td>
<td>Trace all runtime library (RTL) function entry and exits</td>
</tr>
<tr>
<td>2</td>
<td>Trace all RTL mutex init/destroy and lock/unlock</td>
</tr>
</tbody>
</table>
Trace all RTL function entry and exits, and all mutex init/destroy and lock/unlock.

Trace all RTL storage allocation/deallocation.

Trace all XPLINK/non-XPLINK transitions for AMODE 31 only. If #pragma linkage (xxxxxxxx, OS_UPSTACK) is specified, no transitions are recorded.

When LE=1 is specified: Table 31 shows the C/C++ records that may be generated. For a detailed description of these records, see “C/C++ contents of the Language Environment trace tables” on page 201.

### Table 31. LE=1 entry records

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>00000001</td>
<td>Base C Library function Entry</td>
</tr>
<tr>
<td>03</td>
<td>00000002</td>
<td>Base C Library function Exit</td>
</tr>
<tr>
<td>03</td>
<td>00000003</td>
<td>Posix C Library function Entry</td>
</tr>
<tr>
<td>03</td>
<td>00000004</td>
<td>Posix C Library function Exit</td>
</tr>
<tr>
<td>03</td>
<td>00000005</td>
<td>XPLINK Base or Posix C Library function Entry</td>
</tr>
<tr>
<td>03</td>
<td>00000006</td>
<td>XPLINK Base or Posix C Library function Exit</td>
</tr>
</tbody>
</table>

When LE=2 is specified: Table 32 shows the Language Environment records that may be generated.

### Table 32. LE=2 entry records

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Class</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>00000101</td>
<td>LT</td>
<td>A</td>
<td>Latch Acquire</td>
</tr>
<tr>
<td>01</td>
<td>00000102</td>
<td>LT</td>
<td>R</td>
<td>Latch Release</td>
</tr>
<tr>
<td>01</td>
<td>00000103</td>
<td>LT</td>
<td>W</td>
<td>Latch Wait</td>
</tr>
<tr>
<td>01</td>
<td>00000104</td>
<td>LT</td>
<td>AW</td>
<td>Latch Acquire after Wait</td>
</tr>
<tr>
<td>01</td>
<td>00000106</td>
<td>LT</td>
<td>I</td>
<td>Latch Increment (Recursive)</td>
</tr>
<tr>
<td>01</td>
<td>00000107</td>
<td>LT</td>
<td>D</td>
<td>Latch Decrement (Recursive)</td>
</tr>
<tr>
<td>01</td>
<td>000002FC</td>
<td>LE</td>
<td>EUO</td>
<td>Latch unowned (not released)</td>
</tr>
<tr>
<td>01</td>
<td>000002FD</td>
<td>LE</td>
<td>EO</td>
<td>Latch already owned (not acquired)</td>
</tr>
<tr>
<td>01</td>
<td>00000301</td>
<td>MX</td>
<td>A</td>
<td>Mutex acquire</td>
</tr>
<tr>
<td>01</td>
<td>00000302</td>
<td>MX</td>
<td>R</td>
<td>Mutex release</td>
</tr>
<tr>
<td>01</td>
<td>00000303</td>
<td>MX</td>
<td>W</td>
<td>Mutex wait</td>
</tr>
<tr>
<td>01</td>
<td>00000304</td>
<td>MX</td>
<td>AW</td>
<td>Mutex acquire after wait</td>
</tr>
<tr>
<td>01</td>
<td>00000305</td>
<td>MX</td>
<td>B</td>
<td>Mutex busy (Trylock failed)</td>
</tr>
<tr>
<td>01</td>
<td>00000306</td>
<td>MX</td>
<td>I</td>
<td>Mutex increment (recursive)</td>
</tr>
<tr>
<td>01</td>
<td>00000307</td>
<td>MX</td>
<td>D</td>
<td>Mutex decrement (recursive)</td>
</tr>
<tr>
<td>01</td>
<td>00000315</td>
<td>MX</td>
<td>IN</td>
<td>Mutex initialize</td>
</tr>
<tr>
<td>01</td>
<td>00000316</td>
<td>MX</td>
<td>DS</td>
<td>Mutex destroy</td>
</tr>
<tr>
<td>01</td>
<td>0000031D</td>
<td>MX</td>
<td>BI</td>
<td>Shared memory lock init</td>
</tr>
<tr>
<td>01</td>
<td>0000031E</td>
<td>MX</td>
<td>BD</td>
<td>Shared memory lock destroy</td>
</tr>
<tr>
<td>01</td>
<td>0000031F</td>
<td>MX</td>
<td>BO</td>
<td>shared memory lock obtain</td>
</tr>
<tr>
<td>01</td>
<td>00000320</td>
<td>MX</td>
<td>BC</td>
<td>shared memory lock obtain on condition</td>
</tr>
</tbody>
</table>
Table 32. LE=2 entry records (continued)

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Class</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>00000321</td>
<td>MX</td>
<td>BR</td>
<td>Shared memory lock release</td>
</tr>
<tr>
<td>01</td>
<td>00000324</td>
<td>MX</td>
<td>CIN</td>
<td>Call to SMC_INIT</td>
</tr>
<tr>
<td>01</td>
<td>00000325</td>
<td>MX</td>
<td>CSD</td>
<td>Call to SMC_DESTROY</td>
</tr>
<tr>
<td>01</td>
<td>00000326</td>
<td>MX</td>
<td>CSO</td>
<td>Shared resource obtain</td>
</tr>
<tr>
<td>01</td>
<td>00000327</td>
<td>MX</td>
<td>CSR</td>
<td>Shared resource release</td>
</tr>
<tr>
<td>01</td>
<td>00000328</td>
<td>MX</td>
<td>CST</td>
<td>Call to SMC_SetupToWait</td>
</tr>
<tr>
<td>01</td>
<td>00000329</td>
<td>MX</td>
<td>CSP</td>
<td>Call to SMC_POST</td>
</tr>
<tr>
<td>01</td>
<td>000004CC</td>
<td>ME</td>
<td>FFR</td>
<td>Error - Forced release (shared mutex)</td>
</tr>
<tr>
<td>01</td>
<td>000004CD</td>
<td>ME</td>
<td>FFD</td>
<td>Error - Forced decrement (shared mutex)</td>
</tr>
<tr>
<td>01</td>
<td>000004CE</td>
<td>ME</td>
<td>FBD</td>
<td>Error - BPX_SMC(DESTROY) error return</td>
</tr>
<tr>
<td>01</td>
<td>000004CF</td>
<td>ME</td>
<td>FBU</td>
<td>Error - BPX_SMC(fail) returns EBUSY</td>
</tr>
<tr>
<td>01</td>
<td>000004D0</td>
<td>ME</td>
<td>FIV</td>
<td>Error - BPX_SMC(fail) returns EINVAL</td>
</tr>
<tr>
<td>01</td>
<td>000004D4</td>
<td>ME</td>
<td>FDU</td>
<td>Error - Destroy failed (uninitialized) (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>000004D5</td>
<td>ME</td>
<td>FP</td>
<td>Error - Program check (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>000004DB</td>
<td>ME</td>
<td>ESC</td>
<td>Error - BPX1SMC error return</td>
</tr>
<tr>
<td>01</td>
<td>000004DE</td>
<td>ME</td>
<td>EDL</td>
<td>Shared memory lock returns deadlock</td>
</tr>
<tr>
<td>01</td>
<td>000004DF</td>
<td>ME</td>
<td>EIV</td>
<td>Shared memory lock returns invalid</td>
</tr>
<tr>
<td>01</td>
<td>000004E0</td>
<td>ME</td>
<td>EPM</td>
<td>Shared memory lock returns eperm</td>
</tr>
<tr>
<td>01</td>
<td>000004E1</td>
<td>ME</td>
<td>EAG</td>
<td>Shared memory lock returns eagain</td>
</tr>
<tr>
<td>01</td>
<td>000004E2</td>
<td>ME</td>
<td>EBU</td>
<td>Shared memory lock returns ebusy</td>
</tr>
<tr>
<td>01</td>
<td>000004E3</td>
<td>ME</td>
<td>ENM</td>
<td>Shared memory lock returns enomem</td>
</tr>
<tr>
<td>01</td>
<td>000004E4</td>
<td>ME</td>
<td>EBR</td>
<td>Shared memory lock release error</td>
</tr>
<tr>
<td>01</td>
<td>000004E5</td>
<td>ME</td>
<td>EBC</td>
<td>Shared memory lock obtain condition error</td>
</tr>
<tr>
<td>01</td>
<td>000004E6</td>
<td>ME</td>
<td>EBO</td>
<td>Shared memory lock obtain error</td>
</tr>
<tr>
<td>01</td>
<td>000004E7</td>
<td>ME</td>
<td>EBD</td>
<td>Shared memory lock destroy error</td>
</tr>
<tr>
<td>01</td>
<td>000004E8</td>
<td>ME</td>
<td>EBI</td>
<td>Shared memory lock initialize error</td>
</tr>
<tr>
<td>01</td>
<td>000004E9</td>
<td>ME</td>
<td>EFR</td>
<td>Mutex forced release</td>
</tr>
<tr>
<td>01</td>
<td>000004EA</td>
<td>ME</td>
<td>EFD</td>
<td>Mutex forced decrement</td>
</tr>
<tr>
<td>01</td>
<td>000004EB</td>
<td>ME</td>
<td>EDD</td>
<td>Mutex destroy failed (damage)</td>
</tr>
<tr>
<td>01</td>
<td>000004EC</td>
<td>ME</td>
<td>EDB</td>
<td>Mutex destroy failed (busy)</td>
</tr>
<tr>
<td>01</td>
<td>000004ED</td>
<td>ME</td>
<td>EIA</td>
<td>Mutex initialize failed (attribute)</td>
</tr>
<tr>
<td>01</td>
<td>000004EE</td>
<td>ME</td>
<td>EIS</td>
<td>Mutex initialize failed (storage)</td>
</tr>
<tr>
<td>01</td>
<td>000004EF</td>
<td>ME</td>
<td>EF</td>
<td>Mutex release (forced by quiesce)</td>
</tr>
<tr>
<td>01</td>
<td>000004F0</td>
<td>ME</td>
<td>EP</td>
<td>Mutex program check</td>
</tr>
<tr>
<td>01</td>
<td>000004FA</td>
<td>ME</td>
<td>EDU</td>
<td>Mutex destroy failed (uninitialized)</td>
</tr>
<tr>
<td>01</td>
<td>000004FB</td>
<td>ME</td>
<td>EUI</td>
<td>Mutex uninitialized</td>
</tr>
<tr>
<td>01</td>
<td>000004FC</td>
<td>ME</td>
<td>EUO</td>
<td>Mutex unowned (not released)</td>
</tr>
<tr>
<td>01</td>
<td>000004FD</td>
<td>E</td>
<td>EO</td>
<td>Mutex already owned (not acquired)</td>
</tr>
</tbody>
</table>
Table 32. LE=2 entry records (continued)

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Class</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>000004FE</td>
<td>ME</td>
<td>EIN</td>
<td>Mutex initialization failed (duplicate)</td>
</tr>
<tr>
<td>01</td>
<td>00000508</td>
<td>CV</td>
<td>MR</td>
<td>CV release mutex</td>
</tr>
<tr>
<td>01</td>
<td>00000509</td>
<td>CV</td>
<td>MA</td>
<td>CV reacquire mutex</td>
</tr>
<tr>
<td>01</td>
<td>0000050A</td>
<td>CV</td>
<td>MW</td>
<td>CV mutex wait</td>
</tr>
<tr>
<td>01</td>
<td>0000050B</td>
<td>CV</td>
<td>MAW</td>
<td>CV reacquire mutex after wait</td>
</tr>
<tr>
<td>01</td>
<td>0000050C</td>
<td>CV</td>
<td>CW</td>
<td>CV condition wait</td>
</tr>
<tr>
<td>01</td>
<td>0000050D</td>
<td>CV</td>
<td>CTW</td>
<td>CV condition timeout</td>
</tr>
<tr>
<td>01</td>
<td>0000050E</td>
<td>CV</td>
<td>CWP</td>
<td>CV wait posted</td>
</tr>
<tr>
<td>01</td>
<td>0000050F</td>
<td>CV</td>
<td>CWI</td>
<td>CV wait interrupted</td>
</tr>
<tr>
<td>01</td>
<td>00000510</td>
<td>CV</td>
<td>CTO</td>
<td>CV wait timeout</td>
</tr>
<tr>
<td>01</td>
<td>00000511</td>
<td>CV</td>
<td>CSS</td>
<td>CV condition signal success</td>
</tr>
<tr>
<td>01</td>
<td>00000512</td>
<td>CV</td>
<td>CSM</td>
<td>CV condition signal miss</td>
</tr>
<tr>
<td>01</td>
<td>00000513</td>
<td>CV</td>
<td>CBS</td>
<td>CV condition broadcast success</td>
</tr>
<tr>
<td>01</td>
<td>00000514</td>
<td>CV</td>
<td>CBM</td>
<td>CV condition broadcast miss</td>
</tr>
<tr>
<td>01</td>
<td>00000515</td>
<td>CV</td>
<td>IN</td>
<td>CV initialize</td>
</tr>
<tr>
<td>01</td>
<td>00000516</td>
<td>CV</td>
<td>DS</td>
<td>CV destroy</td>
</tr>
<tr>
<td>01</td>
<td>00000522</td>
<td>CV</td>
<td>CIN</td>
<td>Call to SMC_INIT</td>
</tr>
<tr>
<td>01</td>
<td>00000523</td>
<td>CV</td>
<td>CSD</td>
<td>Call to SMC_DESTROY</td>
</tr>
<tr>
<td>01</td>
<td>00000529</td>
<td>CV</td>
<td>CSP</td>
<td>Call to SMC_POST</td>
</tr>
<tr>
<td>01</td>
<td>0000052A</td>
<td>CV</td>
<td>CSB</td>
<td>Call to SMC_POSTALL</td>
</tr>
<tr>
<td>01</td>
<td>0000052B</td>
<td>CV</td>
<td>CSW</td>
<td>Call to SMC_WAIT</td>
</tr>
<tr>
<td>01</td>
<td>0000052C</td>
<td>CV</td>
<td>DBM</td>
<td>Shared condition broadcast - miss</td>
</tr>
<tr>
<td>01</td>
<td>0000052D</td>
<td>CV</td>
<td>DBS</td>
<td>Shared condition broadcast - success</td>
</tr>
<tr>
<td>01</td>
<td>0000052E</td>
<td>CV</td>
<td>DDS</td>
<td>Destroy (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>0000052F</td>
<td>CV</td>
<td>DIN</td>
<td>Initialize (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>00000530</td>
<td>CV</td>
<td>DSM</td>
<td>Condition signal - miss (shared CV)</td>
</tr>
<tr>
<td>01</td>
<td>00000531</td>
<td>CV</td>
<td>DSS</td>
<td>Condition signal - success (shared CV)</td>
</tr>
<tr>
<td>01</td>
<td>00000532</td>
<td>CV</td>
<td>DWI</td>
<td>Wait interrupted (shared CV)</td>
</tr>
<tr>
<td>01</td>
<td>00000533</td>
<td>CV</td>
<td>DTO</td>
<td>Wait timeout (shared CV)</td>
</tr>
<tr>
<td>01</td>
<td>00000534</td>
<td>CV</td>
<td>DWP</td>
<td>Wait posted (shared CV)</td>
</tr>
<tr>
<td>01</td>
<td>000006CB</td>
<td>CE</td>
<td>FBT</td>
<td>Error - Invalid system TOD (shared)</td>
</tr>
<tr>
<td>01</td>
<td>000006D1</td>
<td>CE</td>
<td>FRM</td>
<td>Error - Recursive mutex (shared)</td>
</tr>
<tr>
<td>01</td>
<td>000006D2</td>
<td>CE</td>
<td>FUO</td>
<td>Error - Shared mutex unowned</td>
</tr>
<tr>
<td>01</td>
<td>000006D3</td>
<td>CE</td>
<td>FDB</td>
<td>Error - Destroy failed (busy) (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>000006D4</td>
<td>CE</td>
<td>FDU</td>
<td>Error - Destroy failed (uninitialized) (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>000006D5</td>
<td>CE</td>
<td>FP</td>
<td>Error - Program check (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>000006D6</td>
<td>CE</td>
<td>FUI</td>
<td>Error - Shared mutex or CV unitialized</td>
</tr>
<tr>
<td>01</td>
<td>000006D7</td>
<td>CE</td>
<td>ENV</td>
<td>Error - BPXSMC(fail) returns EINVAL</td>
</tr>
</tbody>
</table>
### Table 32. LE=2 entry records (continued)

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Class</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>000006D8</td>
<td>CE</td>
<td>EPE</td>
<td>Error - BPX1SMC(fail) returns EPERM</td>
</tr>
<tr>
<td>01</td>
<td>000006D9</td>
<td>CE</td>
<td>EAN</td>
<td>Error - BPX1SMC(fail) returns EAGAIN</td>
</tr>
<tr>
<td>01</td>
<td>000006DA</td>
<td>CE</td>
<td>EIB</td>
<td>Error - BPX1SMC failed (EBUSY)</td>
</tr>
<tr>
<td>01</td>
<td>000006DB</td>
<td>CE</td>
<td>ESC</td>
<td>Error - BPX1SMC failed</td>
</tr>
<tr>
<td>01</td>
<td>000006EB</td>
<td>CE</td>
<td>EDD</td>
<td>CV destroy failed (damage)</td>
</tr>
<tr>
<td>01</td>
<td>000006EC</td>
<td>CE</td>
<td>EDB</td>
<td>CV destroy failed (busy)</td>
</tr>
<tr>
<td>01</td>
<td>000006ED</td>
<td>CE</td>
<td>EIA</td>
<td>CV initialization failed (attribute)</td>
</tr>
<tr>
<td>01</td>
<td>000006EE</td>
<td>CE</td>
<td>EIS</td>
<td>CV initialization failed (storage)</td>
</tr>
<tr>
<td>01</td>
<td>000006EF</td>
<td>CE</td>
<td>EF</td>
<td>CV forced by quiesce</td>
</tr>
<tr>
<td>01</td>
<td>000006F0</td>
<td>CE</td>
<td>EP</td>
<td>CV program check</td>
</tr>
<tr>
<td>01</td>
<td>000006F1</td>
<td>CE</td>
<td>EBT</td>
<td>CV invalid system TOD</td>
</tr>
<tr>
<td>01</td>
<td>000006F2</td>
<td>CE</td>
<td>EBN</td>
<td>CV invalid timespec (nanoseconds)</td>
</tr>
<tr>
<td>01</td>
<td>000006F3</td>
<td>CE</td>
<td>EBS</td>
<td>CV invalid timespec (seconds)</td>
</tr>
<tr>
<td>01</td>
<td>000006F4</td>
<td>CE</td>
<td>EPO</td>
<td>CV condition post callable service fail</td>
</tr>
<tr>
<td>01</td>
<td>000006F5</td>
<td>CE</td>
<td>ETW</td>
<td>CV condition timed wait callable service fail</td>
</tr>
<tr>
<td>01</td>
<td>000006F6</td>
<td>CE</td>
<td>EWA</td>
<td>CV condition wait callable service fail</td>
</tr>
<tr>
<td>01</td>
<td>000006F7</td>
<td>CE</td>
<td>ESE</td>
<td>CV condition setup callable service fail</td>
</tr>
<tr>
<td>01</td>
<td>000006F8</td>
<td>CE</td>
<td>ERM</td>
<td>CV recursive mutex</td>
</tr>
<tr>
<td>01</td>
<td>000006F9</td>
<td>CE</td>
<td>EWM</td>
<td>CV wrong mutex</td>
</tr>
<tr>
<td>01</td>
<td>000006FA</td>
<td>CE</td>
<td>EDU</td>
<td>CV destroy failed (uninitialized)</td>
</tr>
<tr>
<td>01</td>
<td>000006FB</td>
<td>CE</td>
<td>EUI</td>
<td>CV mutex or CV uninitialized</td>
</tr>
<tr>
<td>01</td>
<td>000006FC</td>
<td>CE</td>
<td>EUO</td>
<td>CV mutex unowned</td>
</tr>
<tr>
<td>01</td>
<td>000006FE</td>
<td>CE</td>
<td>EIN</td>
<td>CV initialization failed (duplicate)</td>
</tr>
<tr>
<td>01</td>
<td>00000702</td>
<td>RW</td>
<td>R</td>
<td>Release</td>
</tr>
<tr>
<td>01</td>
<td>00000704</td>
<td>RW</td>
<td>AW</td>
<td>Acquire after wait</td>
</tr>
<tr>
<td>01</td>
<td>00000706</td>
<td>RW</td>
<td>I</td>
<td>Increment (recursive)</td>
</tr>
<tr>
<td>01</td>
<td>00000707</td>
<td>RW</td>
<td>D</td>
<td>Decrement (recursive)</td>
</tr>
<tr>
<td>01</td>
<td>00000715</td>
<td>RW</td>
<td>IN</td>
<td>Initialize</td>
</tr>
<tr>
<td>01</td>
<td>00000716</td>
<td>RW</td>
<td>DS</td>
<td>Destroy</td>
</tr>
<tr>
<td>01</td>
<td>00000717</td>
<td>RW</td>
<td>RA</td>
<td>Read acquire</td>
</tr>
<tr>
<td>01</td>
<td>00000718</td>
<td>RW</td>
<td>WA</td>
<td>Write acquire</td>
</tr>
<tr>
<td>01</td>
<td>00000719</td>
<td>RW</td>
<td>RB</td>
<td>Read busy (tryread failed)</td>
</tr>
<tr>
<td>01</td>
<td>0000071A</td>
<td>RW</td>
<td>WB</td>
<td>Write busy (trywrite failed)</td>
</tr>
<tr>
<td>01</td>
<td>0000071B</td>
<td>RW</td>
<td>RW</td>
<td>Read wait</td>
</tr>
<tr>
<td>01</td>
<td>0000071C</td>
<td>RW</td>
<td>WW</td>
<td>Write wait</td>
</tr>
<tr>
<td>01</td>
<td>0000071D</td>
<td>RW</td>
<td>BI</td>
<td>Call to SLK_INIT</td>
</tr>
<tr>
<td>01</td>
<td>0000071E</td>
<td>RW</td>
<td>BD</td>
<td>Call to SLK_DESTROY</td>
</tr>
<tr>
<td>01</td>
<td>0000071F</td>
<td>RW</td>
<td>BO</td>
<td>Call to SLK_OBTAIN</td>
</tr>
<tr>
<td>01</td>
<td>00000720</td>
<td>RW</td>
<td>BC</td>
<td>Call to SLK_OBTAIN_COND</td>
</tr>
</tbody>
</table>
Table 32. LE=2 entry records (continued)

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Class</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>00000721</td>
<td>RW</td>
<td>BR</td>
<td>Call to SLK_RELEASE</td>
</tr>
<tr>
<td>01</td>
<td>000008DC</td>
<td>RE</td>
<td>EOW</td>
<td>Error - Already owned for write (not acquired)</td>
</tr>
<tr>
<td>01</td>
<td>000008DD</td>
<td>RE</td>
<td>EOR</td>
<td>Error - Already owned for read (not acquired)</td>
</tr>
<tr>
<td>01</td>
<td>000008DE</td>
<td>RE</td>
<td>EDL</td>
<td>Error - BPX1SLK(fail) returns EDEADLK</td>
</tr>
<tr>
<td>01</td>
<td>000008DF</td>
<td>RE</td>
<td>EIV</td>
<td>Error - BPX1SLK(fail) returns EINVAL</td>
</tr>
<tr>
<td>01</td>
<td>000008E0</td>
<td>RE</td>
<td>EPM</td>
<td>Error - BPX1SLK(fail) returns EPERM</td>
</tr>
<tr>
<td>01</td>
<td>000008E1</td>
<td>RE</td>
<td>EAG</td>
<td>Error - BPX1SLK(fail) returns EAGAIN</td>
</tr>
<tr>
<td>01</td>
<td>000008E2</td>
<td>RE</td>
<td>EBS</td>
<td>Error - BPX1SLK(fail) returns EBUSY</td>
</tr>
<tr>
<td>01</td>
<td>000008E3</td>
<td>RE</td>
<td>ENM</td>
<td>Error - BPX1SLK(fail) returns ENOMEM</td>
</tr>
<tr>
<td>01</td>
<td>000008E4</td>
<td>RE</td>
<td>EBR</td>
<td>Error - BPX1SLK(RELEASE) error return</td>
</tr>
<tr>
<td>01</td>
<td>000008E5</td>
<td>RE</td>
<td>EBC</td>
<td>Error - BPX1SLK(OBTAIN_COND) error return</td>
</tr>
<tr>
<td>01</td>
<td>000008E6</td>
<td>RE</td>
<td>EBO</td>
<td>Error - BPX1SLK(OBTAIN) error return</td>
</tr>
<tr>
<td>01</td>
<td>000008E7</td>
<td>RE</td>
<td>EBD</td>
<td>Error - BPX1SLK(DESTROY) error return</td>
</tr>
<tr>
<td>01</td>
<td>000008E8</td>
<td>RE</td>
<td>EBI</td>
<td>Error - BPX1SLK(INIT) error return</td>
</tr>
<tr>
<td>01</td>
<td>000008E9</td>
<td>RE</td>
<td>EFR</td>
<td>Error - Forced release</td>
</tr>
<tr>
<td>01</td>
<td>000008EA</td>
<td>RE</td>
<td>EFD</td>
<td>Error - Forced decrement</td>
</tr>
<tr>
<td>01</td>
<td>000008ED</td>
<td>RE</td>
<td>EIA</td>
<td>Error - Initialization failed (attribute)</td>
</tr>
<tr>
<td>01</td>
<td>000008EE</td>
<td>RE</td>
<td>EIS</td>
<td>Error - Initialization failed (storage)</td>
</tr>
<tr>
<td>01</td>
<td>000008EF</td>
<td>RE</td>
<td>EF</td>
<td>Error - Forced by quiesce</td>
</tr>
<tr>
<td>01</td>
<td>000008F0</td>
<td>RE</td>
<td>EP</td>
<td>Error - Program check</td>
</tr>
<tr>
<td>01</td>
<td>000008FB</td>
<td>RE</td>
<td>EUI</td>
<td>Error - Uninitialized</td>
</tr>
<tr>
<td>01</td>
<td>000008FC</td>
<td>RE</td>
<td>EUO</td>
<td>Error - Unowned (not released)</td>
</tr>
<tr>
<td>01</td>
<td>000008FD</td>
<td>RE</td>
<td>EO</td>
<td>Error - Already owned (not acquired)</td>
</tr>
<tr>
<td>01</td>
<td>000008FE</td>
<td>RE</td>
<td>EIN</td>
<td>Error - Initialization failed (duplicate)</td>
</tr>
</tbody>
</table>

Table 33 shows the format for the Mutex – Condition Variable – Latch entries in the trace table.

Table 33. Format of the mutex/CV/latch records

<table>
<thead>
<tr>
<th>Record fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
</tr>
<tr>
<td>unused</td>
</tr>
</tbody>
</table>

**Class**

Two character EBCDIC representation of the trace class.

- **LT**  Latch
- **LE**  Latch Exception
- **MX**  Mutex
- **ME**  Mutex Exception
- **CV**  Condition Variable
- **CE**  Condition Variable Exception

**Source**

One character EBCDIC representation of the event.
C  C/C++
S  Sockets

**Blank**  Blank character

**Event**  Two character EBCDIC representation of the event. See Table 32 on page 156.

**Object Addr**  Fullword address of the mutex object.

**Name 1**  Optional eight character field containing the name of the function or object to be recorded.

**Name 2**  Optional eight character field containing the name of the function or object to be recorded.

**When LE=3 is specified:**  The trace table will include the records generated by both LE=1 and LE=2.

**When LE=8 is specified:**  The trace table will contain only storage allocation records, as shown in Table 34. Currently this is only supported by C/C++. For a detailed description of these records, see “C/C++ contents of the Language Environment trace tables” on page 201.

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>00000001</td>
<td>Storage allocation entry</td>
</tr>
<tr>
<td>03</td>
<td>00000001</td>
<td>Storage allocation exit</td>
</tr>
</tbody>
</table>

**Table 34. LE=8 entry records**

**When LE=20 is specified:**  Table 35 shows the C/C++ records that might be generated. For a detailed description of these records, see “C/C++ contents of the Language Environment trace tables” on page 201.

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>00000007</td>
<td>XPLINK calls non-XPLINK entry</td>
</tr>
<tr>
<td>03</td>
<td>00000008</td>
<td>non-XPLINK calls XPLINK entry</td>
</tr>
</tbody>
</table>

**Table 35. LE=20 entry records**

**Sample dump for the trace table entry**

The following sample shows an example of a dump of the trace table when you specify the LE=1 suboption (the library call/return trace).
Requesting a UNIX System Services syscall trace for debugging

Signal SIGTRACE can be sent to a process or process group to start or stop a trace of the z/OS UNIX System Services syscalls made by the application. The signal is implemented as a toggle. With the trace turned on, the z/OS UNIX System Services kernel gathers the syscall trace records for the targeted processes. A system dump of the user address space can be generated by sending signal SIGDUMP to the same processes to capture the trace output. See z/OS UNIX System Services Command Reference for more information about the SIGTRACE signal.

...
Part 2. Debugging language-specific routines

This part provides specific information for debugging applications written in C/C++, COBOL, Fortran, and PL/I. It also discusses techniques for debugging under CICS.
Chapter 4. Debugging C/C++ routines

This chapter provides specific information to help you debug applications that contain one or more C/C++ routines. It also provides information about debugging C/C++ applications compiled with XPLINK. It includes the following topics:

- Debugging C/C++ I/O routines
- Using C/C++ compiler listings
- Generating a Language Environment dump of a C/C++ routine
- Generating a Language Environment dump of a C/C++ routine with XPLINK
- Finding C/C++ information in a Language Environment dump
- Debugging example of C/C++ routines
- Debugging example of C/C++ routines with XPLINK

There are several debugging features that are unique to C/C++ routines. Before examining the C/C++ techniques to find errors, you might want to consider the following areas of potential problems:

- If you suspect that you are using uninitialized storage, you may want to use the STORAGE runtime option.
- If you are using the fetch() function, see z/OS XL C/C++ Programming Guide to ensure that you are creating the fetchable module correctly.
- If you are using DLLs, see z/OS XL C/C++ Programming Guide to ensure that you are using the DLL correctly.
- For non-System Programming C routines, ensure that the entry point of the load module is CEESTART.
- You should avoid:
  - Incorrect casting
  - Referencing an array element with a subscript outside the declared bounds
  - Copying a string to a target with a shorter length than the source string
  - Declaring but not initializing a pointer variable, or using a pointer to allocated storage that has already been freed

If a routine exception occurred and you need more information than the condition handler provided, run your routine with the following runtime options: TRAP(ON, NOSPIE) and TERMTHDACT(UAIMM). Setting these runtime options generates a system dump of the user address space of the original abend or program interrupt prior to the Language Environment condition manager processing the condition. After the system dump is taken by the operating system, the Language Environment condition manager continues processing.

Debugging C/C++ programs

You can use C/C++ conventions such as __amrc and perror() when you debug C/C++ programs.

Using the __amrc and __amrc2 structures to debug input/output

__amrc, a structure defined in stdio.h, can help you determine the cause of errors resulting from an I/O operation, because it contains diagnostic information (for example, the return code from a failed VSAM operation). There are two structures:
- __amrc (defined by type __amrc_type
- __amrc2 (defined by type __amrc2_type)

The __amrc2_type structure contains secondary information that C can provide.

Because any I/O function calls, such as printf(), can change the value of __amrc
or __amrc2, make sure you save the contents into temporary structures of
__amrc_type and __amrc2_type respectively, before dumping them.

Figure 36 shows the structure as it appears in stdio.h.

```c
typedef struct __amrctype {
    union {
        long int __error;
        struct {
            unsigned short __syscode,
            __rc;
        } __abend;
        struct {
            unsigned char __fdbk_fill,
            __rc,
            __ftncd,
            __fdbk;
        } __feedback;
        struct {
            unsigned short __svc99_info,
            __svc99_error;
        } __alloc;
    } __code;
    unsigned long __RBA;
    unsigned int __last_op;
    struct {
        unsigned long __len_fill; /* __len + 4 */
        unsigned long __len;
        char __str[120];
        unsigned long __parmr0;
        unsigned long __parmr1;
        unsigned long __fill2[2];
        char __str2[64];
    } __msg;
    #if __EDC_TARGET >= 0x22080000
    unsigned char __rplfdbwd[4];
    #endif
    #if __EDC_TARGET >= 0x41080000
    #ifdef __LP64
    unsigned long __XRBA;
    #else defined(__LL)
    unsigned long long __XRBA;
    #else
    unsigned int __XRBA1;
    unsigned int __XRBA2;
    #endif
    unsigned char __amrc_noseek_to_seek;
    char __amrc_pad[23];
    #endif
} __amrc_type;
```

Figure 36. __amrc structure
Figure 37 shows the __amrc2 structure as it appears in stdio.h.

```c
struct {
  long int __error2;
  char __pad__error2[4];
  FILE *__fileptr;
  long int __reserved[6];
};
```

**Figure 37. __amrc2 structure**

1. **union { ... } __code**
   The error or warning value from an I/O operation is in __error, __abend, __feedback, or __alloc. Look at __last_op to determine how to interpret the __code union.

2. **__error**
   A structure that contains error codes for certain macros or services your application uses. Look at __last_op to determine the error codes. __syscode is the system abend code.

3. **__abend**
   A structure that contains the abend code when errno is set to indicate a recoverable I/O abend. __rc is the return code. For more information on abend codes, see [z/OS MVS System Codes](#).

4. **__feedback**
   A structure that is used for VSAM only. The __rc stores the VSAM register 15, __fdbk stores the VSAM error code or reason code, and __RBA stores the RBA after some operations.

5. **__alloc**
   A structure that contains errors during fopen or freopen calls when defining files to the system using SVC 99.

6. **__RBA**
   The RBA value returned by VSAM after an ESDS or KSDS record is written out. For an RRDS, its the calculated value from the record number. It can be used in subsequent calls to flocate.

7. **__last_op**
   A field containing a value that indicates the last I/O operation being performed by C/C++ at the time the error occurred. These values are shown in Table 36 on page 168.

8. **__msg**
   May contain the system error messages from read or write operations emitted from the DFSMS/MVS SYNADAF macro instruction. Because the message can start with a hexadecimal address followed by a short integer, it is advisable to start printing at MSG+6 or greater so the message can be printed as a string. Because the message is not null-terminated, a maximum of 114 characters should be printed. This can be accomplished by specifying a printf format specifier as %.114s.

9. **__amrc_noseek_to_seek**
   This field contains the reason for the switch from QSAM (noseek) to BSAM with NOTE and POINT macros requested (seek) by the XL C/C++ Runtime...
Library. This field is set when system-level I/O macro processing triggers an ABEND condition. The macro name values (defined in stdio.h) for this field are as follows:

<table>
<thead>
<tr>
<th>Macro</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>__AM_BSAM_NOSWITCH</td>
<td>No switch was made.</td>
</tr>
<tr>
<td>__AM_BSAM_UPDATE</td>
<td>The data set is open for update</td>
</tr>
<tr>
<td>__AM_BSAM_BSAMWRITE</td>
<td>The data set is already open for write (or update) in the same C process.</td>
</tr>
<tr>
<td>__AM_BSAM_FBS_APPEND</td>
<td>The data set is recfm=FBS and open for append</td>
</tr>
<tr>
<td>__AM_BSAM_LRECLX</td>
<td>The data set is recfm=LRECLX (used for VBS data sets where records span the largest blocksize allowed on the device)</td>
</tr>
<tr>
<td>__AM_BSAM_PARTITIONED_DIRECTORY</td>
<td>The data set is the directory for a regular or extended partitioned data set</td>
</tr>
<tr>
<td>__AM_BSAM_PARTITIONED_INDIRECT</td>
<td>The data set is a member of a partitioned data set, and the member name was not specified at allocation</td>
</tr>
</tbody>
</table>

[10] __XRBA
This is the 8 byte relative byte address returned by VSAM after an ESDS or KSDS record is written out. For an RRDS, it is the calculated value from the record number. It may be used in subsequent calls to flocate().

A secondary error code. For example, an unsuccessful rename or remove operation places its reason code here.

[12] __fileptr
A pointer to the file that caused a SIGIOERR to be raised. Use an fldata() call to get the actual name of the file.

[13] __reserved
Reserved for future use.

__last_op values
The __last_op field is the most important of the __amrc fields. It defines the last I/O operation C/C++ was performing at the time of the I/O error. You should note that the structure is neither cleared nor set by non-I/O operations, so querying this field outside of a SIGIOERR handler should only be done immediately after I/O operations. Table 36 lists __last_op values you could receive and where to look for further information.

<table>
<thead>
<tr>
<th>Value</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>__IO_INIT</td>
<td>Will never be seen by SIGIOERR exit value given at initialization.</td>
</tr>
<tr>
<td>__BSAM_OPEN</td>
<td>Sets __error with return code from OS OPEN macro.</td>
</tr>
<tr>
<td>__BSAM_CLOSE</td>
<td>Sets __error with return code from OS CLOSE macro.</td>
</tr>
<tr>
<td>__BSAM_READ</td>
<td>No return code (either __abend (errno == 92) or __msg (errno == 66) filled in).</td>
</tr>
<tr>
<td>__BSAM_NOTE</td>
<td>NOTE returned 0 unexpectedly, no return code.</td>
</tr>
</tbody>
</table>
Table 36. __last_op values and diagnosis information (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSAM_POINT</td>
<td>This will not appear as an error lastop.</td>
</tr>
<tr>
<td>BSAM_WRITE</td>
<td>No return code (either __abend (errno == 92) or __msg (errno == 65) filled in).</td>
</tr>
<tr>
<td>BSAM_CLOSE_T</td>
<td>Sets __error with return code from OS CLOSE TYPE=T.</td>
</tr>
<tr>
<td>BSAM_BDL</td>
<td>Sets __error with return code from OS BDL macro.</td>
</tr>
<tr>
<td>BSAM_STOW</td>
<td>Sets __error with return code from OS STOW macro.</td>
</tr>
<tr>
<td>TGET_READ</td>
<td>Sets __error with return code from TSO TGET macro.</td>
</tr>
<tr>
<td>TPUT_WRITE</td>
<td>Sets __error with return code from TSO TPUT macro.</td>
</tr>
<tr>
<td>IO_DEVTYPE</td>
<td>Sets __error with return code from I/O DEVTYPE macro.</td>
</tr>
<tr>
<td>IO_RDJFCB</td>
<td>Sets __error with return code from I/O RDJFCB macro.</td>
</tr>
<tr>
<td>IO_TRKCALC</td>
<td>Sets __error with return code from I/O TRKCALC macro.</td>
</tr>
<tr>
<td>IO_OBTAIN</td>
<td>Sets __error with return code from I/O CAMLIST OBTAIN.</td>
</tr>
<tr>
<td>IO_LOCATE</td>
<td>Sets __error with return code from I/O CAMLIST LOCATE.</td>
</tr>
<tr>
<td>IO_CATALOG</td>
<td>Sets __error with return code from I/O CAMLIST CAT. The associated macro is CATALOG.</td>
</tr>
<tr>
<td>IO_UNCATALOG</td>
<td>Sets __error with return code from I/O CAMLIST UNCAT. The associated macro is CATALOG.</td>
</tr>
<tr>
<td>IO_RENAME</td>
<td>Sets __error with return code from I/O CAMLIST RENAME.</td>
</tr>
<tr>
<td>SVC99_ALLOC</td>
<td>Sets __alloc structure with info and error codes from SVC 99 allocation.</td>
</tr>
<tr>
<td>SVC99_ALLOC_NEW</td>
<td>Sets __alloc structure with info and error codes from SVC 99 allocation of NEW file.</td>
</tr>
<tr>
<td>SVC99_UNALLOC</td>
<td>Sets __unalloc structure with info and error codes from SVC 99 unallocation.</td>
</tr>
<tr>
<td>C_TRUNCATE</td>
<td>Set when C or C++ truncates output data. Usually, this is data written to a text file with no newline such that the record fills up to capacity and subsequent characters cannot be written. For a record I/O file this refers to an fwrite() writing more data than the record can hold. Truncation is always rightmost data. There is no return code.</td>
</tr>
<tr>
<td>C_FCBCHECK</td>
<td>Set when C or C++ FCB is corrupted. This is due to a pointer corruption somewhere. File cannot be used after this.</td>
</tr>
<tr>
<td>C_DBCS_TRUNCATE</td>
<td>This occurs when writing DBCS data to a text file and there is no room left in a physical record for anymore double byte characters. A new-line is not acceptable at this point. Truncation will continue to occur until an SI is written or the file position is moved. Cannot happen if MB_CUR_MAX is 1.</td>
</tr>
<tr>
<td>C_DBCS_SO_TRUNCATE</td>
<td>This occurs when there is not enough room in a record to start any DBCS string or else when a redundant SO is written to the file before an SI. Cannot happen if MB_CUR_MAX is 1.</td>
</tr>
<tr>
<td>C_DBCS_SI_TRUNCATE</td>
<td>This occurs only when there was not enough room to start a DBCS string and data was written anyways, with an SI to end it. Cannot happen if MB_CUR_MAX is 1.</td>
</tr>
<tr>
<td>C_DBCS_UNEVEN</td>
<td>This occurs when an SI is written before the last double byte character is completed, thereby forcing C or C++ to fill in the last byte of the DBCS string with a padding byte X'FE'. Cannot happen if MB_CUR_MAX is 1.</td>
</tr>
</tbody>
</table>
### Table 36. `__last_op` values and diagnosis information (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>__C_CANNOT_EXTEND</code></td>
<td>This occurs when an attempt is made to extend a file that allows writing, but cannot be extended. Typically this is a member of a partitioned data set being opened for update.</td>
</tr>
<tr>
<td><code>__VSAM_OPEN_FAIL</code></td>
<td>Set when a low level VSAM OPEN fails, sets <code>__rc</code> and <code>__fdbk</code> fields in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__VSAM_OPEN_ESDS</code></td>
<td>Does not indicate an error; set when the low level VSAM OPEN succeeds, and the file type is ESDS.</td>
</tr>
<tr>
<td><code>__VSAM_OPEN_RRDS</code></td>
<td>Does not indicate an error; set when the low level VSAM OPEN succeeds, and the file type is RRDS.</td>
</tr>
<tr>
<td><code>__VSAM_OPEN_KSDS</code></td>
<td>Does not indicate an error; set when the low level VSAM OPEN succeeds, and the file type is KSDS.</td>
</tr>
<tr>
<td><code>__VSAM_OPEN_ESDS_PATH</code></td>
<td>Does not indicate an error; set when the low level VSAM OPEN succeeds, and the file type is ESDS PATH.</td>
</tr>
<tr>
<td><code>__VSAM_OPEN_KSDS_PATH</code></td>
<td>Does not indicate an error; set when the low level VSAM OPEN succeeds, and the file type is KSDS PATH.</td>
</tr>
<tr>
<td><code>__VSAM_MODCB</code></td>
<td>Set when a low level VSAM MODCB macro fails, sets <code>__rc</code> and <code>__fdbk</code> fields in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__VSAM_TESTCB</code></td>
<td>Set when a low level VSAM TESTCB macro fails, sets <code>__rc</code> and <code>__fdbk</code> fields in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__VSAM_SHOWCB</code></td>
<td>Set when a low level VSAM SHOWCB macro fails, sets <code>__rc</code> and <code>__fdbk</code> fields in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__VSAM_GENCB</code></td>
<td>Set when a low level VSAM GENCB macro fails, sets <code>__rc</code> and <code>__fdbk</code> fields in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__VSAM_GET</code></td>
<td>Set when the last op was a low level VSAM GET; if the GET fails, sets <code>__rc</code> and <code>__fdbk</code> in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__VSAM_PUT</code></td>
<td>Set when the last op was a low level VSAM PUT; if the PUT fails, sets <code>__rc</code> and <code>__fdbk</code> in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__VSAM_POINT</code></td>
<td>Set when the last op was a low level VSAM POINT; if the POINT fails, sets <code>__rc</code> and <code>__fdbk</code> in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__VSAM_ERASE</code></td>
<td>Set when the last op was a low level VSAM ERASE; if the ERASE fails, sets <code>__rc</code> and <code>__fdbk</code> in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__VSAM_ENDREQ</code></td>
<td>Set when the last op was a low level VSAM ENDREQ; if the ENDREQ fails, sets <code>__rc</code> and <code>__fdbk</code> in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__VSAM_CLOSE</code></td>
<td>Set when the last op was a low level VSAM CLOSE; if the CLOSE fails, sets <code>__rc</code> and <code>__fdbk</code> in the <code>__amrc</code> struct.</td>
</tr>
<tr>
<td><code>__QSAM_GET</code></td>
<td>__error is not set (if abend (errno == 92), __abend is set, otherwise if read error (errno == 66), look at __msg.</td>
</tr>
<tr>
<td><code>__QSAM_PUT</code></td>
<td>__error is not set (if abend (errno == 92), __abend is set, otherwise if write error (errno == 65), look at __msg.</td>
</tr>
<tr>
<td><code>__QSAM_TRUNC</code></td>
<td>This is an intermediate operation. You will only see this if an I/O abend occurred.</td>
</tr>
<tr>
<td><code>__QSAM_FREEPOOL</code></td>
<td>This is an intermediate operation. You will only see this if an I/O abend occurred.</td>
</tr>
<tr>
<td><code>__QSAM_CLOSE</code></td>
<td>Sets __error to result of OS CLOSE macro.</td>
</tr>
<tr>
<td><code>__QSAM_OPEN</code></td>
<td>Sets __error to result of OS OPEN macro.</td>
</tr>
<tr>
<td><code>__CMS_OPEN</code></td>
<td>Sets __error to result of FSOPEN.</td>
</tr>
<tr>
<td><code>__CMS_CLOSE</code></td>
<td>Sets __error to result of FSCLOSE.</td>
</tr>
</tbody>
</table>
Table 36. __last_op values and diagnosis information (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>__CMS_READ</td>
<td>Sets __error to result of FSREAD.</td>
</tr>
<tr>
<td>__CMS_WRITE</td>
<td>Sets __error to result of FSWRITE.</td>
</tr>
<tr>
<td>__CMS_STATE</td>
<td>Sets __error to result of FSSTATE.</td>
</tr>
<tr>
<td>__CMS_ERASE</td>
<td>Sets __error to result of FSERASE.</td>
</tr>
<tr>
<td>__CMS_RNAME</td>
<td>Sets __error to result of CMS RENAME command.</td>
</tr>
<tr>
<td>__CMS_EXTRACT</td>
<td>Sets __error to result of DMS EXTRACT call.</td>
</tr>
<tr>
<td>__CMS_LINERD</td>
<td>Sets __error to result of LINERD macro.</td>
</tr>
<tr>
<td>__CMS_LINEWRT</td>
<td>Sets __error to result of LINEWRT macro.</td>
</tr>
<tr>
<td>__CMS_QUERY</td>
<td>__error is not set.</td>
</tr>
<tr>
<td>__HSP_CREATE</td>
<td>Indicates last op was a DSPSERV CREATE to create a hiperbake for a hiperbake memory file. If CREATE fails, stores abend code in __amrc__code__abend__syscode, reason code in __amrc__code__abend__rc.</td>
</tr>
<tr>
<td>__HSP_DELETE</td>
<td>Indicates last op was a DSPSERV DELETE to delete a hiperbake for a hiperbake memory file during termination. If DELETE fails, stores abend code in __amrc__code__abend__syscode, reason code in __amrc__code__abend__rc.</td>
</tr>
<tr>
<td>__HSP_READ</td>
<td>Indicates last op was a HPSERV READ from a hiperbake. If READ fails, stores abend code in __amrc__code__abend__syscode, reason code in __amrc__code__abend__rc.</td>
</tr>
<tr>
<td>__HSP_WRITE</td>
<td>Indicates last op was a HPSERV WRITE to a hiperbake. If WRITE fails, stores abend code in __amrc__code__abend__syscode, reason code in __amrc__code__abend__rc.</td>
</tr>
<tr>
<td>__HSP_EXTEND</td>
<td>Indicates last op was a HPSERV EXTEND during a write to a hiperbake. If EXTEND fails, stores abend code in __amrc__code__abend__syscode, reason code in __amrc__code__abend__rc.</td>
</tr>
<tr>
<td>__CICS_WRITEQ_TD</td>
<td>Sets __error with error code from EXEC CICS WRITEQ TD.</td>
</tr>
<tr>
<td>__LFS_OPEN</td>
<td>Sets __error with reason code from HFS services. Reason code from HFS services must be broken up. The low order 2 bytes can be looked up in z/OS UNIX System Services Programming.</td>
</tr>
<tr>
<td>__LFS_CLOSE</td>
<td>Sets __error with reason code from HFS services. Reason code from HFS services must be broken up. The low order 2 bytes can be looked up in z/OS UNIX System Services Programming.</td>
</tr>
<tr>
<td>__LFS_READ</td>
<td>Sets __error with reason code from HFS services. Reason code from HFS services must be broken up. The low order 2 bytes can be looked up in z/OS UNIX System Services Programming.</td>
</tr>
<tr>
<td>__LFS_WRITE</td>
<td>Sets __error with reason code from HFS services. Reason code from HFS services must be broken up. The low order 2 bytes can be looked up in z/OS UNIX System Services Programming.</td>
</tr>
</tbody>
</table>
Using file I/O tracing to debug C/C++ file I/O problems

You can use file I/O tracing to debug C/C++ file I/O problems. For more information, see Debugging I/O programs in z/OS XL C/C++ Programming Guide.

Displaying an error message with the perror() function

To find a failing routine, check the return code of all function calls. After you have found the failing routine, use the perror() function after the routine to display the error message. perror() displays the string that you pass to it and an error message corresponding to the value of errno. perror() writes to the standard error stream (stderr). Figure 38 is an example of a routine using perror().

By default, the errno2 value will be appended to the end of the perror() string. If you do not want the errno2 value appended to the perror() string, set the _EDC_ADD_ERRNO2 environment variable to 0.

```
#include <stdio.h>
int main(void)
{
    FILE *fp;
    fp = fopen("myfile.dat", "w");
    if (fp == NULL)
        perror("fopen error");
}
```

Figure 38. Example of a routine using perror()

Using __errno2() to diagnose application problems

Use the __errno2() function when diagnosing problems in an application program. This function enables z/OS XL C/C++ application programs to access additional diagnostic information, errno2 (errnojr), associated with errno. The __errno2 may be set by the z/OS XL C/C++ runtime library, z/OS UNIX callable services, or other callable services. The errno2 is intended for diagnostic display purposes only and is not a programming interface.

Note: Not all functions set errno2 when errno is set. In the cases where errno2 is not set, the __errno2() function may return a residual value. You may use the __err2ad() function to clear errno2 to reduce the possibility of a residual value being returned.

Figure 39 on page 173 is an example of a routine using __errno2().
Figure 40 shows the output from the sample routine in Figure 39.

Figure 41 is an example of a routine using the environment variable _EDC_ADD_ERRNO2.

Figure 42 shows the sample output from the routine in Figure 41.

Figure 43 on page 174 is an example of a routine using __err2ad() in combination with __errno2().
#pragma runopts(posix(on))
define _EXT
#include <stdio.h>
#include <errno.h>
#include <stdlib.h>

int main(void) {
  FILE *f;
  setenv("_EDC_ADD_ERRNO2", "0", 1);
  f = fopen("testfile.dat", "r");
  if (f == NULL) {
    perror("fopen() failed");
    printf("__errno2 = %08x\n", __errno2());
  }
  /* reset errno2 to zero */
  *__errno2 = 0x0;
  printf("__errno2 = %08x\n", __errno2());
  f = fopen("testfile.dat", "r");
  if (f == NULL) {
    perror("fopen() failed");
    printf("__errno2 = %08x\n", __errno2());
  }
  return 0;
}

Figure 43. Example of a routine using __err2ad() in combination with __errno2()

Figure 44 shows the sample output from the routine shown in Figure 43

fopen() failed: EDC5129I No such file or directory.
__errno2 = 05620062
__errno2 = 00000000
fopen() failed: EDC5129I No such file or directory.
__errno2 = 05620062

Figure 44. Sample output of routine using __err2ad() in combination with __errno2()

For more information about _EDC_ADD_ERRNO2, see z/OS XL C/C++ Programming Guide

For more information about __errno2() and __err2ad(), see z/OS XL C/C++ Runtime Library Reference

Diagnosing DLL problems

Use the _EDC_DLL_DIAG environment variable to diagnose DLL problems. For more information, see z/OS XL C/C++ Programming Guide

You can also see the diagnostic output in CEEDUMP and Verbexit LEDATA reports. For more information, see “Using the DLL failure control block” on page 79.

Using C/C++ listings

For a detailed description of available listings, see z/OS XL C/C++ User’s Guide
Finding variables

You can determine the value of a variable in the routine at the point of interrupt by using the compiled code listing as a guide to its address, then finding this address in the Language Environment dump. The method you use depends on the storage class of variable.

This method is generally used when no symbolic variables have been dumped (by using the TEST compiler option).

It is possible for the routine to be interrupted before the value of the variable is placed in the location provided for it. This can explain unexpected values in the dump.

Steps for finding automatic variables

Perform the following steps to find automatic variables in the Language Environment dump:

1. Identify the start of the stack frame. If a dump has been taken, each stack frame is dumped. The stack frames can be cross-referenced to the function name in the traceback.

2. Determine the value of the base register (in this example, GPR13) in the Saved Registers section for the function you are interested in.

3. Find the offset of the variable (which is given in decimal) in the storage offset listing.

   aa1 85-0:85 Class = automatic, Offset = 164(r13), Length = 40

4. Add this base address to the offset of the variable.

When you are done, the contents of the variable can be read in the DSA Frame section corresponding to the function the variable is contained in.

Locating the Writable Static Area (WSA)

The Writable Static Area (WSA) address is the base address of the writable static area which is available for all C and C++ programs except C programs compiled with the NORENT compiler option. If you have C code compiled with the RENT option or C++ code (hereafter called RENT code) you must determine the base address of the WSA if you want to calculate the address of a static or external variable. Use the following table to determine where to find the WSA base address:

<table>
<thead>
<tr>
<th>If you want the WSA base address for:</th>
<th>Locate the WSA base address in:</th>
</tr>
</thead>
<tbody>
<tr>
<td>application code</td>
<td>the WSA address field in the Enclave Control Blocks section</td>
</tr>
<tr>
<td>a fetched module</td>
<td>the WSA address field of the Fetch() Information section for the fetch() function pointer for which you are interested</td>
</tr>
<tr>
<td>a DLL</td>
<td>the corresponding WSA address in the DLL Information section</td>
</tr>
</tbody>
</table>

Use the WSA base address to locate the WSA in the Enclave Storage section.

Steps for finding the static storage area

If you have C code compiled with the NORENT option (hereafter called NORENT code) you must determine the base address of the static storage area if you want to calculate the address of a static or external variable.
Perform the following steps to find the static storage area:

1. Name the static storage area CSECT by using the `pragma csect` directive. Once this is done, a CSECT is generated for the static storage area for each source file.

2. Determine the origin and length of the CSECT from the linker map.

3. Locate the external variables corresponding to the CSECT with the same name.

4. Determine the origin and length of the external variable CSECT from the linker map.

**Note:**

1. Address calculation for static and external variables uses the static storage area as a base address with 1 or more offsets added to this address.

2. The storage associated with these CSECTs is not dumped when an exception occurs. It is dumped when `cdump` or `CEE3DMP` is called, but it is written to a separate ddname called `CEESNAP`. For information about `cdump`, `CEE3DMP`, and enabling the `CEESNAP` ddname, see “Generating a Language Environment dump of a C/C++ routine” on page 182.

**Steps for finding RENT static variables**

Before you begin, you need to know the WSA. To find this information, see “Locating the Writable Static Area (WSA)” on page 175. For this procedure’s example, assume that the address of writable static is X'02D66E40'.

Perform the following steps to find RENT static variables:

1. Find the offset of `@STATIC` (associated with the file where the static variable is located) in the Writable Static Map section of the prelinker map. Figure 45 on page 177 shows an example; in this Writable Static Map section of a prelinker map, the offset is X'58'.
2. Add the offset to the WSA to get the base address of static variables, as shown.
   \[X'02D66E40' + X'58' = X'2D66E98'\]

3. Find the offset of the static variable in the partial storage offset compiler listing.
   In the following example, the offset is 96 (X'60').
   \[
   \text{sa0} 66-0:66 \text{ Class = static, Location = WSA + @STATIC + 96, Length = 4}
   \]

4. Add the offset of the static variable in the partial storage offset compiler listing (found in step 3) to the base address of static variables (calculated in step 2).
   \[X'2D66E98' + X'60' = X'2D66EF8'\]

When you are done, you have the address of the value of the static variable in the Language Environment dump.

**Figure 46** shows the path to locate RENT C++ and C static variables by adding the address of writable static, the offset of @STATIC, and the variable offset.

---

### Writable Static Map

<table>
<thead>
<tr>
<th>OFFSET</th>
<th>LENGTH</th>
<th>FILE ID</th>
<th>INPUT NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>000001</td>
<td>DFHC011</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>000001</td>
<td>DFHC010</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>000001</td>
<td>DFHDUMMY</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>000001</td>
<td>DFHB025</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>000001</td>
<td>DFHB024</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>000001</td>
<td>DFHB023</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
<td>000001</td>
<td>DFHB022</td>
</tr>
<tr>
<td>1C</td>
<td>2</td>
<td>000001</td>
<td>DFHB021</td>
</tr>
<tr>
<td>20</td>
<td>2</td>
<td>000001</td>
<td>DFHB020</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>000001</td>
<td>DFHE1B0</td>
</tr>
<tr>
<td>28</td>
<td>4</td>
<td>000001</td>
<td>DFHE1PTR</td>
</tr>
<tr>
<td>2C</td>
<td>4</td>
<td>000001</td>
<td>DFHC011</td>
</tr>
<tr>
<td>30</td>
<td>4</td>
<td>000001</td>
<td>DFHC010</td>
</tr>
<tr>
<td>34</td>
<td>4</td>
<td>000001</td>
<td>DFHB025</td>
</tr>
<tr>
<td>38</td>
<td>4</td>
<td>000001</td>
<td>DFHB024</td>
</tr>
<tr>
<td>3C</td>
<td>4</td>
<td>000001</td>
<td>DFHB023</td>
</tr>
<tr>
<td>40</td>
<td>4</td>
<td>000001</td>
<td>DFHB022</td>
</tr>
<tr>
<td>44</td>
<td>4</td>
<td>000001</td>
<td>DFHB021</td>
</tr>
<tr>
<td>48</td>
<td>4</td>
<td>000001</td>
<td>DFHB020</td>
</tr>
<tr>
<td>4C</td>
<td>4</td>
<td>000001</td>
<td>DFHEICB</td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>000001</td>
<td>DFHE00</td>
</tr>
<tr>
<td>54</td>
<td>4</td>
<td>000001</td>
<td>DFHEI000</td>
</tr>
<tr>
<td>58</td>
<td>278</td>
<td>000001</td>
<td>@STATIC</td>
</tr>
<tr>
<td>720</td>
<td>30</td>
<td>000002</td>
<td>@STATIC</td>
</tr>
</tbody>
</table>

**Figure 45. Writable static map produced by prelinker**
Steps for finding external RENT variables

Before you begin: You need to know the WSA. To find this information see "Locating the Writable Static Area (WSA)" on page 175. For this procedure's example, the address of writable static is X'02D66E40'.

Perform the following steps to find external RENT variables:

1. Find the offset of the external variable in the Prelinker Writable Static Map. In the example shown in Figure 47, the offset for DFHEIPTR is X'28'.

2. Add the offset of the external variable to the address of writable static, as shown below.
   
   \[ X'02D66E40' + X'28' = X'2D66E68' \]

When you are done, you have the address of the value of the external variable in the Language Environment dump.

Steps for finding NORENT static variables

Before you begin: You need to know the name and address of the static storage area. To find this information see "Steps for finding the static storage area" on page 175. For this procedure's example, the static storage area is called STATSTOR and has an address of X'02D66E40'.

Perform the following steps to find external RENT variables:

1. Find the offset of the static variable in the partial storage offset compiler listing. As shown in the following example, the offset is 96 (X'60').
   
   \[ sa0 \ 66:0:66 \ Class = static, \ Location = STATSTOR +96, \ Length = 4 \]

2. Add the offset to the base address of static variables, as shown in the following example:
When you are done, you have the address of the value of the static variable in the Language Environment dump.

Figure 48 shows how to locate NORENT C static variables by adding the Static Storage Area CSECT address to the variable offset.

---

**Steps for finding external NORENT variables**

**Before you begin:** You need to find the address of the external variable CSECT. To find this information, see "Steps for finding the static storage area" on page 175. For this procedure's example, the address of the external variable CSECT is X'02D66E40'.

The address of the external variable CSECT is the address of the value of the external variable in the Language Environment dump.

**Steps for finding the C/370 parameter list**

Perform the following steps to locate a parameter in the Language Environment dump:

1. Identify the address of the start of the parameter list. A pointer to the parameter list is passed to the called function in register 1. This is the address of the start of the parameter list. Figure 49 shows an example code for the parameter variable.

```c
func0() {
    ...;
    func1(a1,a2);
    ...;
}

func1(int ppx, int pp0) {
    ...;
}
```

**Figure 49. Example code for parameter variable**

Parameters `ppx` and `pp0` correspond to copies of `a1` and `a2` in the stack frame belonging to `func0`.

2. Use the address of the start of the parameter list to find the register and offset in the partial storage offset listing. As shown in the following example, the offset is 4 (X'4') from register 1.

   ```c
   ppx 62-0:62 Class = parameter, Location = 4(r1), Length = 4
   ```

3. Determine the value of GPR1 in the Saved Registers section for the function that called the function you are interested in.

4. Add this base address to the offset of the parameter.
When you are done, the contents of the variable can then be read in the DSA frame section corresponding to the function the parameter was passed from.

**Steps for finding the C++ parameter list**

**Before you begin:** To locate C++ functions with *extern C* attributes, see [“Steps for finding the C/370 parameter list”](#) on page 179.

Perform the following steps to find the C++ parameter list:

1. Identify the address of the start of the parameter list. A pointer to the parameter list is passed to the called function in register 1. This is the address of the start of the parameter list. [Figure 50](#) shows an example code for the parameter variable.

```c
func0() {
    ...
    func1(a1,a2);
    ...
}

func1(int ppx, int pp0) {
    ...
}
```

**Figure 50. Example code for parameter variable**

Parameters *ppx* and *pp0* correspond to copies of *a1* and *a2* in the stack frame belonging to *func1*.

2. Locate the value of the base register in the Saved Registers section of the function you are interested in.

3. Find the offset of the static variable in the partial storage offset compiler listing, as shown in [Figure 51](#).

```plaintext
<table>
<thead>
<tr>
<th>Variable</th>
<th>Address</th>
<th>Type</th>
<th>Offset</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>ppx</td>
<td>62-0:62</td>
<td>parameter</td>
<td>188(r13)</td>
<td>4</td>
</tr>
<tr>
<td>pp0</td>
<td>62-0:62</td>
<td>parameter</td>
<td>192(r13)</td>
<td>4</td>
</tr>
</tbody>
</table>
```

**Figure 51. Partial storage offset listing**

4. Add the value of the base register to the offset.

5. Locate the parameter.

**Restriction:** When OPTIMIZE is on, the parameter value might never be stored, since the first few parameters might be passed in registers and there might be no need to save them.

**Steps for finding members of aggregates**

You can define aggregates in any of the storage classes or pass them as parameters to a called function. The first step is to find the start of the aggregate. You can compute the start of the aggregate as described in previous sections, depending on the type of aggregate used.

The aggregate map provided for each declaration in a routine can further assist in finding the offset of a specific variable within an aggregate. [Structure maps](#) are generated using the AGGREGATE compiler option. [Figure 52](#) on page 181 shows
an example of a static aggregate.

```c
static struct {
    short int ss01;
    char ss02[56];
    int sz0[6];
    int ss03;
} ss0;
```

Figure 52. Example code for structure variable

Figure 53 shows an example aggregate map.

<table>
<thead>
<tr>
<th>Aggregate map for: ss0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Bytes(Bits)</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>58</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>04</td>
</tr>
</tbody>
</table>

Figure 53. Example of aggregate map

Assume the structure has been compiled as RENT. To find the value of variable sz0[0]:

1. Find the address of the writable static. For this example the address of writable static is X’02D66E40’.
2. Find the offset of @STATIC in the Writable Static Map. In this example, the offset is X’58’. Add this offset to the address of writable static. The result is X’2D66E98’ (X’02D66E40’ + X’58’). Figure 54 on page 182 shows the Writable Static Map produced by the prelinker.
3. Find the offset of the static variable in the storage offset listing. The offset is 96 (X'60'). The following is an example of a partial storage offset listing.

Add this offset to the result from step 2. The result is X'2D66EF8' (X'2D66E98' + X'60'). This is the address of the value of the static variable in the dump.

4. Find the offset of sz0 in the Aggregate Map, shown in Figure 53 on page 181. The offset is 60.

Add the offset from the Aggregate Map to the address of the ss0 struct. The result is X'60' (X'3C' + X'60'). This is the address of the values of sz0 in the dump.

Finding the timestamp
The timestamp is in the compile unit block. The address for the compile unit block is located at eight bytes past the function entry point. The compile unit block is the same for all functions in the same compilation. The fourth word of the compile unit block points to the timestamp. The timestamp is 16 bytes long and has the following format:

YYYYMMDDHHMMSSSS

Generating a Language Environment dump of a C/C++ routine
You can use the CEE3DMP callable service or the cdump(), csnap(), and ctrace() C/C++ functions to generate a Language Environment dump of C/C++ routines. These C/C++ functions call CEE3DMP with specific options.

To use these functions, you must add #include <ctest.h> to your C/C++ code. The dump is directed to output dumpname, which is specified in a //CEEDUMP DD statement in MVS/JCL.
cdump(), csnap(), and ctrace() all return a 1 code in the SPC environment because they are not supported in SPC.

See the [z/OS XL C/C++ Runtime Library Reference](#) for more details about the syntax of these functions.

### cdump()

If your routine is running under z/OS or CICS, you can generate useful diagnostic information by using the cdump() function. cdump() produces a main storage dump with the activation stack. This is equivalent to calling CEE3DMP with the option string:

```
TRACEBACK BLOCKS VARIABLES FILES STORAGE STACKFRAME(ALL) CONDITION ENTRY
```

When cdump() is invoked from a user routine, the C/C++ library issues an OS SNAP macro to obtain a dump of virtual storage. The first invocation of cdump() results in a SNAP identifier of 0. For each successive invocation, the ID is increased by one to a maximum of 256, after which the ID is reset to 0.

The output of the dump is directed to the CEESNAP data set. The DD definition for CEESNAP is as follows:

```
//CEESNAP DD SYSOUT=*  
```

If the data set is not defined, or is not usable for any reason, cdump() returns a failure code of 1. This occurs even if the call to CEE3DMP is successful. If the SNAP is not successful, the CEE3DMP DUMP file displays the following message:

```
Snap was unsuccessful
```

If the SNAP is successful, CEE3DMP displays the following message, where nnn corresponds to the SNAP identifier described above. An unsuccessful SNAP does not result in an incrementation of the identifier.

```
Snap was successful; snap ID = nnn
```

Because cdump() returns a code of 0 only if the SNAP was successful or 1 if it was unsuccessful, you cannot distinguish whether a failure of cdump() occurred in the call to CEE3DMP or SNAP. A return code of 0 is issued only if both SNAP and CEE3DMP are successful.

Support for SNAP dumps using the _cdump function is provided only under z/OS and z/VM. SNAP dumps are not supported under CICS; no SNAP is produced in this environment. A successful SNAP results in a large quantity of output. A routine calling cdump() under CICS receives a return code of 0 if the ensuing call to CEE3DMP is successful. In addition to a SNAP dump, a Language Environment formatted dump is also taken.
csnap()

The csnap() function produces a condensed storage dump. csnap() is equivalent to calling CEE3DMP with the option string:

```
TRACEBACK FILES BLOCKS VARIABLES NOSTORAGE STACKFRAME(ALL) CONDITION ENTRY
```

ctrace()

The ctrace() function produces a traceback and includes the offset addresses from which the calls were made. ctrace() is equivalent to calling CEE3DMP with the option string:

```
TRACEBACK NOFILES NOBLOCKS NOVARIABLES NOSTORAGE STACKFRAME(ALL) NOCONDITION NOENTRY
```

Sample C routine that calls cdump()

The code example below shows a sample C routine that uses the cdump function to generate a dump. The sample here shows the dump output.

```c
#include <stdio.h>
#include <signal.h>
#include <stdlib.h>

void hsigfpe(int);
void hsigterm(int);
void atf1(void);

typedef int (*FuncPtr_T)(void);

int st1 = 99;
int st2 = 255;
int xcount = 0;

int main(void) {
    /*
     * 1) Open multiple files
     * 2) Register 2 signals
     * 3) Register 1 atexit function
     * 4) Fetch and execute a module
     */

    FuncPtr_T fetchPtr;
    FILE* fp1;
    FILE* fp2;
    int rc;

    fp1 = fopen("myfile.data", "w");
    if (!fp1) {
        perror("Could not open myfile.data for write");
        exit(101);
    }

    fprintf(fp1, "record 1
");
    fprintf(fp1, "record 2
");
    fprintf(fp1, "record 3
");

    fp2 = fopen("memory.data", "wb,type=memory");
    if (!fp2) {
        perror("Could not open memory.data for write");
        exit(102);
    }

    fprintf(fp2, "some data");
    fprintf(fp2, "some more data");
    fprintf(fp2, "even more data");
    signal(SIGFPE, hsigfpe);
    ```
signal(SIGTERM, hsigterm);
rc = atexit(atf1);
if (rc) {
    fprintf(stderr, "Failed on registration of atexit function atf1\n");
    exit(103);
}
fetchPtr = (FuncPtr_T) fetch("MODULE1");
if (!fetchPtr) {
    fprintf(stderr, "Failed to fetch MODULE1\n");
    exit(104);
    fetchPtr();
    return(0);
}
void hsigfpe(int sig) {
    ++st1;
    return;
}
void hsigterm(int sig) {
    ++st2;
    return;
}
void atf1() {
    ++xcount;
}

Figure 55 shows a fetched C module.

#include <ctest.h>
#pragma linkage(func1, fetchable)
int func1(void) {
    cdump("This is a sample dump");
    return(0);
}

Figure 55. Fetched module for C routine

Sample C++ routine that generates a Language Environment dump

Figure 56 on page 186 shows a sample C++ routine that uses a protection exception to generate a dump.
```cpp
#include <iostream.h>
#include <ctest.h>
#include "stack.h"

int main() {
    cout << "Program starting:\n";
    cerr << "Error report:\n";
    Stack<int> x;
    x.push(1);
    cout << "Top value on stack: " << x.pop() << '\n';
    cout << "Next value on stack: " << x.pop() << '\n';
    return(0);
}
```

**Figure 56. Example C++ routine with protection exception generating a dump**

```cpp
#ifndef __STACK__
#include "stack.h"
#endif

template <class T> T Stack<T>::pop() {
    T value = head->value;
    head = head->next;
    return(value);
}

template <class T> void Stack<T>::push(T value) {
    Node* newNode = new Node;
    newNode->value = value;
    newNode->next = head;
    head = newNode;
}
```

**Figure 57. Template file STACK.C**

```cpp
#ifndef __STACK_
#define __STACK__

template <class T> class Stack {
    public:
        Stack() {
            char* badPtr = 0; badPtr -= (0x01010101);
            head = (Node*) badPtr; /* head initialized to 0xFEFEFEFF */
        }
        T pop();
        void push(T);
    private:
        struct Node {
            T value;
            struct Node* next;
        }* head;
    #endif
```

**Figure 58. Header file STACK.H**
Sample Language Environment dump with C/C++-specific information

The sample dump below was produced by compiling the routine in this sample with the TEST(SYM) compiler option, then running it. Notice the sequence of calls in the traceback section - EDCZMINV is the C-C++ management module that invokes main and @@FECBMODULE1 fetches the user-defined function func1, which in turn calls the library routine __cdump.

If source code is compiled with the GONUMBER or TEST compile option, statement numbers are shown in the traceback. If source code is compiled with the TEST(SYM) compile option, variables and their associated type and value are dumped out. Note that the high half of register 14 at entry to CEE3DMP is not available and is shown in the dump as ********. For more information about C/C++-specific information contained in a dump, see Finding C/C++ information in a Language Environment dump on page 191.

Information for enclave main

Registers on Entry to CEE3DMP:

```
PM........ 0100
GPR0...... 00000000_056BFA4F GPR1...... 00000000_05FC85A0 GPR2...... 00000000_05FC85C4 GPR3...... 00000000_05FC85E8 GPR4...... 00000000_05FC860C GPR5...... 00000000_05FC8630 GPR6...... 00000000_05FC8654 GPR7...... 00000000_05FC8678
GPR8...... 00000000_05FC869C GPR9...... 00000000_05FC86B8 GPR10..... 00000000_05FC86D4 GPR11..... 00000000_05FC86F0 GPR12..... 00000000_05FC8708 GPR13..... 00000000_05FC872C GPR14..... 00000000_05FC8748 GPR15..... 00000000_05FC876C
GPR16..... 00000000_05FC8780 GPR17..... 00000000_05FC879C GPR18..... 00000000_05FC87B8 GPR19..... 00000000_05FC87D4 GPR20..... 00000000_05FC87F0 GPR21..... 00000000_05FC880C GPR22..... 00000000_05FC8828 GPR23..... 00000000_05FC884C
GPR24..... 00000000_05FC8868 GPR25..... 00000000_05FC888C GPR26..... 00000000_05FC88A8 GPR27..... 00000000_05FC88CA GPR28..... 00000000_05FC88EC GPR29..... 00000000_05FC88FC GPR30..... 00000000_05FC891C
```

Information for thread 0000000000000000

Registers on Entry to CEE3DMP:

```
PM........ 0100
GPR0...... 00000000_056BFA4F GPR1...... 00000000_05FC85A0 GPR2...... 00000000_05FC85C4 GPR3...... 00000000_05FC85E8 GPR4...... 00000000_05FC860C GPR5...... 00000000_05FC8630 GPR6...... 00000000_05FC8654 GPR7...... 00000000_05FC8678
GPR8...... 00000000_05FC869C GPR9...... 00000000_05FC86B8 GPR10..... 00000000_05FC86D4 GPR11..... 00000000_05FC86F0 GPR12..... 00000000_05FC8708 GPR13..... 00000000_05FC872C GPR14..... 00000000_05FC8748 GPR15..... 00000000_05FC876C
GPR16..... 00000000_05FC8780 GPR17..... 00000000_05FC879C GPR18..... 00000000_05FC87B8 GPR19..... 00000000_05FC87D4 GPR20..... 00000000_05FC87F0 GPR21..... 00000000_05FC880C GPR22..... 00000000_05FC8828 GPR23..... 00000000_05FC884C
GPR24..... 00000000_05FC8868 GPR25..... 00000000_05FC888C GPR26..... 00000000_05FC88A8 GPR27..... 00000000_05FC88CA GPR28..... 00000000_05FC88EC GPR29..... 00000000_05FC88FC GPR30..... 00000000_05FC891C
```

Traceback:

<table>
<thead>
<tr>
<th>GSA Entry</th>
<th>E Offset</th>
<th>Statement</th>
<th>Load Mod</th>
<th>Program Unit</th>
<th>Service</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+0000001C</td>
<td>CEEV003</td>
<td></td>
<td></td>
<td>D108B</td>
<td>Call</td>
</tr>
<tr>
<td>2 Func1</td>
<td>+00000066</td>
<td>MODULE1</td>
<td>MODULE1</td>
<td></td>
<td></td>
<td>Call</td>
</tr>
<tr>
<td>3 @@FECBMODULE1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 @@GETFN</td>
<td>+000000E7</td>
<td>CEEV003</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 main</td>
<td>+000000A2</td>
<td>CSAMPLE</td>
<td>CSAMPLE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 EDCZMINV</td>
<td>+000000C2</td>
<td>CEEV003</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 CEEBEKET</td>
<td>+000001B6</td>
<td>CEEPLMA</td>
<td>CEEBEKET</td>
<td></td>
<td>D108B</td>
<td>Call</td>
</tr>
</tbody>
</table>

Chapter 4. Debugging C/C++ routines 187
null
Chapter 4. Debugging C/C++ routines

...
Finding C/C++ information in a Language Environment dump

When a Language Environment traceback or dump is generated for a C/C++ routine, information is provided that is unique to C/C++ routines. C/C++-specific information includes:

- Control block information for active routines
- Condition information for active routines
- Enclave level data

Each of the unique C/C++ sections of the Language Environment dump are described in Table 38.

### Table 38. Contents of the C/C++ sections of the Language Environment

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] Storage for Active Routines</td>
<td>Shows the DSAs for the active C and C++ routines. To relate a DSA frame to a particular function name, use the address associated with the frame to find the corresponding DSA. In this example, the function <code>func1</code> DSA address is X'20FCB468'.</td>
</tr>
</tbody>
</table>
| [2] Control Blocks Associated with the Active Thread | Contains the following information:
- Fields from the CAA
- Fields specific from the CTHD and CEDB
- Signal information |
| [2A] C/C++ CAA Fields | Contains several fields that the C/C++ programmer can use to find information about the runtime environment. For each C/C++ program, there is a C-C++ Specific Thread area and a C-C++ Specific Enclave area. |
| [2B] C-C++ Specific CAA | The C-C++ specific CAA fields that are of interest to users are described below. |

**errno value**

A variable used to display error information. Its value can be set to a positive number that corresponds to an error message. The functions `perror()` and `strerror()` print the error message that corresponds to the value of `errno`.

**Memory file control block**

You can use the memory file control block (MFCB) to locate additional information about memory files. This control block resides at the C/C++ thread level. For more information about the MFCB, see "Memory file control block" on page 193.

**Open FCB chain**

A pointer to the start of a linked list of open file control blocks (FCBs). For more information about FCBs, see File Control Block Information.
## Table 38. Contents of the C/C++ sections of the Language Environment (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[3] Signal Information</td>
<td>When the POSIX(OFF) runtime option is specified, signal information is provided in the dump to aid you in debugging. For each signal that is disabled with SIG_IGN, an entry value of 00000001 is made in the first field of the Signal Information field for the specified signal name. For each signal that has a handler registered, the signal name and the handler name are listed. If the handler is a fetched C function, the value @0FECE8 is entered as the function name and the address of the fetched pointer is in the first field. If you compile a C routine as NORENT, the WSA address is not available (N/A). For more information about the signal function, see [z/OS XL C/C++ Programming Guide](z/OS XL C/C++ Programming Guide).</td>
</tr>
<tr>
<td>[4] WSA Address</td>
<td>The WSA Address is the base address of the writable static area which is available for all C and C++ programs except C programs compiled with the NORENT compile option.</td>
</tr>
<tr>
<td>[5] atexit() Information</td>
<td>Lists the functions registered with the atexit() function that would be run at normal termination. The functions are listed in chronological order of registration. If you compile a C routine as NORENT, the WSA address is not available (N/A). For more information about the atexit() function, see [z/OS XL C/C++ Runtime Library Reference](z/OS XL C/C++ Runtime Library Reference).</td>
</tr>
<tr>
<td>[6] fetch() Information</td>
<td>Shows information about modules that you have dynamically loaded using fetch(). For each module that was fetched, the fetch() pointer and the function pointer are included. ptr1 = fetch(&quot;MOD&quot;); If you compile a C routine as NORENT, the WSA address is not available (N/A). For more information about the fetch() function, see [z/OS XL C/C++ Programming Guide](z/OS XL C/C++ Programming Guide).</td>
</tr>
</tbody>
</table>
Table 38. Contents of the C/C++ sections of the Language Environment (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
</table>
| [7] File Control Block Information | Includes the file control block (FCB) information for each C/C++ file. The FCB contains file status and attributes for files open during C/C++ active routines. You can use this information to find the data set or file name. The FCB is a handle that points to the following file information, which is displayed when applicable, for the file:  
  - Access method control block (ACB) address  
  - Data control block (DCB) address  
  - Data control block extension (DCBE) address  
  - Job file control block (JFCB) address  
  - RPL address  
  - Current buffer address  
  - Saved buffer address  
  - ddname  

  Not all FCB fields are always filled in. For example, RPLs are used only for VSAM data sets. The ddname field contains blanks if it is not used.  

  The save block buffer represents auxiliary buffers that are used to save the contents of the main buffers. Such saving occurs only when a reposition is performed and there is new data; for example, an incomplete text record or an incomplete fixed-block standard (FBS) block in the buffers that cannot be flushed out of the system.  

  Because the main buffers represent the current position in the file, while the save buffers merely indicate a save has occurred, check the save buffers only if data appears to be missing from the external device and is not found in the main buffers. Also, do not infer that the presence of save buffers means that data present there belongs at the end of the file. (The buffers remain, even when the data is eventually written.)  

  For information about the job file control block, see z/OS MVS Data Areas in z/OS Internet Library at http://www.ibm.com/systems/z/os/zos/bkserv/. |
| [8] Information for __amrc | __amrc is a structure defined in the stdio.h header file to assist in determining errors resulting from I/O operations. The contents of __amrc can be checked for system information, such as the return code for VSAM. Certain fields of the __amrc structure can provide useful information about what occurred previously in your routine. For more information about __amrc, see “Debugging C/C++ programs” on page 165 and to z/OS XL C/C++ Programming Guide. |
| [9] Errno Information | Shows the thread ID of the thread that generated the dump and the settings of the errno and errnojr variables for that thread. Both the errno and the errnojr variables contain the return code of the last failing z/OS UNIX system service call. These variables provide z/OS UNIX application programs access to diagnostic information returned from an underlying z/OS UNIX callable service. For more information on these return and reason codes, see z/OS UNIX System Services Messages and Codes. |

Memory file control block  
This section of the dump holds the following memory file control block information for each memory file the routine uses. A sample memory file control block is shown in Figure 59 on page 194.  

Memory file name  
The name assigned to this memory file.  

First memory data space  
A dump of the first 1K maximum of actual user data associated with this memory file.
Additional Floating-Point registers

The Language Environment dump formats Additional Floating Point (AFP) registers and Floating Point Control (FPC) registers when the AFP suboption of the FLOAT XL C/C++ compiler option is specified and the registers are needed. These floating-point registers are displayed in three sections of the CEEDUMP: Registers on Entry to CEE3DMP; Parameters, Registers, and Variables; and Condition Information for Active Routines. Samples of each section are given. For information on the FLOAT XL C/C++ compiler option, see z/OS XL C/C++ User’s Guide.

Registers on entry to CEE3DMP: This section of the Language Environment dump displays the sixteen floating-point registers. Figure 60 shows sample output. Note that the high half of general purpose register 14 at entry to CEE3DMP is not available and is shown in the dump as ********.

Parameters, registers, and variables for active routines: This section of the Language Environment dump displays the non-volatile floating-point registers that are saved in the stack frame. The registers are only displayed if the program owning the stack frame saved them. Dashes are displayed in the registers when the register values are not saved. A sample output is shown.
Condition information for active routines:

This section of the Language Environment dump displays the floating-point registers when they are saved in the machine state; Figure 62 shows sample output.

Vector registers

The Language Environment dump formats vector registers when the vector registers are needed. These vector registers are displayed in three sections of the CEEDUMP: Registers on Entry to CEE3DMP; Parameters, Registers, and Variables; and Condition Information for Active Routines. Samples of each section are given.

Registers on entry to CEE3DMP: This section of the Language Environment dump displays the 32 vector registers. Figure 63 on page 196 shows sample output.
Parameters, registers, and variables for active routines: This section of the Language Environment dump displays the non-volatile vector registers that are saved in the stack frame. The registers are only displayed if the program owning the stack frame saved them. Asterisks are displayed in the registers when the register values are not saved. A sample output is shown.

Parameters, Registers, and Variables for Active Routines:

Parameters, Registers, and Variables for Active Routines:

Figure 63. Registers on entry to CEE3DMP

Parameters, registers, and variables for active routines: This section of the Language Environment dump displays the vector registers when they are saved in the

Figure 64. Parameters, registers, and variables for active routines
machine state; Figure 65 shows sample output.

Figure 65. Condition information for active routines

Sample Language Environment dump with XPLINK-specific information

The programs tranmain (Figure 66 on page 198) and trandll (Figure 67 on page 198) were used to produce a Language Environment dump. The Language Environment dump produced by running these program is shown in "Example dump of calling between XPLINK and non-XPLINK programs" on page 199. The dump shows XPLINK-compiled routines calling NOXPLINK-compiled routines, and NOXPLINK-compiled routines calling XPLINK-compiled routines. The program tranmain was compiled XPLINK and trandll was compiled NOXPLINK. Each was link-edited as a separate program object with the sidedeck from the other. Explanations for some of the sections are in "Finding XPLINK information in a Language Environment dump" on page 201.
#pragma runopts(TRACE(ON,1M,NODUMP,LE=1),XPLINK(ON),TERMTHDACT(UADUMP))
#include <stdio.h>
#pragma export(tran2)

int tran1(int, int, int, long double, int);
int tran3(int, int, int, long double, int);

void main(void) {
  int parm1 = 0x11111111;
  int parm2 = 0x22222222;
  int parm3 = 0x33333333;
  long double parm4 = 1234.56789;
  int parm5 = 0x55555555;
  int retval;

  printf("Main: Call Tran1\n");
  retval = tran1(parm1,parm2,parm3,parm4,parm5);
  printf("Main: Return value from Tran1 = %d\n",retval);
}

int tran2(int parm1,int parm2,int parm3,long double parm4,int parm5) {
  int retval;

  printf("Tran2: Call Tran3\n");
  retval = tran3(parm1,parm2,parm3,parm4,parm5);
  printf("Tran2: Return value from Tran3 = %d\n",retval);
  return retval;
}

int tran3(int parm1,int parm2,int parm3,long double parm4,int parm5) {
  _INT4 code, timing;
  code = 1001; /* Abend code to issue */
  timing = 1;
  printf("Tran3: About to ABEND\n");
  CEE3ABD(&code,&timing);
  return parm1 + parm2 + parm3;
}

Figure 66. Sample XPLINK-compiled program (tranmain) which calls a NOXPLINK-compiled program

#include <stdio.h>
#include <ctest.h>
#include <leawi.h>
#pragma export(tran1)
#pragma export(tran3)

int tran2(int, int, int, long double, int);
int tran1(int parm1,int parm2,int parm3,long double parm4,int parm5) {
  int retval;

  printf("Tran1: Call Tran2\n");
  retval = tran2(parm1,parm2,parm3,parm4,parm5);
  printf("Tran1: Return value from Tran2 = %d\n",retval);
  return retval;
}

int tran3(int parm1,int parm2,int parm3,long double parm4,int parm5) {
  _INT4 code, timing;
  code = 1001; /* Abend code to issue */
  timing = 1;
  printf("Tran3: About to ABEND\n");
  CEE3ABD(&code,&timing);
  return parm1 + parm2 + parm3;
}

Figure 67. Sample NOXPLINK-compiled program (trandll) which calls an XPLINK-compiled program
Example dump of calling between XPLINK and non-XPLINK programs

This article displays an example dump of calling between XPLINK and non-XPLINK programs.

```plaintext
<table>
<thead>
<tr>
<th>DSA</th>
<th>Addr</th>
<th>EAddr</th>
<th>PU Addr</th>
<th>PU Offset</th>
<th>Comp Date</th>
<th>Compile Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2110C808 2094C238</td>
<td>2094C238</td>
<td>+00004030</td>
<td>20061215</td>
<td>CEL</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2110C808 2094C238</td>
<td>2094C238</td>
<td>+00004030</td>
<td>20061215</td>
<td>CEL</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2110C808 2094C238</td>
<td>2094C238</td>
<td>+00004030</td>
<td>20061215</td>
<td>CEL</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2110C808 2094C238</td>
<td>2094C238</td>
<td>+00004030</td>
<td>20061215</td>
<td>CEL</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2110C808 2094C238</td>
<td>2094C238</td>
<td>+00004030</td>
<td>20061215</td>
<td>CEL</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2110C808 2094C238</td>
<td>2094C238</td>
<td>+00004030</td>
<td>20061215</td>
<td>CEL</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2110C808 2094C238</td>
<td>2094C238</td>
<td>+00004030</td>
<td>20061215</td>
<td>CEL</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2110C808 2094C238</td>
<td>2094C238</td>
<td>+00004030</td>
<td>20061215</td>
<td>CEL</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2110C808 2094C238</td>
<td>2094C238</td>
<td>+00004030</td>
<td>20061215</td>
<td>CEL</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2110C808 2094C238</td>
<td>2094C238</td>
<td>+00004030</td>
<td>20061215</td>
<td>CEL</td>
<td></td>
</tr>
</tbody>
</table>

Condition Information for Active Routines

Condition Information for CEL4ABD0 (DSA address 2110C808)

Program Unit: CEL4ABD0 Statement: Offset: +000024C

Machine State:
ILC..... 0002 Interruption Code..... 000D
PSW..... 078D1400 A0AFCC54
GPR0..... 00000000_84000000 GPR1..... 00000000_840003E9 GPR2..... 00000000_00000000 GPR3..... 00000000_2110C9B0
GPR4..... 00000000_00000001 GPR5..... 20914E10 GPR6..... 00000000_00000002 GPR7..... 00000000_00000000
GPR8..... A0900003 GPR9..... 212BB868 GPR10.... 212BB8C0 GPR11.... 20ACDF1C
GPR12.... 209139B0 GPR13.... 2110C910 GPR14.... A12BB998 GPR15.... A09BFCD0

Chapter 4. Debugging C/C++ routines 199
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|
|

.
.
.
Storage around GPR15(209BFCD0)
-0020 209BFCB0 209BFA00 F2F0F0F6 F1F2F1F5 F1F1F5F2 F0F0F0F1 F0F9F0F0 0005C4F1 F9F0F800 |....20061215115200010900..D1908.|
+0000 209BFCD0 47F0F014 00C3C5C5 00000098 000000E0 47F0F001 90ECD00C 18BF5800 B0D05810 |.00..CEE...q.....00.............|
+0020 209BFCF0 D04C1E01 5500C00C 47D0B034 58F0C2BC 05EF181F 5000104C D7011000 100018FD |.<...........0B.....&..<P.......|
Local Variables:
timing
signed long int
1
code
signed long int
1001
CEEVRONU (DSA address 2110C750):
TRANSITION DSA
Saved Registers:
GPR0..... 20914D70 GPR1..... 212B6D70 GPR2..... 212BBE18 GPR3..... 0000001F
GPR4..... 212B6530 GPR5..... 21109718 GPR6..... 00000000 GPR7..... 00000000
GPR8..... A0900003 GPR9..... 212BB868 GPR10.... 212BB8C0 GPR11.... 20ACDF1C
GPR12.... 209139B0 GPR13.... 2110C750 GPR14.... A0ACDA80 GPR15.... 212BB8C0
.
.
.
tran2 (DSA address 212B6530):
DOWNSTACK DSA
Parameters:
parm5
signed int
parm4
long double
parm3
signed int
parm2
signed int
parm1
signed int
Saved Registers:
GPR0..... 55555555 GPR1.....
GPR4..... 212B6530 GPR5.....
GPR8..... A09000F2 GPR9.....
GPR12.... 209139B0 GPR13....

1431655765
1.234567889999999977135303197E+03
858993459
572662306
286331153
11111111
21109718
20914E80
2110C5C8

GPR2.....
GPR6.....
GPR10....
GPR14....

22222222
20ACCAD8
209000B8
209000B8

GPR3.....
GPR7.....
GPR11....
GPR15....

33333333
A090015A
A0ACAA48
0000000C

.
.
.
Local Variables:
retval
signed int
CEEVROND (DSA address 212B65B0):
TRANSITION DSA
Saved Registers:
GPR0..... ******** GPR1.....
GPR4..... 212B65B0 GPR5.....
GPR8..... 209000B8 GPR9.....
GPR12.... ******** GPR13....

********
20914E80
20ACBA47
********

GPR2.....
GPR6.....
GPR10....
GPR14....

********
209000E8
********
********

GPR3.....
GPR7.....
GPR11....
GPR15....

********
A0ACBC9C
********
********

tran1 (DSA address 2110C500):
UPSTACK DSA
Saved Registers:
GPR0..... 211080A8 GPR1.....
GPR4..... 33333333 GPR5.....
GPR8..... A0900203 GPR9.....
GPR12.... 209139B0 GPR13....

2110C598
20914E10
212BB9E8
2110C500

GPR2.....
GPR6.....
GPR10....
GPR14....

55555555
22222222
212BBA40
A12BBB34

GPR3.....
GPR7.....
GPR11....
GPR15....

212BBA7A
11111111
20ACDF1C
A0ACAA48

-455613482

.
.
.

.
.
.
[3]Control Blocks for Active Routines:
.
.
.
DSA for tran3: 2110C910
+000000 FLAGS.... 1010
+000010 R15...... A09BFCD0
+000024 R4....... 2110C9B0
+000038 R9....... 212BB868
+00004C NAB...... 2110C9C8
+000064 reserved. A0A9AED0
+000078 reserved. A0A8299C
DSA for CEEVRONU: 2110C750
+000000 FLAGS.... 0000
+000010 R15...... 212BB8C0
+000024 R4....... 212B6530
+000038 R9....... 212BB868
+00004C NAB...... 2110C910
+000064 reserved. 2110C7D0
+000078 reserved. 00000000
DSA for CEEVRONU: 2110C7D0
+000000 EYE...... DOWNTOUP
+000018 SSDSAU... 2110C750
+00002C TR_R3.... 33333333
+000040 TR_R8.... A09000F2
+000054 TR_R13... 2110C5C8
+000068 INTF_MAP. 018F1000
DSA for tran2: 212B6D30
+000000 R4....... 212B65B0
+000014 R9....... 20ACBA47
+000028 R14...... 209000B8
+00003C reserved. 55555555
DSA for CEEVROND: 212B6DB0
+000000 R4....... E3D9C1D5
+000014 R9....... 00000000
+000028 R14...... 212B6E10
+00003C reserved. 000000D0
DSA for CEEVROND: 212B6E10
+000000 EYE...... UPTODOWN
+000018 SSDSAU... 2110C340
+00002C TR_R3.... 00000000
+000040 TR_R8.... 00000000
+000054 TR_R13... 00000000
+000068 INTF_MAP. 00000000
DSA for tran1: 2110C500
+000000 FLAGS.... 1000
+000010 R15...... A0ACAA48

200

member...
R0.......
R5.......
R10......
PNAB.....
reserved.
reserved.

803C
20914D70
20914E10
212BB8C0
00000001
209139B0
00000000

BKC......
R1.......
R6.......
R11......
reserved.
MODE.....

2110C750
2110C9A8
00000000
20ACDF1C
20914E70
20A9CD06

FWC......
R2.......
R7.......
R12......
209011DC
reserved.

2110C9C8
2110C9B4
00000000
209139B0

member...
R0.......
R5.......
R10......
PNAB.....
reserved.
reserved.

0000
20914D70
21109718
212BB8C0
2110C910
00000000
00000000

BKC......
R1.......
R6.......
R11......
reserved.
MODE.....

FFFFFFFF
212B6D70
00000000
20ACDF1C
00000000
00000000

FWC......
R2.......
R7.......
R12......
00000000
reserved.

2110C910
212BBE18
00000000
209139B0

TRTYPE...
TRANEP...
TR_R4....
TR_R9....
TR_R14...

00000003
20ACCA58
212B6530
20914E80
209000B8

BOS......
TR_R0....
TR_R5....
TR_R10...
TR_R15...

00000000
55555555
21109718
209000B8
0000000C

STACKFLR.
TR_R1....
TR_R6....
TR_R11...
CRENT....

00000000
11111111
20ACCAD8
A0ACAA48
00000000

R5.......
R10......
R15......
reserved.

20914E80 R6....... 209000E8 R7....... A0ACBC9C R8....... 209000B8
209000B8 R11...... A0ACAA48 R12...... 209139B0 R13...... 2110C5C8
0000000C reserved. 00000A68 reserved. 20F2E0C7 HPTRAN... 00000000
11111111

R5.......
R10......
R15......
reserved.

00000000 R6....... 20ACAAA0 R7....... 00000000 R8....... 2110C8B0
00000000 R11...... A0A82AE8 R12...... 00000000 R13...... 00000000
00000000 reserved. 20914E1C reserved. 2110C5C0 HPTRAN... 212B6E10
11111111

TRTYPE...
TRANEP...
TR_R4....
TR_R9....
TR_R14...

00000002
20ACAAA0
2110C500
00000000
00000000

BOS......
TR_R0....
TR_R5....
TR_R10...
TR_R15...

00000000
00000000
00000000
00000000
00000000

STACKFLR.
TR_R1....
TR_R6....
TR_R11...
CRENT....

R14......
R3.......
R8.......
reserved.

A12BB998
212BB8FA
A0900003
00000000

R14......
R3.......
R8.......
reserved.

A0ACDA80
0000001F
A0900003
00000000

SSTOPD...
TR_R2....
TR_R7....
TR_R12...
ROND_DSA.

212B6680
22222222
A090015A
209139B0
2110C5C8

20912668

00000000

00000000
00000000
00000000
00000000
A0ACAA48

SSTOPD...
TR_R2....
TR_R7....
TR_R12...
ROND_DSA.

212B6680
00000000
A12BBB34
00000000
00000000

member... 0000
BKC...... 2110C340 FWC...... 2110C8B0 R14...... A12BBB34
R0....... 211080A8 R1....... 2110C598 R2....... 55555555 R3....... 212BBA7A

z/OS V2R1.0 Language Environment Debugging Guide


Finding XPLINK information in a Language Environment dump

Table 39 describes the specific XPLINK information in sections of the Language Environment dump.

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] Traceback</td>
<td>When an XPLINK-compiled routine calls a NOXPLINK-compiled routine, a glue routine gets control to convert the linkage conventions of the XPLINK caller to those of the NOXPLINK callee. In the sample dump, this routine is CEEVRONU and it appears between main() and tran1() and again between tran2() and tran3(). When a NOXPLINK-compiled routine calls an XPLINK-compiled routine, a glue routine gets control to convert the linkage conventions of the NOXPLINK caller to those of the XPLINK callee. In the sample dump, this routine is CEEVROND and it appears between EDCZHINV and main() and again between tran1() and tran2().</td>
</tr>
<tr>
<td>[2] Parameters, Registers, and Variables for Active Routines</td>
<td>In this section, each DSA is identified as one of the following:</td>
</tr>
<tr>
<td></td>
<td><strong>UPSTACK DSA</strong></td>
</tr>
<tr>
<td></td>
<td>The DSA format is that for a NOXPLINK-compiled program that uses an upward growing stack.</td>
</tr>
<tr>
<td></td>
<td><strong>DOWNSTACK DSA</strong></td>
</tr>
<tr>
<td></td>
<td>The DSA format is that for a XPLINK-compiled program that uses an downward growing stack.</td>
</tr>
<tr>
<td></td>
<td><strong>TRANSITION DSA</strong></td>
</tr>
<tr>
<td></td>
<td>The DSA format is that of its callee. A transition DSA can occur between an UPSTACK DSA and a DOWNSTACK DSA where it represents a transition from one linkage convention to another. A transition DSA can also occur between two DOWNSTACK DSAs where it represents a transition from one stack segment to another (a stack overflow).</td>
</tr>
<tr>
<td>[3] Control Blocks for Active Routines</td>
<td>In this section, DSAs are formatted. Those previously identified as UPSTACK DSAs will have one format and those identified as DOWNSTACK DSAs will have a different format. Those identified as TRANSITION DSAs will have two parts; the first will be either the downstack or upstack format, the second is unique to transition DSAs and contains information about the transition. It is important to understand that the registers saved in an upstack DSA are those saved by a routine that the DSA-owning routine called. Typically register 15 is the entry point of the routine that was called, and register 14 is the return address into the DSA-owning routine. In contrast, the registers saved in a downstack DSA are those saved by the DSA-owning routine on entry. Register 7 is the return address back to the caller of the DSA-owning routine. Register 6 may be the entry point of the DSA-owning routine. (This is not true when the Branch Relative and Save instruction is used to implement the call.)</td>
</tr>
</tbody>
</table>

C/C++ contents of the Language Environment trace tables

Language Environment provides the following C/C++ trace table entry types that contain character data. For more information about the Language Environment trace table format, see "Understanding the trace table entry (TTE)" on page 154.

- Trace entry 1 occurs when a base C library function is called.
• Trace entry 2 occurs when a base C library function returns.
• Trace entry 3 occurs when a POSIX C library function is called.
• Trace entry 4 occurs when a POSIX C library function returns.
• Trace entry 5 occurs when an XPLINK base C or POSIX C library function is called.
• Trace entry 6 occurs when an XPLINK base C or POSIX C library function returns.
• Trace entry 7 occurs when an XPLINK function calls a non-XPLINK function.
• Trace entry 8 occurs when a non-XPLINK function calls an XPLINK function.

The format for trace table entry 1 is:

```
NameOfCallingFunction
    —>(xxx) NameOfCalledFunction
```

or, for called functions calloc, free, malloc, and realloc:

```
NameOfCallingFunction
    —>(xxx) NameOfCalledFunction<\{input_parameters\}>
```

In addition, when the call is due to one of these C++ operators:

- new,
- new[],
- delete,
- delete[]

then, the C++ operator will appear and the format becomes:

```
NameOfCallingFunction
    —>(xxx) NameOfCalledFunction<\{input_parameters\}>
NameOfC++Operator
```

The format for trace table entry 2 is:

```
<—(xxx) R15=value ERRNO=value
```

The format for trace table entry 3 is:

```
NameOfCallingFunction
    —>(xxx) NameOfCalledFunction
```

The format for trace table entry 4 is:

```
<—(xxx) R15=value ERRNO=value ERRNO2=value
```

The format for trace table entry 5, which is shown below, is just like trace table entry 1. The input_parameters and NameOfC++Operator only appear for the appropriate functions. The angle brackets (<> ) indicate that this information does
not always appear.

The format for trace table entry 6 is:

```
-->(xxx) NameOfCalledFunction(input_parameters)
```

In all entry types, (xxx) and (xxxx) are numbers associated with the called library function and are used to associate a specific entry record with its corresponding return record.

For entry types 5 and 6, the number will be the same as the number of the function as seen in the C runtime library definition side-deck, SCEELIB dataset member CELHS003, on the IMPORT statement for that function.

The format for trace table entry 7 is:

```
ModuleNameOfCallingFunction:NameOfCallingXplinkFunction
---ModuleNameOfCalledFunction:NameOfCalledNonXplinkFunction
```

For entry types 7 and 8, 16 bytes is for the module name and 32 bytes is for the function name. If the name is longer than 16 or 32 bytes, an extra trace entry is taken. The name is truncated and only the first 32/64(16/32) bytes will appear in the trace table entry. Also, a module name might not always be located, such as when a DLL is freed. If that occurs, "UNKNOWN" appears for the module name in the trace table entry.

The below trace table shows a non-XPLINK trace that has examples of C/C++ trace table entry types 1 thru 4.
Figure 68 on page 206 shows an example of the format of the trace table entry type 7 and 8.
### LE=20 suboption.

The following is an example of a dump of the trace table when you specify the LE=20 suboption.

#### Language Environment Trace Table:

<table>
<thead>
<tr>
<th>Displacement</th>
<th>Trace Entry in Hexadecimal</th>
<th>Trace Entry in EBCDIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>Time 22.10.56.799195</td>
<td>Date 2005.05.01</td>
</tr>
<tr>
<td>+00010</td>
<td>Member ID: 03 Flags: 00000000 Entry Type: 00000008</td>
<td></td>
</tr>
<tr>
<td>+000038</td>
<td>40040400 40040400 40040400 40040400 40040400 40040400</td>
<td>CELHV003 :EDC2HINV</td>
</tr>
<tr>
<td>+00058</td>
<td>40040400 7A5A48189 45004040 40040400 40040400 40040400</td>
<td>:main --&gt;a859c41x</td>
</tr>
<tr>
<td>+00078</td>
<td>40040400 40040400</td>
<td>:function_name_length_equal_to_0 --&gt;CEPFLPKA</td>
</tr>
<tr>
<td>+000090</td>
<td>Time 22.10.56.804695</td>
<td>Date 2005.05.01</td>
</tr>
<tr>
<td>+000099</td>
<td>Member ID: 03 Flags: 000000 Entry Type: 00000007</td>
<td></td>
</tr>
<tr>
<td>+000138</td>
<td>40040400 40040400 40040400 40040400 40040400 40040400</td>
<td>:34 --&gt;a859c41fn134</td>
</tr>
<tr>
<td>+00018</td>
<td>Time 22.10.56.825904</td>
<td>Date 2005.05.01</td>
</tr>
<tr>
<td>+000190</td>
<td>Member ID: 03 Flags: 000000 Entry Type: 00000007</td>
<td></td>
</tr>
<tr>
<td>+000289</td>
<td>40040400 40040400 40040400 40040400 40040400 40040400</td>
<td>a859c41x</td>
</tr>
<tr>
<td>+000299</td>
<td>40040400 40040400 40040400 40040400 40040400 40040400</td>
<td>: --&gt;funcion_name_length_equal_to_0 --&gt;CEPFLPKA</td>
</tr>
<tr>
<td>+000358</td>
<td>40040400 7A979989 953A8640 40040400 40040400 40040400</td>
<td>:printf</td>
</tr>
<tr>
<td>+000458</td>
<td>40040400 7A979989 953A8640 40040400 40040400 40040400</td>
<td>:printf</td>
</tr>
<tr>
<td>+000490</td>
<td>40040400 40040400 40040400 40040400 40040400 40040400</td>
<td>:funcion_name_length_equal_to_0 --&gt;CEPFLPKA</td>
</tr>
<tr>
<td>+000500</td>
<td>40040400 40040400 40040400 40040400 40040400 40040400</td>
<td>:printf</td>
</tr>
<tr>
<td>+000510</td>
<td>Member ID: 03 Flags: 000000 Entry Type: 00000008</td>
<td></td>
</tr>
</tbody>
</table>
## Debugging examples of C/C++ routines

This section contains examples that demonstrate the debugging process for C/C++ routines. Important areas of the output are highlighted. Data unnecessary to the debugging examples has been replaced by ellipses.

### Divide-by-zero error

Figure 69 on page 208 illustrates a C program that contains a divide-by-zero error. The code was compiled with RENT so static and external variables need to be calculated from the WSA field. The code was compiled with XREF, LIST and OFFSET to generate a listing, which is used to calculate addresses of functions and data. The code was processed by the binder with MAP to generate a binder map, which is used to calculate the addresses of static and external variables.
To debug this routine, use the following steps:

1. Locate the Original Condition message in the Condition Information for Active Routines section of the dump. In this example, the message is CEE3209S. The system detected a fixed-point divide exception. This message indicates the error was caused by an attempt to divide by zero. For more information about CEE3209S, see z/OS Language Environment Runtime Messages.

The traceback section of the dump indicates that the exception occurred at offset X'76' within function funcb. This information is used along with the compiler-generated Pseudo Assembly Listing to determine where the problem occurred.

If the TEST compiler option is specified, variable information is in the dump. If the GONUMBER compiler option is specified, statement number information is in the dump. Figure 70 on page 209 shows the generated traceback from the dump.

```c
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>

int statint = 73;
int fa;
void funcb(int *pp);

int main(void) {
    int aa, bb=1;
    aa = bb;
    funcb(&aa);
    return(99);
}

void funcb(int *pp) {
    int result;
    fa = *pp;
    result = fa/(statint-73);
    return;
}
```

Figure 69. C routine with a divide-by-zero error
2. Locate the instruction with the divide-by-zero error in the Pseudo Assembly Listing in Figure 71 on page 210.

The offset (within funcb) of the exception from the traceback (X’76’) reveals the divide instruction: DR r4, r1 at that location. Instructions X’66’ through X’76’ refer to the result = fa/(statint-73); line of the C/C++ routine.
```plaintext
<table>
<thead>
<tr>
<th>OFFSET</th>
<th>OBJECT CODE</th>
<th>LINE#</th>
<th>FILE#</th>
<th>PSEUDO ASSEMBLY LISTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>000000</td>
<td>500D E004</td>
<td>00015</td>
<td></td>
<td><code>int funcb(int *pp)</code> {</td>
</tr>
<tr>
<td>000015</td>
<td></td>
<td></td>
<td></td>
<td>funcb DS 0D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.</td>
</tr>
<tr>
<td>000004</td>
<td></td>
<td></td>
<td></td>
<td>ST r13,4(,r14)</td>
</tr>
<tr>
<td>000005</td>
<td></td>
<td></td>
<td></td>
<td>LR r13,r14</td>
</tr>
<tr>
<td>000015</td>
<td></td>
<td></td>
<td></td>
<td>End of Prolog</td>
</tr>
<tr>
<td>000046</td>
<td>50D0 E004</td>
<td>00015</td>
<td></td>
<td>ST r13,4(,r14)</td>
</tr>
<tr>
<td>00004A</td>
<td>18DE</td>
<td>00015</td>
<td></td>
<td>LR r13,r14</td>
</tr>
<tr>
<td>00004C</td>
<td></td>
<td></td>
<td></td>
<td>Start of Prolog</td>
</tr>
<tr>
<td>000016</td>
<td></td>
<td></td>
<td></td>
<td><code>int result;</code></td>
</tr>
<tr>
<td>000017</td>
<td></td>
<td></td>
<td></td>
<td>fa = *pp;</td>
</tr>
<tr>
<td>000050</td>
<td>5820 1000</td>
<td>00017</td>
<td></td>
<td>L r2,pp(r1,0)</td>
</tr>
<tr>
<td>000054</td>
<td>5810 3062</td>
<td>00018</td>
<td></td>
<td>L r1,=Q(statint)(r3,98)</td>
</tr>
<tr>
<td>000058</td>
<td>58F0 3066</td>
<td>00017</td>
<td></td>
<td>L r15,=Q(fa)(r3,102)</td>
</tr>
<tr>
<td>00005C</td>
<td></td>
<td></td>
<td></td>
<td>LARL r0,F'38'</td>
</tr>
<tr>
<td>00005E</td>
<td></td>
<td></td>
<td></td>
<td>L r4,(*)int(r2,0)</td>
</tr>
<tr>
<td>000062</td>
<td>5840 2000</td>
<td>00018</td>
<td></td>
<td>result = fa/(statint-73);</td>
</tr>
<tr>
<td>00005E</td>
<td></td>
<td></td>
<td></td>
<td>L r1,statint(r1,r14,0)</td>
</tr>
<tr>
<td>000066</td>
<td>5811 E000</td>
<td>00018</td>
<td></td>
<td>L r4,fa(r15,r14,0)</td>
</tr>
<tr>
<td>00006A</td>
<td>504F E000</td>
<td>00018</td>
<td></td>
<td>AHI r1,H'-73'</td>
</tr>
<tr>
<td>00006C</td>
<td></td>
<td></td>
<td></td>
<td>L r12,printf(r3,106)</td>
</tr>
<tr>
<td>000070</td>
<td></td>
<td></td>
<td></td>
<td>LA r1,#MX_TEMP2(r13,152)</td>
</tr>
<tr>
<td>000074</td>
<td></td>
<td></td>
<td></td>
<td>ST r0,#MX_TEMP2(r13,156)</td>
</tr>
<tr>
<td>00007C</td>
<td></td>
<td></td>
<td></td>
<td>ST r5,#MX_TEMP2(r13,156)</td>
</tr>
<tr>
<td>000080</td>
<td></td>
<td></td>
<td></td>
<td>BASR r14,r15</td>
</tr>
<tr>
<td>00008A</td>
<td>18F5</td>
<td>00019</td>
<td></td>
<td>return result;</td>
</tr>
<tr>
<td>00008C</td>
<td>00019</td>
<td></td>
<td></td>
<td>}</td>
</tr>
<tr>
<td>00008C</td>
<td></td>
<td></td>
<td></td>
<td>Start of Epilog</td>
</tr>
<tr>
<td>000090</td>
<td>5800 D004</td>
<td>00021</td>
<td></td>
<td>L r13,4(,r13)</td>
</tr>
<tr>
<td>000094</td>
<td>58ED D00C</td>
<td>00021</td>
<td></td>
<td>L r14,12(,r13)</td>
</tr>
<tr>
<td>000098</td>
<td>051E</td>
<td>00021</td>
<td></td>
<td>LM r2,r5,28(r13)</td>
</tr>
<tr>
<td>00009C</td>
<td>0707</td>
<td>00021</td>
<td></td>
<td>NOPR 7</td>
</tr>
<tr>
<td>00009C</td>
<td></td>
<td></td>
<td></td>
<td>Start of Literals</td>
</tr>
<tr>
<td>00009C</td>
<td></td>
<td></td>
<td></td>
<td>=Q(statint)</td>
</tr>
<tr>
<td>00009C</td>
<td></td>
<td></td>
<td></td>
<td>=Q(fa)</td>
</tr>
<tr>
<td>0000A4</td>
<td></td>
<td></td>
<td></td>
<td>=V(printf)</td>
</tr>
<tr>
<td>0000A8</td>
<td></td>
<td></td>
<td></td>
<td>End of Literals</td>
</tr>
<tr>
<td>0000A8</td>
<td></td>
<td></td>
<td></td>
<td>*** General purpose registers used: 1111110000001111</td>
</tr>
<tr>
<td>0000A8</td>
<td></td>
<td></td>
<td></td>
<td>*** Floating point registers used: 1111111100000000</td>
</tr>
<tr>
<td>0000A8</td>
<td></td>
<td></td>
<td></td>
<td>*** Size of register spill area: 128(max) 0(used)</td>
</tr>
<tr>
<td>0000A8</td>
<td></td>
<td></td>
<td></td>
<td>*** Size of dynamic storage: 168</td>
</tr>
<tr>
<td>0000A8</td>
<td></td>
<td></td>
<td></td>
<td>*** Size of executable code: 156</td>
</tr>
<tr>
<td>0000A8</td>
<td></td>
<td></td>
<td></td>
<td>Constant Area</td>
</tr>
<tr>
<td>000000</td>
<td>D985A2A4</td>
<td>00015</td>
<td></td>
<td>Result = %d..</td>
</tr>
</tbody>
</table>

**Figure 71. Pseudo assembly listing (C/C++ routine divide-by-zero error)**

---

**PPA1: Entry Point Constants**

- F'483303686' Flags
- A(PPA2-main)
- F'0' No EPD
- F'-33554432' Register save mask
- A(PPA3-main)
- F'0' Member flags
- H'64' Flags
- AL1(144) Flags
- AL3(0) Callee's DSA use/8
- H'18' Offset/2 to CDL
- F'0' Reserved
- F'1342177340' COL function length/2
- F'-312' COL function EP offset
- F'942014464' COL prolog
- F'0' COL epilog
- F'0' COL end
- AL2(4),C'main'

**PPA1 End**
3. Verify the value of the divisor statint. The procedure specified below is to be used for determining the value of static variables only. If the divisor is an automatic variable, there is a different procedure for finding the value of the variable. For more information about finding automatic variables in a dump, see “Steps for finding automatic variables” on page 175.

Because this routine was compiled with the RENT option, find the WSA address in the Enclave Control Blocks section of the dump. In this example, this address is X'20914F50'. Figure 72 shows the WSA address.

```
Enclave Control Blocks:

: WSA address..................20914F50
: ........................................

Figure 72. C/C++ CAA information in dump (C/C++ routine divide-by-zero error)
```

4. Routines compiled with the RENT option must also be processed by the binder. The binder produces the Writable Static Map. Find the offset of statint in the Writable Static Map in Figure 73. In this example, the offset is X'0'.

```
: ........................................
: CLASS C_WSA                     LENGTH = AC     ATTRIBUTES = MRG, DEFER , RMODE=ANY
: OFFSET = 0 IN SEGMENT 002       ALIGN = DBLWORD
: ........................................

<table>
<thead>
<tr>
<th>CLASS</th>
<th>OFFSET</th>
<th>NAME</th>
<th>TYPE</th>
<th>LENGTH</th>
<th>SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>statint</td>
<td>PART</td>
<td>4</td>
<td>statint</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>fa</td>
<td>PART</td>
<td>4</td>
<td>fa</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>environ</td>
<td>PART</td>
<td>4</td>
<td>environ</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>errno</td>
<td>PART</td>
<td>4</td>
<td>errno</td>
<td></td>
</tr>
</tbody>
</table>
: ........................................

Figure 73. Writable static map (C/C++ routine divide-by-zero error)
```

5. Add the WSA address of X'20914F50' to the offset of statint. The result is X'20914F50'. This is the address of the variable statint, which is in the writable static area.

The writable static area is shown in the Enclave Storage section of the dump. For a load module, the writable static area is storage allocated by the C/C++ runtime for the C/C++ user, so it is in the user heap. For a program object, the writable static area is storage allocated by the loader and is shown in the WSA for Program Object(s) section of the dump.

For this example, the program was built as a program object. The writable static area is displayed in the Enclave Storage section of the dump, shown in Figure 74 on page 212.

6. To find the variable statint in the writable static area, locate the closest address listed that is before the address of statint. In this case, that address is X'20914F50'. Count across X'00' to location X'20914F50'. The value at that location is X'49' (that is, statint is 73), and hence the fixed point divide exception.
Calling a nonexistent non-XPLINK function

Figure 75 demonstrates the error of calling a nonexistent function. This routine was compiled with the compiler options LIST, OFFSET, and RENT and was run with the option TERMTHDACT(DUMP). The code was processed by the binder with MAP to generate a binder map, which is used to calculate the addresses of static and external variables. This routine was not compiled with the TEST(ALL) compiler option. As a result, arguments and variables do not appear in the dump.

```
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
#include <signal.h>

void funca(int* aa);
int (*func_ptr)(void)=0;

int main(void) {
  int aa;
  funca(&aa);
  printf("result of funca = %d\n",aa);
  return;
}

void funca(int* aa) {
  *aa = func_ptr();
  return;
}
```

Figure 75. C/C++ example of calling a nonexistent subroutine

To debug this routine, use the following steps:
1. Locate the Original Condition message in the Condition Information for Active Routines section of the dump, shown in Figure 76 on page 213. In this example, the message is CEE3201S The system detected an operation exception (System Completion Code=0C1). This message suggests that the error was caused by an attempt to branch to an unknown address. For additional information about CEE3201S, see z/OS Language Environment Runtime Messages.

The Location section of the dump indicates that the exception occurred at offset X’-20900078’ within function funca and that there may have been a bad branch from offset X’+0000005A’ within function funca. The negative offset indicates that the offset cannot be used to locate the instruction that caused the error. Another indication of bad data is the value of X’80000002’ in the instruction address of the PSW. This address indicates that an instruction in the routine branched outside the bounds of the routine.
2. **Find the branch instructions at offset X'+0000005A' of funca in the listing in Figure 77 on page 214.** The instruction is BASR r14, r15. This branch is part of the source statement *aa = func_ptr().
3. Find the offset of `func_ptr` in the Writable Static Map, shown in Figure 78, as produced by the binder.

4. Add the offset of `FUNC@PTR(X'0')` to the address of WSA (X'20914F58'). The result (X'20914F58') is the address of the function pointer `func_ptr` in the writable static storage area within the heap. This value is 0, indicating the variable is uninitialized. Figure 79 on page 215 shows the sections of the dump.
Calling a nonexistent XPLINK function

Figure 80 demonstrates the error of calling a nonexistent function. This routine was compiled with the compiler options XPLINK, LIST and RENT and was run with the option TERMTHDACT(DUMP). This routine was not compiled with the TEST(ALL) compile option. As a result, arguments and variables do not appear in the dump.

To debug this routine, use the following steps:

1. Locate the Original Condition message in the Condition Information for Active Routines section of the dump, shown in Figure 80. In this example, the message is CEE3201S The system detected an operation exception (System Completion Code=0C1). This message suggests that the error was caused by an attempt to branch to an unknown address. For additional information about CEE3201S, see z/OS Language Environment Runtime Messages.

   The location section of the dump indicates that the exception occurred at offset X'2090A86A' within function funca and that there may have been a bad branch from offset X'0000001C'. The negative offset indicates that the offset cannot be used to locate the instruction that caused the error. Another indication of bad data is the value of X'00000004' in the instruction address of the PSW. This address indicates that an instruction in the routine branched outside the bounds of the routine.

2. Find the branch instruction at offset X'+0000001C' of funca in the listing in Figure 81 on page 216. This instruction is BASR r7,r6. This branch is part of the
source statement *aa = func_ptr().

00015  | * void funca(int* aa) {

00020  |     ...
00020  |     02L0  DS  0D
00024  |     00C300C5   =f'12779717'   XPLink entrypoint marker
00028  |     00C500F1   =f'12910833'
00032  |     00000000   =f'128'
00036  |     00000000   =f'1128'
00040  |     00015  | funca DS  0D
00044  |     00015  | 9057  4784  =F'12910833'
00048  |     00015  | 47AA  FF00  =F'12779717'
00052  |     End of Prolog

00056  |     00015  | 5010  4800  ST r1,aa(,r4,2240)
00060  |     00016  | * *aa = func_ptr();
00064  |     00016  |   L r6,#Save_ADA_Ptr_2(,r4,2052)
00068  |     00016  |   L r6,=A(func_ptr)(,r6,24)
00072  |     00016  |   L r6,func_ptr(,r6,0)
00076  |     00016  |   LM r5,r6,ADA_EPA(r6,16)
00080  |     00016  |   BASR r7,r6
00084  |     00016  |   NOP 4
00088  |     00016  |   LR r0,r3
00092  |     00016  |   L r6,aa(,r4,2240)
00096  |     00016  |   ST r0,(*)int(,r6,0)
000100  |     00017  | * return;
000104  |     00018  |   02L3  DS  0H
000108  |     00018  |   Start of Epilog
000112  |     00018  |   5870  480C  L r7,2060(,r4)
000116  |     00018  |   4140  4080  LA r4,1280(,r4)
000120  |     00018  |   07F7  0000  BR r7

Figure 81. Pseudo assembly listing (calling a nonexistent XPLINK function)

3. Find the offset of func_ptr in the Writable Static Map, shown in Figure 82.

----------------
CLASS C_WSA LENGTH = 3C ATTRIBUTES = MRG, DEFER , RMODE=ANY
OFFSET = 0 IN SEGMENT 002 ALIGN = DBLWORD
----------------

<table>
<thead>
<tr>
<th>CLASS</th>
<th>OFFSET</th>
<th>NAME</th>
<th>TYPE</th>
<th>LENGTH</th>
<th>SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>PRIV0000011</td>
<td>PART</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>exist</td>
<td>PART</td>
<td>20</td>
<td>EXIST</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>func_ptr</td>
<td>PART</td>
<td>4</td>
<td>func_ptr</td>
<td></td>
</tr>
</tbody>
</table>

Figure 82. Writable static map (calling a nonexistent XPLINK function)

4. Add the offset of func_ptr (X'38') to the address of WSA (X'20914FC0'). The result (X'20914FF8') is the address of the function pointer func_ptr in the writable static storage area within the heap. This value is 0, indicating the variable is uninitialized. Figure 83 on page 217 shows the sections of the dump.

---

**Figure 81. Pseudo assembly listing (calling a nonexistent XPLINK function)**

**Figure 82. Writable static map (calling a nonexistent XPLINK function)**

**Figure 83 on page 217**

---

216  z/OS V2R1.0 Language Environment Debugging Guide
Sections of the dump from example C routine (calling a nonexistent XPLINK function)

Condition Information for Active Routines
Condition Information For (DSA address 21100620) 
CIB Address: 21100620
Current Condition: 
CEE0035S The termination of a thread was signaled due to an unhandled condition.
Original Condition: 
CEE0035S The system detected an operation exception (System Completion Code=0C1).
Location: 
Program Unit: Entry: funca Statement: Offset: -20900158
Possible Bad Branch: Statement: Offset: +0000001C
Machine State:
ILC..... 0002 Interruption Code..... 0001
PSW..... 078D2400 80000002
GPR0..... 00000000_2110C500 GPR1..... 00000000_211B5988 GPR2..... 00000000_2110C294 GPR3..... 00000000_2110C298
GPR4..... 209D7734 GPR5..... A0915000 GPR6..... 2090C2A8 GPR7..... 2110CE20
GPR8..... A09D665A GPR9..... 2110E4FE GPR10.... 2110D4FF GPR11.... 209D2B08
GPR12.... 209139B0 GPR13.... 2110C500 GPR14.... A09D6B3A GPR15.... A09EFFD8...

Storage dump near condition, beginning at location: 00000000
+000000 00000000 Inaccessible storage.

Figure 83. Enclave control blocks and storage sections in dump (calling a nonexistent XPLINK function)
Handling dumps written to the z/OS UNIX file system

When a z/OS UNIX C/C++ application program is running in an address space created as a result of a call to spawn(), vfork(), or one of the exec family of functions, the SYSMDUMP DD allocation information is not inherited. Even though the SYSMDUMP allocation is not inherited, a SYSMDUMP allocation must exist in the parent in order to obtain a HFS storage dump.

Alternatively, you can specify the DYNDUMP runtime option to generate a system dump. For more information, see [z/OS Language Environment Programming Reference](#).

If the program terminates abnormally while running in this new address space, the kernel causes an unformatted storage dump to be written to an HFS file in the user's working directory. The file is placed in the current working directory or into /tmp if the current working directory is not defined. The file name has the following format; directory is the current working directory or tmp, and pid is the hexadecimal process ID (PID) for the process that terminated. For details on how to generate the system dump, see "Steps for generating a system dump in a z/OS UNIX shell" on page 85.

```
/directory/coredump.pid
```

To debug the dump, use the MVS Interactive Problem Control System (IPCS). If the dump was written to an HFS file, you must allocate a data set that is large enough and has the correct attributes for receiving a copy of the HFS file. For example, from the ISPF DATA SET UTILITY panel you can specify a volume serial and data set name to allocate. Doing so brings up the DATA SET INFORMATION panel for specifying characteristics of the data set to be allocated. The following filled-in panel shows the characteristics defined for the URCOMPJRUSL.COREDUMP dump data set:
Fill in the information for your data set as shown, and estimate the number of cylinders required for the dump file you are going to copy.

Use the TSO/E OGET or OCOPY command with the BINARY keyword to copy the file into the data set. For example, to copy the HFS storage dump file coredump.00060007 into the data set URCOMP.JRUSL.COREDUMP just allocated, a user with the user ID URCOMP enters the following command:

```
OGET '/u/urcomp/coredump.00060007' 'urcomp.jrusl.coredump' BINARY
```

For more information on using the copy commands, see z/OS UNIX System Services User’s Guide.

After you have copied the storage dump file to the data set, you can use IPCS to analyze the dump. See “Formatting and analyzing system dumps” on page 86 for information about formatting Language Environment control blocks.

**Multithreading consideration**

Certain control blocks are locked while a dump is in progress. For example, a csnap() of the file control block would prevent another thread from using or dumping the same information. An attempt to do so causes the second thread to wait until the first one completes before it can continue.

**Understanding C/C++ heap information in storage reports**

Storage reports that contain specific C/C++ heap information can be generated in two ways; details on how to request and interpret the reports are provided in the following sections.

- By setting the Language Environment RPTSTG(ON) runtime option for Language Environment created heaps
- By issuing a stand-alone call to the C function __uheapreport() for user-created heaps.
Language Environment storage report with heap pools statistics

To request a Language Environment storage report set RPTSTG(ON). If the C/C++ application specified the HEAPPOOLS(ON) runtime option, then the storage report displays heap pools statistics. Figure 4 on page 16 is a sample storage report that shows heap pools statistics for a multithreaded C/C++ application. The following sections describe the C/C++ specific heap pools information.

HEAPPOOLS storage statistics
The HEAPPOOLS runtime option controls usage of the heap pools storage algorithm at the enclave level. The heap pools algorithm allows for the definition of one to twelve heap pools, each consisting of a number of storage cells of a specified length.

Note: The use of an alternative Vendor Heap Manager (VHM) overrides the use of the HEAPPOOLS runtime option.

HEAPPOOLS statistics:
- Pool p size: ssss Get requests: gggg
  p the number of the pool. When there are multiple pools for a cell size, the pools are numbered using the format aa.bbb.
  aa the number for the cell size.
  bbb the number for the pool within the cell size.
  ssss the cell size specified for the pool.
  gggg the number of storage requests that were satisfied from this pool.
- Successful Get Heap requests: xxxx-yyyy n
  xxxx the low side of the 8 byte range
  yyyy the high side of the 8 byte range
  n the number of requests in the 8 byte range.
- Requests greater than the largest cell size — the number of storage requests that are not satisfied by heap pools.

Note: Values displayed in the HEAPPOOLS statistics report are not serialized when collected; therefore, the values are not necessarily exact.

HEAPPOOLS summary: The HEAPPOOLS summary displays a report of the HEAPPOOLS statistics and provides suggested percentages for current cell sizes as well as suggested cell sizes.
- Specified Cell Size — the size of the cell specified in the HEAPPOOLS runtime option
- Element Size — the size of the cell plus any additional storage needed for control information or to maintain alignment
- Extent Percent — the cell pool percent specified by the HEAPPOOLS runtime option
- Cells Per Extent — the number of cells per extent. This number is calculated using the following formula, with a minimum of four cells:
  \[ \text{Initial Heap Size} \times \left( \frac{\text{Extent Percent}}{100} \right) / \text{(Element Size)} \]
Note: Having a small number of cells per extent is not recommended since the pool could allocate many extents, which would cause the HEAPPOOLS algorithm to perform inefficiently.

- Extents Allocated — the number of times that each pool allocated an extent.
  
  To optimize storage usage, the extents allocated should be either one or two. If the number of extents allocated is too high, then increase the percentage for the pool.

- Maximum Cells Used — the maximum number of cells used for each pool.

- Cells In Use — the number of cells that were never freed.
  
  A large number in this field could indicate a storage leak.

- Suggested Percentages for current Cell Sizes — percentages calculated to find the optimal size of the cell pool extent. The calculation is based on the following formula:

\[
\frac{\text{Maximum Cells Used} \times (\text{Element Size}) \times 100}{\text{Initial Heap Size}}
\]

With a minimum of 1% and a maximum of 90%

Make sure that your cell pool extents are neither too large nor too small. If your percentages are too large then additional, unreferenced virtual storage will be allocated, thereby causing the program to exhaust the region size. If the percentages are too small then the HEAPPOOLS algorithm will run inefficiently.

- Suggested Cell Sizes — sizes that are calculated to optimally use storage (assuming that the application will \texttt{malloc}/\texttt{free} with the same frequency).

  The suggested cell sizes are given with no percentages because the usage of each new cell pool size is not known. If there are less than 12 cell sizes calculated and the last calculated cell size is smaller than the largest cell size currently in effect, the largest cell size currently in effect will be used for the last suggested cell size.

For more information about stack and heap storage, see \texttt{z/OS Language Environment Programming Guide}.

C function \texttt{__uheapreport()} storage report

To generate a user-created heap storage report use the C function, \texttt{__uheapreport()}. Use the information in the report to assist with tuning your application’s use of the user-created heap.

\texttt{Figure 85 on page 222} shows a sample storage report generated by \texttt{__uheapreport()}. For more information on the \texttt{__uheapreport()} function, see \texttt{z/OS XL C/C++ Runtime Library Reference}. For tuning tips, see \texttt{z/OS Language Environment Programming Guide}. 

Chapter 4. Debugging C/C++ routines 221
User-created HeapPools statistics

- Pool \( p \) size: \( ssss \)
  - \( p \) the number of the pool
  - \( ssss \) the cell size specified for the pool.
- Successful Get Heap requests: \( xxxx-yyyy \ n \)
  - \( xxxx \) the low side of the range
  - \( yyyy \) the high side of the range
  - \( n \) the number of requests in the range.
- Requests greater than the largest cell size — the number of storage requests that are not satisfied by heap pools.

Note: Values displayed in the HeapPools statistics report are not serialized when collected; therefore, the values are not necessarily exact.

HeapPools summary

The HeapPools summary displays a report of the HeapPool statistics and provides suggested percentages for current cell sizes as well as suggested cell sizes.

- Cell Size — the size of the cell specified on the \_ucreate() call
- Extent Percent — the cell pool percent specified on the \_ucreate() call
- Cells Per Extent — the number of cells per extent. This number is calculated using the following formula:

\[
\text{Initial Heap Size} \times (\text{Extent Percent}/100))/(8 \times \text{Cell Size})
\]

with a minimum of four cells.
• Extents Allocated — the number of times that each pool allocated an extent.
• Maximum Cells Used — the maximum number of cells used for each pool.
• Cells In Use — the number of cells that were never freed.

**Note:** A large number in this field could indicate a storage leak.

• Suggested Percentages for current Cell Sizes — percentages calculated to find the optimal size of the cell pool extent. The calculation is based on the following formula:

\[(\text{Maximum Cells Used} \times (\text{Cell Size} + 8) \times 100) / \text{Initial Heap Size}\]

With a minimum of 1% and a maximum of 90%

Make sure that your cell pool extents are neither too large nor too small. If your percentages are too large then additional, unreferenced virtual storage will be allocated, thereby causing the program to exhaust the region size. If the percentages are too small then the HeapPools algorithm will run inefficiently.

• Suggested Cell Sizes — sizes that are calculated to optimally use storage (assuming that the application will `__umalloc/__ufree` with the same frequency).

**Note:** The suggested cell sizes are given with no percentages because the usage of each new cell pool size is not known. If there are less than 12 cell sizes calculated and the last calculated cell size is smaller than the largest cell size currently in effect, the largest cell size currently in effect will be used for the last suggested cell size.

For more information about stack and heap storage, see [z/OS Language Environment Programming Guide](#).

**MEMCHECK VHM memory leak analysis tool**

The MEMCHECK VHM memory leak analysis tool is an alternative vendor heap manager used to diagnose memory problems. MEMCHECK VHM performs the following functions and displays the results in two reports:

• check for heap storage leaks, double free, and overlays
• trace user heap storage allocation and deallocation requests

**Restrictions**

• MEMCHECK VHM works with C/C++ and Enterprise PL/I applications, but is not enabled for COBOL or Fortran.
• MEMCHECK VHM and HEAPPOOLS are mutually exclusive. HEAPPOOLS will be ignored when MEMCHECK VHM is active.
• MEMCHECK VHM should not be used in PIPI, PICI, CICS, and SPC environments.

**Invoking MEMCHECK VHM**

As with any alternate vendor heap manager, you must specify the `dllname` with the environment variable `CEE_HEAP_MANAGER` to indicate that MEMCHECK VHM will be used to manage the user heap. Since `CEE_HEAP_MANAGER` must be set before any user code gains control, use the `ENVAR` runtime option to set the variable or set it inside the file specified by environment variables `CEE_ENVFILE` or `CEE_ENVFILE_S`. The format follows:
The following two DLLs are associated with MEMCHECK VHM and use the following events.

- CEL4MCHK: 31-bit base and XPLINK
- CELQMCHK: 64-bit

**_VHM_INIT**
- replaces C-RTL malloc(), calloc(), realloc(), and free() with the corresponding MEMCHECK VHM functions. This event is only at Language Environment Initialization and only called by Language Environment.

**_VHM_TERM**
- terminates Vendor Heap Manager to free the memcheck storage functions. This event is called only by Language Environment at Language Environment Termination.

**_VHM_REPORT**
- generates the Heap Leak Report and the optional Trace Report. This new event will be called by Language Environment at Language Environment Termination and will write the Heap Leak Report (and the optional Trace Report if the _CEE_MEMCHECK_TRACE environment variable is active) in the output file name specified in _CEE_MEMCHECK_OUTFILENAME. This event can also be called dynamically by the __vhm_event() API.

### MEMCHECK VHM environment variables

The MEMCHECK VHM environment variables control the tool, the call levels of the Heap Leak Report and Trace Report, the Overlay Analysis, the pad length added in the user heap allocation for overlay analysis, and the output file name for the reports. They should be activated through the ENVAR runtime option, the file specified by the _CEE_ENVFILE (or _CEE_ENVFILE_S) environment variable, or using the export command from the z/OS UNIX shell before any user code gets control (prior to the HLL user exit, static constructors, or main getting control).

Setting these environment variables after the user code has begun execution will not activate them and the default values will be used.

**_CEE_MEMCHECK_DEPTH**
- **Description:** Controls the number of call-levels to be generated on the Heap Leak Report.
- **Valid settings:** integer value : the minimum is 1 and the maximum is 100. If the value specified is not valid, the default will be used.
- **Default:** 10.

**_CEE_MEMCHECK_OVERLAY**
- **Description:** Activates the storage overlays analysis beyond the end of the malloc'd storage.
- **Valid settings:** ON to activate the analysis, OFF to deactivate. If an invalid value is specified, the default value will be used.
- **Default:** OFF

**_CEE_MEMCHECK_OVERLAYLEN**
- **Description:** Sets the pad length added in the user heap allocation for overlay analysis. This environment variable will be used only if _CEE_MEMCHECK_OVERLAY is active.
Valid settings: integer value, multiple of 8: the minimum is 8 and the
maximum is 80. Non-multiples of 8 will be rounded up to the next multiple.

Default: 8

_CEE_MEMCHECK_TRACE

Description: Enables tracing of all heap storage allocation and deallocation and
a Trace Report will be generated at Language Environment Termination.

Valid settings: ON to activate the analysis, OFF to deactivate. If an invalid
value is specified, the default value will be used.

Default: OFF

_CEE_MEMTRACE_DEPTH

Description: Controls the number of call-levels to be generated in the Trace
Report, on each call to a library function that deals with heap. This
environment variable will be used only if _CEE_MEMCHECK_TRACE is
active.

Valid settings: integer value: the minimum is 1 and the maximum is 100. If the
value specified is not valid, the default value will be used.

Default: 10

_CEE_MEMCHECK_OUTFILENAME

Description: Sets the name of the fully qualified path name of the file in which
the Heap Leak Report and Trace Report should be directed. The report name
could be any valid name used in C-RTL fopen() function, then it could also
generates the reports in a Data Set.

Valid settings: string value. If an invalid value is specified, the default value
will be used.

Default: standard error output

MEMCHECK VHM report sample scenario

In this example, the MEMCHECK VHM tool is used by specifying the environment
variables from the z/OS UNIX shell. The user specifies a depth of 8 call levels in
the Heap Leak Report and 8 call levels in the Trace Report for 31-bit.
1. Specifies the depth to trace on storage requests (written to the Heap Leak
Report):
   Export CEE_MEMCHECK_DEPTH=8
2. Activates the Trace Report option:
   Export CEE_MEMCHECK_TRACE=ON
3. Specifies the depth to trace on storage requests (written to the Trace Report):
   Export CEE_MEMTRACE_DEPTH=8
4. Activates the Overlay analysis option:
   Export CEE_MEMCHECK_OVERLAY=ON
5. Activates the tool with the 31-bit DLL (automatically generating the Heap Leak
Report):
   Export CEE_HEAP_MANAGER=CEL4MCHK

MEMCHECK VHM report examples

Both reports are written at Language Environment termination (_VHM_TERM
event). They are written in the output file name specified in
_CEE_MEMCHECK_OUTFILENAME and are consistent with the format of other
Language Environment reports.
The following trace report will be generated at Language Environment termination (_VHM_TERM event) if the _CEE_MEMCHECK_TRACE environment variable is active. The report generates the traceback information of all heap storage allocations and deallocations.

MEMCHECK
Language Environment V1 R7
TRACE REPORT for enclave main, termination report

DEALLOCATE of storage at 0x25a2e3a0
- sequence 12
  Called from: 25a43c78 +00000120 MemFree
  Called from: 05cd9918 +0000005c CEEPGTFN
  Called from: 257668b8 +000002b0 _cterm
  Called from: 05d46788 +0000040c (unknown)

DEALLOCATE of storage at 0x25a2ebc8
- sequence 11
  Called from: 25a43c78 +00000120 MemFree
  Called from: 05cd9918 +0000005c CEEPGTFN
  Called from: 257f6888 +000002b0 _cterm
  Called from: 05d46788 +0000040c (unknown)

DEALLOCATE of storage at 0x25a2ecf8
- sequence 10
  Called from: 25a43c78 +00000120 MemFree
  Called from: 05cd9918 +0000005c CEEPGTFN
  Called from: 257f6888 +000002b0 _cterm
  Called from: 05d46788 +0000040c (unknown)

ALLOCATE of storage at 0x25a2ebc8 for 5 bytes
- sequence 9
  Called from: 25a44330 +000000fc MemAlloc
  Called from: 05cd9918 +0000005c CEEPGTFN
  Called from: 25601c68 +000000ca function1
  Called from: 25601a60 +00000062 main

ALLOCATE of storage at 0x25a2ecf8 for 8 bytes
- sequence 8
  Called from: 25a44330 +000000fc MemAlloc
  Called from: 05cd9918 +0000005c CEEPGTFN
  Called from: 25601c68 +000000ca function1
  Called from: 25601a60 +00000062 main

DEALLOCATE of storage at 0x25a2e1f8 for 2074 bytes
- sequence 7
  Called from: 25a43c78 +00000120 MemFree
  Called from: 05cd9918 +0000005c CEEPGTFN
  Called from: 25601c68 +000000ca function1
  Called from: 25601a60 +00000062 main

ALLOCATE of storage at 0x25a2e1f8 for 48 bytes
- sequence 6
  Called from: 25a44330 +000000fc MemAlloc
  Called from: 05cd9918 +0000005c CEEPGTFN
  Called from: 25601c68 +000000ca function1
  Called from: 25601a60 +00000062 main

ALLOCATE of storage at 0x25a2e1f8 for 4 bytes
- sequence 5
  Called from: 25a44330 +000000fc MemAlloc
  Called from: 05cd9918 +0000005c CEEPGTFN
  Called from: 25601c68 +000000ca function1
  Called from: 25601a60 +00000062 main

ALLOCATE of storage at 0x25a2e1f90 for 48 bytes
- sequence 4
  Called from: 25a44330 +000000fc MemAlloc
  Called from: 05cd9918 +0000005c CEEPGTFN
  Called from: 25725c08 +000000a0 dlimit
  Called from: 05d49c88 +000007fc (unknown)

ALLOCATE of storage at 0x25a2e380 for 584 bytes
- sequence 3
  Called from: 25a44330 +000000fc MemAlloc
  Called from: 05cd9918 +0000005c CEEPGTFN
  Called from: 258c6d70 +00000186 setlocale
  Called from: 25862540 +0000059e tzset
  Called from: 2571e630 +000002f2 _cinit
  Called from: 05d4ab0 +00000cb4 (unknown)

ALLOCATE of storage at 0x25a2e1f8 for 2074 bytes
- sequence 2
The Heap Leak Report (Figure 86) will be generated with any remaining entries in the memory leak control block. The allocated entries will be reported as storage leaks, while the deallocated entries will be reported as duplicated deallocations and the overlay entries as overlay damage.

MEMCHECK
Language Environment V1 R7
HEAP LEAK REPORT for enclave main, termination report

Total number of ALLOCATE calls = 7
Total number of DEALLOCATE calls = 5

Current number of bytes allocated = 288928
Maximum number of bytes allocated = 289824

Total number of unmatched ALLOCATE calls = 3
Unmatched ALLOCATE of 8 bytes at address 0x25a2ecd8
- sequence 8
  Called from: 25a44330 +000000fc MemAlloc
  Called from: 05c9918 +0000005c CEEPGTFN
  Called from: 258c6958 +00000070 realloc_name_buffer
  Called from: 258c6d70 +0000132 setlocale
  Called from: 25825240 +000059e tzset
  Called from: 257f6d30 +00002df2 _cinit
  Called from: 05d4abb0 +00000cb4 (unknown)

Unmatched ALLOCATE of 48 bytes at address 0x25a2ec90
- sequence 4
  Called from: 25a44330 +000000fc MemAlloc
  Called from: 05c9918 +0000005c CEEPGTFN
  Called from: 25601bb8 +0000007e function2
  Called from: 25601c68 +00000132 setlocale
  Called from: 25862540 +0000059e tzset
  Called from: 257f6d30 +00002df2 _cinit
  Called from: 05d4abb0 +00000cb4 (unknown)

Unmatched ALLOCATE of 2074 bytes at address 0x25a2e2f0
- sequence 2
  Called from: 25a44330 +000000fc MemAlloc
  Called from: 05c9918 +0000005c CEEPGTFN
  Called from: 258c6958 +00000070 realloc_name_buffer
  Called from: 258c6d70 +00000132 setlocale
  Called from: 25825240 +0000059e tzset
  Called from: 257f6d30 +00002df2 _cinit
  Called from: 05d4abb0 +00000cb4 (unknown)

Total number of unmatched DEALLOCATE calls = 1
Unmatched DEALLOCATE at address 0x25a2e2db
- sequence 7
  Called from: 25a43c78 +000000f2 MemFree
  Called from: 05c9918 +0000005c CEEPGTFN
  Called from: 25601c68 +000000bc function1
  Called from: 25601a60 +00000062 main

Total number of OVERLAY calls = 1
OVERLAY damage using more than 5 bytes requested at address 0x25a2ecf0
  Called from: 25a44330 +000000fc MemAlloc
  Called from: 05c9918 +0000005c CEEPGTFN
  Called from: 25601a68 +00000084 function3
  Called from: 25601c68 +00000062 main

Figure 86. Heap Leak Report generated by MEMCHECK VHM
The following names are used within MEMCHECK to denote special cases and may be displayed in any of the reports:

(unknown)
Name of the routine is not known.

(noname)
Routine does not have a name in the PPA section. (For example, module compiled with compress option).

(nospace)
Internal memory space reserved by MEMCHECK is full, so name was not saved for the traceback information. No action is needed from the user.
Chapter 5. Debugging COBOL programs

This section provides information for debugging applications that contain one or more COBOL programs. It includes information about:

- Determining the source of error
- Generating COBOL listings and the Language Environment dump
- Finding COBOL information in a dump
- Debugging example COBOL programs

Determining the source of error

The following sections describe how you can determine the source of error in your COBOL program. They explain how to simplify the process of debugging COBOL programs by using features such as the DISPLAY statement, declaratives, and file status keys. The following methods for determining errors are covered:

- Tracing program logic
- Finding and handling input/output errors
- Validating data
- Assessing switch problems
- Generating information about procedures

After you have located and fixed any problems in your program, you should delete all debugging aids and recompile it before running it in production. Doing so helps the program run more efficiently and use less storage.

For detailed information about any of the topics and techniques discussed in the following sections, refer to the appropriate COBOL documentation in the Enterprise COBOL for z/OS library (http://www-01.ibm.com/support/docview.wss?uid=swg27036733).

Tracing program logic

You can add DISPLAY statements to help you trace through the logic of the program in a non-CICS environment. If, for example, you determine that the problem appears in an EVALUATE statement or in a set of nested IF statements, DISPLAY statements in each path tell you how the logic flows. You can also use DISPLAY statements to show you the value of interim results. Scope terminators can also help you trace the logic of your program because they clearly indicate the end of a statement.

For example, to check logic flow, you might insert the following statement to determine if you started and finished a particular procedure:

```
DISPLAY "ENTER CHECK PROCEDURE".
" (checking procedure routine)
DISPLAY "FINISHED CHECK PROCEDURE".
```

After you are sure that the program works correctly, comment out the DISPLAY statement lines by putting asterisks in position 7 of the appropriate lines.
Finding input/output errors

VSAM file status keys can help you determine whether routine errors are due to the logic of your routine or are I/O errors occurring on the storage media. To use file status keys as a debugging aid, include a test after each I/O statement to check for a value other than 0 in the file status key. If the value is other than 0, you can expect to receive an error message. You can use a nonzero value to indicate how the I/O procedures in the routine were coded. You can also include procedures to correct the error based on the file status key value.

Handling input/output errors

If you have determined that the problem lies in one of the I/O procedures in your program, you can include the USE EXCEPTION/ERROR declarative to help debug the problem. If the file does not open, the appropriate USE EXCEPTION/ERROR declarative is activated. You can specify the appropriate declarative for the file or for the different open attributes: INPUT, OUTPUT, I/O, or EXTEND. Code each USE AFTER STANDARD ERROR statement in a separate section immediately after the Declarative Section keyword of the Procedure Division.

Validating data (class test)

If you suspect that your program is trying to perform arithmetic on nonnumeric data or is somehow receiving the wrong type of data on an input record, you can use the class test to validate the type of data.

Assessing switch problems

Using INITIALIZE or SET statements to initialize a table or data item is useful when you suspect that a problem is caused by residual data left in those fields. If your problem occurs intermittently and not always with the same data, the problem could be that a switch is not initialized, but is generally set to the right value (0 or 1). By including a SET statement to ensure that the switch is initialized, you can determine if the uninitialized switch is the cause of the problem.

Generating information about procedures

You can use the USE FOR DEBUGGING declarative to include COBOL statements in a COBOL program and specify when they should run. Use these statements to generate information about your program and how it is running. Code each USE FOR DEBUGGING declarative in a separate section in the DECLARATIVES SECTION of the PROCEDURE DIVISION.

For example, to check how many times a procedure is run, include a special procedure for debugging (in the USE FOR DEBUGGING declarative) that adds 1 to a counter each time control passes to that procedure. The adding-to-a-counter technique can be used as a check for:

- How many times a PERFORM ran. This shows you whether the control flow you are using is correct.
- How many times a loop routine actually runs. This tells you whether the loop is running and whether the number you have used for the loop is accurate.

You can use debugging lines, debugging statements, or both in your program. Debugging lines are placed in your program, and are identified by a D in position 7. Debugging statements are coded in the DECLARATIVES SECTION of the PROCEDURE DIVISION.

- The USE FOR DEBUGGING declaratives must:
- Be only in the DECLARATIVES SECTION
- Follow a DECLARATIVES header USE FOR DEBUGGING

With USE FOR DEBUGGING, the TEST compiler option must have the NONE
hook-location suboption specified or the NOTEST compiler option must be
specified. The TEST compiler option and the DEBUG runtime option are
mutually exclusive, with DEBUG taking precedence.

- Debugging lines must have a D in position 7 to identify them.

To use debugging lines and statements in your declarative procedures, you must
include both:
- WITH DEBUGGING MODE in the SOURCE-COMPUTER paragraph in the
  ENVIRONMENT DIVISION
- The DEBUG runtime option

Figure 87 shows how to use the DISPLAY statement and the USE FOR
DEBUGGING declarative to debug a program.

Environment Division
Source Computer . . With Debugging Mode.
...
Data Division.
...
File Section.
Working-Storage Section.
*(among other entries you would need:)
  *(among other entries you would need:)
  01 Trace-Msg PIC X(30) Value " Trace for Procedure-Name : ".
  01 Total PIC 99 Value Zeros.
*(balance of Working-Storage Section)
Procedure Division.
Declaratives.
Debug-Decl Section.
  Use For Debugging On 501-Some-Routine.
Debug-Decl-Paragraph.
  Display Trace-Msg, Debug-Name, Total.
  Exit.
End Declaratives.
Begin-Program Section.
: Perform 501-Some-Routine.
  *(within the module where you want to test, place:)
  Add 1 To Total
  *(whether you put a period at the end depends on
  * where you put this statement.)

Figure 87. Example of using the WITH DEBUGGING MODE clause

In the example in Figure 87 portions of a program are shown to illustrate the kind
of statements needed to use the USE FOR DEBUGGING declarative. The DISPLAY
statement specified in the DECLARATIVES SECTION issues the following message
every time the PERFORM 501-SOME-ROUTINE runs. The total shown, \( nn \), is the value accumulated in the data item named TOTAL:

\[ \text{Trace For Procedure-Name : 501-Some-Routine } nn \]

Another use for the DISPLAY statement technique shown above is to show the flow through your program. You do this by changing the USE FOR DEBUGGING declarative in the DECLARATIVES SECTION to the following value and dropping the word TOTAL from the DISPLAY statement.

USE FOR DEBUGGING ON ALL PROCEDURES.

**Using COBOL listings**

When you are debugging, you can use one or more of the listings shown in Table 40. The following sections give an overview of each of these listings and the compiler option you use to obtain each listing.

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
<th>Compiler Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorted Cross-Reference</td>
<td>Provides sorted cross-reference listings of DATA DIVISION, PROCEDURE DIVISION, and program names. The listings provide the location of all references to this information.</td>
<td>XREF</td>
</tr>
<tr>
<td>Listings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Map listing</td>
<td>Provides information about the locations of all DATA DIVISION items and all implicitly declared variables. This option also supplies a nested program map, which indicates where the programs are defined and provides program attribute information.</td>
<td>MAP</td>
</tr>
<tr>
<td>Verb Cross-Reference listing</td>
<td>Produces an alphabetic listing of all the verbs in your program and indicates where each is referenced.</td>
<td>VBREF</td>
</tr>
<tr>
<td>Procedure Division listings</td>
<td>Tells the COBOL compiler to generate a listing of the PROCEDURE DIVISION along with the assembler coding produced by the compiler. The list output includes the assembler source code, a map of the task global table (TGT), information about the location and size of WORKING-STORAGE and control blocks, and information about the location of literals and code for dynamic storage usage.</td>
<td>LIST</td>
</tr>
<tr>
<td>Procedure Division listings</td>
<td>Instead of the full PROCEDURE DIVISION listing with assembler expansion information, you can use the OFFSET compiler option to get a condensed listing that provides information about the program verb usage, global tables, WORKING-STORAGE, and literals. The OFFSET option takes precedence over the LIST option. That is, OFFSET and LIST are mutually exclusive; if you specify both, only OFFSET takes effect.</td>
<td>OFFSET</td>
</tr>
</tbody>
</table>

**Generating a Language Environment dump of a COBOL program**

The sample programs shown in Figure 88 on page 233 and Figure 89 on page 234 generate Language Environment dumps with COBOL-specific information.

**COBOL program that calls another COBOL program**

In Figure 88 on page 233, program COBDUMP1 calls COBDUMP2, which in turn calls the Language Environment dump service CEE3DMP.
COBOL program that calls the Language Environment

CEE3DMP callable service

In the example in Figure 89 on page 234, program COBDUMP2 calls the Language Environment dump service CEE3DMP.
Sample Language Environment dump with COBOL-specific information

The call in program COBDUMP2 to CEE3DMP generates a Language Environment dump, shown below. The dump includes a traceback section, which shows the names of both programs, a section on register usage at the time the dump was generated, and a variables section, which shows the storage and data items for each program. Note that the high half of register 14 at entry to CEE3DMP is not available and is shown in the dump as ********. Character fields in the dump are indicated by single quotes. For an explanation of these sections of the dump, see “Finding COBOL information in a dump” on page 236.

```
Figure 89. COBOL program COBDUMP2 calling the Language Environment dump service CEE3DMP
```

```
CBL TEST(SYSM,SYM),IDENTIFICATION DIVISION.
  PROGRAM-ID. COBDUMP2.
  AUTHOR. USER NAME
ENVIRONMENT DIVISION.
  INPUT-OUTPUT SECTION.
  FILE-CONTROL.
  SELECT OPTIONAL IOFSS1 ASSIGN AS-ESDS1DD
    ORGANIZATION SEQUENTIAL ACCESS SEQUENTIAL.
DATA DIVISION.
  FILE SECTION.
  FD IOFSS1 GLOBAL.
    1 IOFSS1R PIC X(40).
  WORKING-STORAGE SECTION.
    01 TEMP4.
      05 A-1 OCCURS 2 TIMES.
      10 A-2 OCCURS 2 TIMES.
      15 A-3V PIC X(3).
      15 A-6 PIC X(3).
    27 DMPTITLE PIC X(80).
    27 OPTIONS PIC X(255).
    27 FC PIC X(12).
  LINKAGE SECTION.
    01 SALARY-RECORD.
      02 NAME PIC X(10).
      02 DEPT PIC 9(4).
      02 SALARY PIC 9(6).
PROCEDURE DIVISION USING SALARY-RECORD.
  START-SEC.
    DISPLAY "STARTING TEST COBDUMP2"
    MOVE "COBOL DUMP" TO DMPTITLE.
    MOVE "XXX" TO A-6(1, 1).
    MOVE "YYY" TO A-6(1, 2).
    MOVE "ZZZ" TO A-6(2, 1).
    MOVE " BLOCKS STORAGE PAGE(55) FILES" TO OPTIONS.
    CALL "CEE3DMP" USING DMPTITLE, OPTIONS, FC.
    DISPLAY "END OF TEST COBDUMP2"
  GOBACK.
END PROGRAM COBDUMP2.
```
Information for enclave COBDMPI

Information for thread 10000000000000000

Parameters, Registers, and Variables for Active Routines:

Traceback:

GPR0......=11480BDC GPR1......=114841D0 GPR2......=11484030 GPR3......=11200398 GPR4......=11200398 GPR5......=20070214 GPR6......=COBOL

GPR8......=114841D0 GPR9......=11480AA0 GPR10.....=11202908 GPR11.....=11202AD4 GPR12....=112129C0 GPR13....=114841D0 GPR14....=91202C78 GPR15....=912EF898

GPR0......=11200398 GPR1......=114842C0 GPR2......=114A4340 GPR3......=11202BBC

Local Variables:

FILE SPECIES as OPTIONAL, ORGANIZATION-VSAM SEQUENTIAL, ACCESS MODE-SEQUENTIAL, RECNO-FIXED. CURRENT STATUS OF FILE IS: NOT OPEN, FILE STATUS CODE=00, VSAM FEEDBACK=000, VSAM DET HD=000, VSAM FUNCTION CODE=000.

Chapter 5. Debugging COBOL programs
Finding COBOL information in a dump

Like the standard Language Environment dump format, dumps generated from COBOL programs contain:

- Control block information for active programs
- Storage for each active program
- Enclave-level data
- Process-level data

Control block information for active routines

The Control Blocks for Active Routines section of the dump, shown in Figure 90, displays the following information for each active COBOL program:

- DSA
- Program name and date/time of compile
- COBOL compiler Version, Release, Modification, and User Level
- COBOL compile Options
- COBOL control blocks TGT and CLLE. The layout of the TGT can be found by looking at the compiler listing of the COBOL program. For Enterprise COBOL V5.1 and later releases, the TGT is replaced by COBDSACB. The CLLE is a COBOL control block that is allocated by the COBOL runtime for each program. The CLLE is dumped for IBM service personnel use.

Figure 90. Control block information for active COBOL routines
Storage for each active routine

The Storage for Active Routines section of the dump, shown in "Storage for active COBOL programs," displays the following information for each COBOL program:

- Program name
- Contents of the base locators for files, WORKING-STORAGE, LINKAGE SECTION, LOCAL-STORAGE SECTION, variably-located areas, and EXTERNAL data.
- File record contents.
- WORKING-STORAGE, including the base locator for WORKING-STORAGE (BLW) and program class storage.

Storage for active COBOL programs:
Enclave-level data

The Enclave Control Blocks section of the dump, shown in Figure 91 on page 239, displays the following information:

- RUNCOM control block. The RUNCOM is a control block that is allocated by the COBOL runtime to anchor enclave level resources. The RUNCOM is dumped for IBM service personnel use.

  Note: In Enterprise COBOL V5.1 and later releases, the RUNCOM control block is replaced by the COBEDB control block.

- Storage for all run units

  - COBOL control blocks FCB, FIB, and GMAREA. The FCB, FIB, and GMAREA are control blocks used for COBOL file processing. These control blocks are dumped for IBM service personnel use.
**Enclave Control Blocks:**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUNCMD</td>
<td>11480100</td>
</tr>
</tbody>
</table>

**Enclave Storage:**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial (User) Heap</td>
<td>1144018</td>
</tr>
<tr>
<td>LE/370 Anywhere Heap</td>
<td>1148000</td>
</tr>
</tbody>
</table>

**File Control Blocks:**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIB for file ES510D in program COBDUMP2: 11480100</td>
<td>1148050</td>
</tr>
</tbody>
</table>

---

**Figure 91. Enclave-level data for COBOL programs**
Process-level data

The Process Control Block section of the dump, shown in Figure 92, displays COBOL process-level control blocks THDCOM, COBCOM, COBVEC, and ITBLK. For Enterprise COBOL V5.1 and later releases, the process-level control blocks are COBPCB (corresponds to THDCOM), COBRCB (corresponds to COBCOM) and LIBVEC (corresponds to COBVEC). The control blocks are dumped for IBM service personnel use. In a non-CICS environment, the ITBLK control block only appears when a VS COBOL II program is active. In a CICS environment, the ITBLK control block always appears.

Debugging example COBOL programs

The following examples help demonstrate techniques for debugging COBOL programs. Important areas of the dump output are highlighted. Data unnecessary to debugging has been replaced by vertical ellipses.

Subscript range error

Figure 93 on page 241 illustrates the error of using a subscript value outside the range of an array. This program was compiled with LIST, TEST, and SSRANGE. The SSRANGE compiler option causes the compiler to generate code that checks (during run time) for data that has been stored or referenced outside of its defined area because of incorrect indexing and subscrupting. The SSRANGE option takes effect during run time. For COBOL V4R2 and prior releases, you can disable the check by specifying the CHECK(OFF) runtime option. For Enterprise COBOL V5.1 and later releases, the CHECK runtime option is ignored.

The program was run with TERMTHDACT(TRACE) to generate the traceback information shown in "Sections of Language Environment dump for COBOLX" on page 241.
To understand the traceback information and debug this program, use the following steps:

1. Locate the current error message in the Condition Information for Active Routines section of the Language Environment traceback, shown in "Sections of Language Environment dump for COBOLX." The message is IGZ006S The reference to table SLOT by verb number 01 on line 000011 addressed an area outside the region of the table. The message indicates that line 11 was the current COBOL statement when the error occurred. For more information about this message, see z/OS Language Environment Runtime Messages.

   Statement 11 in the traceback section of the dump occurred in program COBOLX.

3. Find the statement on line 11 in the listing for program COBOLX, shown in Figure 94. This statement moves the 1 value to the array SLOT (J).

        Move 9 to J.
        Move 1 to SLOT (J).
        GOBACK.

4. Find the values of the local variables in the Parameters, Registers, and Variables for Active Routines section of the traceback, shown in "Sections of Language Environment dump for COBOLX." J, which is of type PIC 9(4) with usage COMP, has a 9 value. J is the index to the array SLOT.

   The array SLOT contains eight positions. When the program tries to move a value into the J or 9th element of the 8-element array named SLOT, the error of moving a value outside the area of the array occurs.
Calling a nonexistent subroutine

Figure 95 on page 243 demonstrates the error of calling a nonexistent subroutine in a COBOL program. In this example, the program COBOLY was compiled with the compiler options LIST, MAP and XREF. The TEST option was also specified with the suboptions NONE and SYM. Figure 95 on page 243 shows the program.
To understand the traceback information and debug this program, use the following steps:

1. Locate the error message for the original condition under the Condition Information for Active Routines section of the dump, shown in Figure 96 on page 244. The message is CEE3501S The module UNKNOWN was not found. For more information about this message, see z/OS Language Environment Messages.

2. Note the sequence of calls in the Traceback section of the dump. COBOL called IGZCFCC; IGZCFCC (a COBOL library subroutine used for dynamic calls) called IGZCLDL; then IGZCLDL (a COBOL library subroutine used to load library routines) called CEESGLT, a Language Environment condition handling routine.

This sequence indicates that the exception occurred in IGZCLDL when COBOL was attempting to make a dynamic call. The call statement in COBOL is located at offset +0000036E.

Note: If COBOL is compiled with Enterprise COBOL V5.1 or later releases, the traceback section of Language Environment dump is shown in Figure 97 on page 244. The only difference is that IGZCFCC and IGZCLDL are combined and replaced by IGZXFC1A. (IGZXFC1A attempts to load a non-existent routine.)
3. Use the offset of X'36E' from the COBOL listing, shown below, to locate the statement that caused the exception in the COBOLY program. At offset X'36E' is an instruction for statement 8. Statement 8 is a call with the identifier SUBNAME specified.

<table>
<thead>
<tr>
<th>DSA Addr</th>
<th>E Addr</th>
<th>PU Addr</th>
<th>PU Offset</th>
<th>Comp Date</th>
<th>Compile Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2605E628</td>
<td>25D6E658</td>
<td>25D6E658</td>
<td>+00004220</td>
<td>20110318</td>
<td>CEL</td>
</tr>
<tr>
<td>2605E490</td>
<td>25D9F9578</td>
<td>25D9F9578</td>
<td>+00000060</td>
<td>20110318</td>
<td>CEL</td>
</tr>
<tr>
<td>2605E240</td>
<td>25F648CD</td>
<td>25F648CD</td>
<td>+00000930</td>
<td>20130605</td>
<td>LIBRARY</td>
</tr>
<tr>
<td>2605E303</td>
<td>25D000000</td>
<td>25D000000</td>
<td>+00000100</td>
<td>20130607</td>
<td>COBOLV5+ EBCDIC HFP</td>
</tr>
</tbody>
</table>

Figure 97. Portion of traceback of Language Environment dump for COBOLY (when compiled with Enterprise COBOL V5.1 or later)
4. Find the value of the local variables in the Parameters, Registers, and Variables for Active Routines section of the dump, shown in Figure 98. Notice that the value of SUBNAME with usage DISP, has a value of 'UNKNOWN'. Correct the problem by either changing the subroutine name to one that is defined, or by ensuring that the subroutine is available at compile time.

Figure 98. Parameters, registers, and variables for active routines section of dump for COBOLY

**Divide-by-zero error**

The following example demonstrates the error of calling an assembler routine that tries to divide by zero. Both programs were compiled with TEST(STMT,SYM) and run with the TERMTHDACT(TRACE) runtime option. Figure 99 on page 247 shows the main COBOL program (COBOLZ1), the COBOL subroutine (COBOLZ2), and the assembler routine.
To debug this application, use the following steps:

1. Locate the error message for the current condition in the Condition Information section of the dump, shown in “Sections of Language Environment dump for program COBOLZ1” on page 249. The message is CEE3209S The system detected a fixed-point divide exception (System Completion Code=0C9).

For additional information about this message, see z/OS Language Environment Runtime Messages.

2. Note the sequence of calls in the call chain. COBOLZ1 called IGZCFCC, which is a COBOL library subroutine used for dynamic calls; IGZCFCC called COBOLZ2; COBOLZ2 then called IGZCFCC; and IGZCFCC called ASSEMZ3. The exception occurred at this point, resulting in a call to CEEHDSP, a Language Environment condition handling routine.

The call to ASSEMZ3 occurred at statement 11 of COBOLZ2. The exception occurred at offset +64 in ASSEMZ3.
3. Locate statement 11 in the COBOL listing for the COBOLZ2 program, shown in Figure 100. This is a call to the assembler routine ASSEMZ3.

4. Check offset +64 in the listing for the assembler routine ASSEMZ3, shown in Figure 101.

   This shows an instruction to divide the contents of register 4 by the variable pointed to by register 6. You can see the two instructions preceding the divide instruction load register 6 from the first word pointed to by register 1 and prepare register 6 for the divide. Because of linkage conventions, you can infer that register 1 contains a pointer to a parameter list that passed to ASSEMZ3. Register 6 points to a 0 value because that was the value passed to ASSEMZ3 when it was called by a higher level routine.

5. Check local variables for COBOLZ2 in the Local Variables section of the dump shown in Figure 102 on page 249. From the dump and listings, you know that
COBOLZ2 called ASSEMZ3 and passed a parameter in the variable DV-VAL. The two variables DV-VAL and D-VAL have 0 values.

6. In the COBOLZ2 subroutine, the variable D-VAL is moved to DV-VAL, the parameter passed to the assembler routine. D-VAL appears in the Linkage section of the COBOLZ2 listing, shown in Figure 103, indicating that the value did pass from COBOLZ1 to COBOLZ2.

7. In the Local Variables section of the dump for program COBOLZ1, shown in Figure 104, D-VAL has a 0 value. This indicates that the error causing a fixed-point divide exception in ASSEMZ3 was actually caused by the value of D-VAL in COBOLZ1.
Condition Information for ASSEMZ3 (DSA address 1147E750)

CIB Address: 1147F0F0

Current Condition:
CEE3209S The system detected a fixed-point divide exception (System Completion Code=0C9).

Location:
Program Unit: ASSEMZ3
Entry: ASSEMZ3
Statement: Offset: +00000064

Machine State:
ILC..... 0004
Interception Code..... 0009

PSW..... 078D0000 9120E4B0
GPR0..... 00000000_1147E7D0 GPR1..... 00000000_1147E4B8 GPR2..... 00000000_1147AE54 GPR3..... 00000000_000212E8
GPR4..... 00000000_00000000 GPR5..... 00000000_0000092C GPR6..... 00000000_000213A8 GPR7..... 00000000_1147E4B8
GPR8..... 00000000_00000002 GPR9..... 00000000_000211B0 GPR10.... 00000000_1147A100 GPR11.... 00000000_9120E448
GPR12.... 00000000_1120C9C0 GPR13.... 1147E3C0 GPR14.... 8001F5C6 GPR15.... 9140A5F8

Storage dump near condition, beginning at location: 1120E49C

Parameters, Registers, and Variables for Active Routines:

COBOLZ2 (DSA address 1147E3C0):
UPSTACK DSA
Saved Registers:
GPR0..... 1147E570 GPR1..... 1147E4C0 GPR2..... 000197FC GPR3..... 000212E8
GPR4..... 1147E128 GPR5..... 1120B778 GPR6..... 00000000 GPR7..... 00000000
GPR8..... 0000A3A8 GPR9..... 0000A1B0 GPR10.... 000084D8 GPR11.... 000085F4
GPR12.... 000084CC GPR13.... 1147E030 GPR14.... 80008660 GPR15.... 9140A5F8

GPREG STORAGE:
Storage around GPR0 (1147E570)
-0020 1147E1C0 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 |................................|
+0000 1147E1E0 00102401 1147E030 1147E3C0 9140A8C4 0001F320 1147E3C0 1147E128 000197FC |..........T.j yD..3...T.......p.|
+0020 1147E200 0000A2E4 1147E130 0000A2E4 1147AF0D 1147E030 000212E8 1147E030 1147E128 |..sU......sU....................|...

COBOLZ1 (DSA address 1147E030):
UPSTACK DSA
Saved Registers:
GPR0..... 1147E1E0 GPR1..... 1147E130 GPR2..... 000197FC GPR3..... 000212E8
GPR4..... 1147E128 GPR5..... 1120B778 GPR6..... 00000000 GPR7..... 00000000
GPR8..... 0000A3A8 GPR9..... 0000A1B0 GPR10.... 000084D8 GPR11.... 000085F4
GPR12.... 000084CC GPR13.... 1147E030 GPR14.... 80008660 GPR15.... 9140A5F8

GPREG STORAGE:
Storage around GPR0 (1147E1E0)
-0020 1147E1E0 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 |................................|
+0000 1147E1E0 00102401 1147E030 1147E3C0 9140A8C4 0001F320 1147E3C0 1147E128 000197FC |..........T.j yD..3...T.......p.|
+0020 1147E200 0000A2E4 1147E130 0000A2E4 1147AF0D 1147E030 000212E8 1147E030 1147E128 |..sU......sU....................|...

Local Variables:
6 77 DV-VAL 9999 COMP 00000
8 77 D-VAL 9999 COMP 00000

COBOLZ2 (DSA address 1147E200):
UPSTACK DSA
Saved Registers:
GPR0..... 1147E200 GPR1..... 1147E130 GPR2..... 000197FC GPR3..... 000212E8
GPR4..... 1147E128 GPR5..... 1120B778 GPR6..... 00000000 GPR7..... 00000000
GPR8..... 0000A3A8 GPR9..... 0000A1B0 GPR10.... 000084D8 GPR11.... 000085F4
GPR12.... 000084CC GPR13.... 1147E030 GPR14.... 80008660 GPR15.... 9140A5F8

GPREG STORAGE:
Storage around GPR0 (1147E200)
-0020 1147E200 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 |................................|
+0000 1147E200 00102401 1147E030 1147E3C0 9140A8C4 0001F320 1147E3C0 1147E128 000197FC |..........T.j yD..3...T.......p.|
+0020 1147E200 0000A2E4 1147E130 0000A2E4 1147AF0D 1147E030 000212E8 1147E030 1147E128 |..sU......sU....................|...

Local Variables:
6 77 D-VAL 9999 COMP 00000
Chapter 6. Debugging Fortran routines

This section provides information to help you debug applications that contain one or more Fortran routines. It includes the following topics:

- Determining the source of errors in Fortran routines
- Using Fortran compiler listings
- Generating a Language Environment dump of a Fortran routine
- Finding Fortran information in a dump
- Examples of debugging Fortran routines

Determining the source of errors in Fortran routines

Most errors in Fortran routines can be identified by the information provided in Fortran runtime messages, which begin with the prefix “FOR”. The Fortran compiler cannot identify all possible errors. The following list identifies several errors not detected by the compiler that could potentially result in problems:

- Failing to assign values to variables and arrays before using them in your program.
- Specifying subscript values that are not within the bounds of an array. If you assign data outside the array bounds, you can inadvertently destroy data and instructions.
- Moving data into an item that is too small for it, resulting in truncation.
- Making invalid data references to EQUIVALENCE items of differing types (for example, integer or real).
- Transferring control into the range of a DO loop from outside the range of the loop. The compiler issues a warning message for all such branches if you specify OPT(2), OPT(3), or VECTOR.
- Using arithmetic variables and constants that are too small to give the precision you need in the result. For example, to obtain more than 6 decimal digits in floating-point results, you must use double precision.
- Concatenating character strings in such a way that overlap can occur.
- Trying to access services that are not available in the operating system or hardware.
- Failing to resolve name conflicts between Fortran and C library routines using the procedures described in the z/OS Language Environment Programming Guide.

Identifying runtime errors

Fortran has several features that help you find runtime errors. Fortran runtime messages are discussed in the z/OS Language Environment Runtime Messages. Other debugging aids include the optional traceback map, program interruption messages, abnormal termination dumps, and operator messages.

- The optional traceback map helps you identify where errors occurred while running your application. The TERMTHDACT(TRACE) runtime option, which is set by default under Language Environment, generates a dump containing the traceback map.

You can also get a traceback map at any point in your routine by invoking the ERRTRA subroutine.
Program interruption messages are generated whenever the program is interrupted during execution. Program interruption messages are written to the Language Environment message file.

The program interruption message indicates the exception that caused the termination; the completion code from the system indicates the specification or operation exception resulting in termination.

Program interruptions causing an abnormal termination produce a dump, which displays the completion code and the contents of registers and system control fields.

To display the contents of main storage as well, you must request an abnormal termination (ABEND) dump by including a SYSUDUMP DD statement in the appropriate job step. The following example shows how the statement can be specified for IBM-supplied cataloged procedures:

```
//GO.SYSUDUMP DD SYSOUT=A
```

You can request various dumps by invoking any of several dump service routines while your program runs. These dump service routines are discussed in "Generating a Language Environment dump of a Fortran routine" on page 253.

Operator messages are displayed when your program issues a PAUSE or STOP statement. These messages help you understand how far execution has progressed before reaching the PAUSE or STOP statement.

The operator message can take the following forms:

- **n**  
  String of 1–5 decimal digits you specified in the PAUSE or STOP statement. For the STOP statement, this number is placed in R15.

- **'message'**  
  Character constant you specified in the PAUSE or STOP statement.

- **0**  
  Printed when a PAUSE statement containing no characters is executed (not printed for a STOP statement).

A PAUSE message causes the program to stop running pending an operator response. The format of the operator’s response to the message depends on the system being used.

Under Language Environment, error messages produced by Language Environment and Fortran are written to a common message file. Its ddname is specified in the MSGFILE runtime option. The default ddname is SYSOUT. Fortran information directed to the message file includes:

- Error messages resulting from unhandled conditions
- Printed output from any of the dump services (SDUMP, DUMP/PDUMP, CDUMP/CPDUMP)
- Output produced by a WRITE statement with a unit identifier having the same value as the Fortran error message unit
- Output produced by a WRITE statement with * given as the unit identifier (assuming the Fortran error message unit and standard print unit are the same unit)
- Output produced by the PRINT statement (assuming the Fortran error message unit and the standard print unit are the same unit)

For more information about handling message output using the Language Environment MSGFILE runtime option, see z/OS Language Environment Programming Guide.
Using Fortran compiler listings

Fortran listings provide you with:
- The date of compilation including information about the compiler
- A listing of your source program
- Diagnostic messages telling you of errors in the source program
- Informative messages telling you the status of the compilation

Table 41 lists the contents of the various compiler-generated listings that you might find helpful when you use information in dumps to debug Fortran programs.

Table 41. Compiler-generated Fortran listings and their contents

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
<th>Compiler Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic message listing</td>
<td>Error messages detected during compilation.</td>
<td>FLAG</td>
</tr>
<tr>
<td>Source program</td>
<td>Source program statements.</td>
<td>SOURCE</td>
</tr>
<tr>
<td>Source program</td>
<td>Source program statements and error messages.</td>
<td>SRCFLG</td>
</tr>
<tr>
<td>Storage map and cross reference</td>
<td>Variable use, statement function, subroutine, or intrinsic function within a program.</td>
<td>MAP and XREF</td>
</tr>
<tr>
<td>Cross reference</td>
<td>Cross reference of names with attributes.</td>
<td>XREF</td>
</tr>
<tr>
<td>Source program map</td>
<td>Offsets of automatic and static internal variables (from their defining base).</td>
<td>MAP</td>
</tr>
<tr>
<td>Object code</td>
<td>Contents of the program control section in hexadecimal notation and translated into a pseudo-assembler format. To limit the size of the object code listing, specify the statement or range of statements to be listed; for example, LIST(20) or LIST(10,30).</td>
<td>LIST</td>
</tr>
<tr>
<td>Variable map, object code, static storage</td>
<td>Same as MAP and LIST options above, plus contents of static internal and static external control sections in hexadecimal notation with comments.</td>
<td>MAP and LIST</td>
</tr>
<tr>
<td>Symbolic dump</td>
<td>Internal statement numbers, sequence numbers, and symbol (variable) information.</td>
<td>SDUMP</td>
</tr>
</tbody>
</table>

Generating a Language Environment dump of a Fortran routine

To generate a dump containing Fortran information, call either DUMP/PDUMP, CDUMP/CPDUMP, or SDUMP. DUMP/PDUMP and CDUMP/CPDUMP produce output that is unchanged from the output generated under Fortran. Under Language Environment, however, the output is directed to the message file.

When SDUMP is invoked, the output is also directed to the Language Environment message file. The dump format differs from other Fortran dumps, however, reflecting a common format shared by the various HLLs under Language Environment.

You cannot make a direct call to CEE3DMP from a Fortran program. It is possible to call CEE3DMP through an assembler routine called by your Fortran program. Fortran programs are currently restricted from directly invoking Language Environment callable services.
DUMP/PDUMP
Provides a dump of a specified area of storage.

CDUMP/CPDUMP
Provides a dump of a specified area of storage in character format.

SDUMP
Provides a dump of all variables in a program unit.

DUMP/PDUMP subroutines
The DUMP/PDUMP subroutine dynamically dumps a specified area of storage to the system output data set. When you use DUMP, the processing stops after the dump; when you use PDUMP, the processing continues after the dump.

Syntax
CALL {DUMP | PDUMP} (a1, b1,k1, a2,b2, k2,...)

a and b
Variables in the program unit. Each indicates an area of storage to be dumped. Either a or b can represent the upper or lower limit of the storage area.

k
The dump format to be used. The values that can be specified for k, and the resulting dump formats, are:

<table>
<thead>
<tr>
<th>Value</th>
<th>Format Requested</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Hexadecimal</td>
</tr>
<tr>
<td>1</td>
<td>LOGICAL*1</td>
</tr>
<tr>
<td>2</td>
<td>LOGICAL*4</td>
</tr>
<tr>
<td>3</td>
<td>INTEGER*2</td>
</tr>
<tr>
<td>4</td>
<td>INTEGER*4</td>
</tr>
<tr>
<td>5</td>
<td>REAL*4</td>
</tr>
<tr>
<td>6</td>
<td>REAL*8</td>
</tr>
<tr>
<td>7</td>
<td>COMPLEX*8</td>
</tr>
<tr>
<td>8</td>
<td>COMPLEX*16</td>
</tr>
<tr>
<td>9</td>
<td>CHARACTER</td>
</tr>
<tr>
<td>10</td>
<td>REAL*16</td>
</tr>
<tr>
<td>11</td>
<td>COMPLEX*32</td>
</tr>
<tr>
<td>12</td>
<td>UNSIGNED*1</td>
</tr>
<tr>
<td>13</td>
<td>INTEGER*1</td>
</tr>
<tr>
<td>14</td>
<td>LOGICAL*2</td>
</tr>
<tr>
<td>15</td>
<td>INTEGER*8</td>
</tr>
<tr>
<td>16</td>
<td>LOGICAL*8</td>
</tr>
</tbody>
</table>

Usage considerations for DUMP/PDUMP
A load module or phase can occupy a different area of storage each time it is executed. To ensure that the appropriate areas of storage are dumped, the following conventions should be observed.

If an array and a variable are to be dumped at the same time, a separate set of arguments should be used for the array and for the variable. The specification of limits for the array should be from the first element in the array to the last element. For example, assume that A is a variable in common, B is a real number, and TABLE is an array of 20 elements. The following call to the storage dump routine could be used to dump TABLE and B in hexadecimal format, and stop the program after the dump is taken.

CALL DUMP(TABLE(1), TABLE(20), 0, B, B, 0)
If an area of storage in common is to be dumped at the same time as an area of storage not in common, the arguments for the area in common should be given separately. For example, the following call to the storage dump routine could be used to dump the variables A and B in REAL*8 format without stopping the program.

```fortran
CALL PDUMP(A,A,6,B,B,6)
```

If variables not in common are to be dumped, each variable must be listed separately in the argument list. For example, if R, P, and Q are defined implicitly in the program, the following statement should be used to dump the three variables in REAL*4 format.

```fortran
CALL PDUMP(R,R,5,P,P,5,Q,Q,5)
```

If the following statement is used, all main storage between R and Q is dumped, which might or might not include P, and could include other variables.

```fortran
CALL PDUMP(R,Q,5)
```

CDUMP/CPDUMP subroutines

The CDUMP/CPDUMP subroutine dynamically dumps a specified area of storage containing character data. When you use CDUMP, the processing stops after the dump; when you use CPDUMP, the processing continues after the dump.

**Syntax**

```
CALL {CDUMP | CPDUMP} (a1, b1, a2, b2,...)
```

- **a** and **b** Variables in the program unit. Each indicates an area of storage to be dumped.

  Either a or b can represent the upper or lower limit of each storage area.

The dump is always produced in character format. A dump format type (unlike for DUMP/PDUMP) must not be specified.

**Usage considerations for CDUMP/CPDUMP**

A load module can occupy a different area of storage each time it is executed. To ensure that the appropriate areas of storage are dumped, the following conventions should be observed.

If an array and a variable are to be dumped at the same time, a separate set of arguments should be used for the array and for the variable. The specification of limits for the array should be from the first element in the array to the last element. For example, assume that B is a character variable and TABLE is a character array of 20 elements. The following call to the storage dump routine could be used to dump TABLE and B in character format, and stop the program after the dump is taken.

```fortran
CALL CDUMP(TABLE(1), TABLE(20), B, B)
```

SDUMP subroutine

The SDUMP subroutine provides a symbolic dump that is displayed in a format dictated by variable type as coded or defaulted in your source. Data is dumped to the error message unit. The symbolic dump is created by program request, on a program unit basis, using CALL SDUMP. Variables can be dumped automatically after abnormal termination using the compiler option SDUMP. For more information on the SDUMP compiler option, see VS FORTRAN Version 2 Programming Guide for CMS and MVS.
Items displayed are:

- All referenced, local, named, and saved variables in their Fortran-defined data representation
- All variables contained in a static common area (blank or named) in their Fortran-defined data representation
- All variables contained in a dynamic common area in their Fortran-defined data representation
- Nonzero or nonblank character array elements only
- Array elements with their correct indexes

The amount of output produced can be very large, especially if your program has large arrays, or large arrays in common blocks. For such programs, you might want to avoid calling SDUMP.

Syntax

CALL SDUMP [(rtn1,rtn2,...)]

\(rtn1, rtn2, \ldots\)

Names of other program units from which data will be dumped. These names must be listed in an EXTERNAL statement.

Usage considerations for SDUMP

- To obtain symbolic dump information and location of error information, compilation must be done either with the SDUMP option or with the TEST option.
- Calling SDUMP and specifying program units that have not been entered gives unpredictable results.
- Calling SDUMP with no parameters produces the symbolic dump for the current program unit.
- An EXTERNAL statement must be used to identify the names being passed to SDUMP as external routine names.
- At higher levels of optimization (1, 2, or 3), the symbolic dump could show incorrect values for some variables because of compiler optimization techniques.
- Values for uninitialized variables are unpredictable. Arguments in uncalled subprograms or in subprograms with argument lists shorter than the maximum can cause the SDUMP subroutine to fail.
- The display of data can also be invoked automatically. If the runtime option TERMTHDACT(DUMP) is in effect and your program abends in a program unit compiled with the SDUMP option or with the TEST option, all data in that program unit is automatically dumped. All data in any program unit in the save area traceback chain compiled with the SDUMP option or with the TEST option is also dumped. Data occurring in a common block is dumped at each occurrence, because the data definition in each program unit could be different.

Examples of calling SDUMP from the main program and from a subprogram follow. Figure 105 on page 257 shows a sample program calling SDUMP and Figure 107 on page 258 shows the resulting output that is generated. In the main program, the following statement

```
EXTERNAL PGM1, PGM2, PGM3
```

makes the address of subprograms PGM1, PGM2, and PGM3 available for a call to SDUMP, as follows:
CALL SDUMP (PGM1, PGM2, PGM3)

This causes variables in PGM1, PGM2, and PGM3 to be printed.

In the subprogram PGM1, the following statement makes PGM2 and PGM3 available. (PGM1 is missing because the call is in PGM1.)

EXTERNAL PGM2, PGM3

The following statements dump the variables PGM1, PGM2, and PGM3.

CALL SDUMP
CALL SDUMP (PGM2, PGM3)

OPTIONS IN EFFECT: LIST NOMAP NOGOSTMT NODECK SOURCE TERM OBJECT FIXED TRMFLG SRCFLG NODDIM NORENT SDUMP(ISN)
NOSYM NOVECTOR IL(DIM) NOTEST SC(*) NODC NOEC NOEMODE NOICA NODIRECTIVE NODBCS NOSAA NOPARALLEL NODYNAMIC NOSYM
NOREORDER NOPC
OPT(I) LANGlvl(77) NOFIPS FLAG(I) HALT(S) AUTODBL(NONE) PTRSIZE(8) LINECOUNT(60) CHARLEN(500) NAME(MAIN#)

Figure 105. Example program that calls SDUMP
Figure 107 shows the resulting output generated by the example in Figure 105 on page 257.

Finding Fortran information in a Language Environment dump

To locate Fortran-specific information in a Language Environment dump, you must understand how to use the traceback section and the section in the symbol table dump showing parameters and variables. Figure 108 on page 259 shows an example of a Fortran dump; Table 42 on page 259 provides additional information.
about each section within the dump.

Table 42 describes the sections shown in the sample dump in Figure 108.

Table 42. Understanding the Language Environment traceback table

<table>
<thead>
<tr>
<th>Section</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>The traceback section of the dump contains condition information about your routine and information about the statement number and address where the exception occurred. The traceback section helps you locate where an error occurred in your program. The information in this section begins with the most recent program unit and ends with the first program unit.</td>
</tr>
</tbody>
</table>
Table 42. Understanding the Language Environment traceback table (continued)

<table>
<thead>
<tr>
<th>Section</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[2]</td>
<td>The condition information section contains information for the active routines. It indicates the program message, program unit name, the statement number, and the offset within the program unit where the error occurred.</td>
</tr>
<tr>
<td>[3]</td>
<td>The local variable section contains information on all variables and arrays in each program unit in the save area chain, including the program that caused the dump to be invoked. The output shows variable items (one line only) and array (more than one line) items. Use the local variable section of the dump to identify the variable name, type, and value at the time the dump was called. Variable and array items can contain either character or noncharacter data, but not both.</td>
</tr>
<tr>
<td>[4]</td>
<td>The file status and attribute section of the dump displays the total number of units defined, the default units for error messages, and the default unit numbers for formatted input or formatted output.</td>
</tr>
</tbody>
</table>

Examples of debugging Fortran routines

This section contains examples of Fortran routines and instructions for using information in the Language Environment dump to debug them.

Calling a nonexistent routine

Figure 109 illustrates an error caused by calling a nonexistent routine. The options in effect at compile time appear at the top of the listing.

OPTIONS IN EFFECT: LIST NOSMAP NOXREF NOGOSTMT NODECK SOURCE TERM OBJECT FIXED TRMFLG SRCFLG NODIM NORENT SDUMP(ISN)
NOSYM NOVECTOR IL(DIM) NOTEST SC(+) NODC NOEC NOEMODE NOICA NODIRECTIVE NODBCS NOSAA NODIRECTIVE NODYNAMIC NOSYM
NOREORDER NOPC
OPT(0) L AngLVL(77) NOPIPS FLAG(1) HALT(S) AUTODBL(NONE) PTRSIZE(8) LINECOUNT(60) CHARLEN(500) NAME(MAINA)

Figure 109. Example of calling a nonexistent routine

Figure 110 on page 261 shows sections of the dump generated by a call to SDUMP.
To understand the traceback section, and debug this example routine, do the following:

1. Find the Current Condition information in the Condition Information for Active Routines section of the dump. The message is CEE3201S. The system detected an operation exception at statement 3. For more information about this message, see z/OS Language Environment Runtime Messages. This section of the dump also provides such information as the name of the active routine and the current statement number at the time of the dump.

2. Locate statement 3 in the routine shown in Figure 109 on page 260. This statement calls subroutine SUBNAM. The message CEE3201S in the Condition Information section of the dump indicates that the operation exception was generated because of an unresolved external reference.

3. Check the linkage editor output for error messages.
**Divide-by-zero error**

Figure 111 demonstrates a divide-by-zero error. In this example, the main Fortran program passed 0 to subroutine DIVZEROSUB, and the error occurred when DIVZEROSUB attempted to use this data as a divisor.

```fortran
PROGRAM DIVZERO
  INTEGER*4 ANY_NUMBER
  INTEGER*4 ANY_ARRAY(3)
  PRINT *, 'EXAMPLE STARTING'
  ANY_NUMBER = 0
  DO I = 1, 3
     ANY_ARRAY(I) = I
  END DO
  CALL DIVZEROSUB(ANY_NUMBER, ANY_ARRAY)
  PRINT *, 'EXAMPLE ENDING'
STOP
END
```

```fortran
SUBROUTINE DIVZEROSUB(DIVISOR, DIVIDEND)
  INTEGER*4 DIVISOR
  INTEGER*4 DIVIDEND(3)
  PRINT *, 'IN SUBROUTINE DIVZEROSUB'
  DIVIDEND(1) = DIVIDEND(3) / DIVISOR
  PRINT *, 'END OF SUBROUTINE DIVZEROSUB'
RETURN
END
```

**Figure 112 on page 263** shows the Language Environment dump for routine DIVZERO.
To debug this application, do the following:

1. Locate the error message, CEE3209S, for the current condition in the Condition Information section of the dump, shown in Figure 112. The system detected a fixed-point divide exception. See z/OS Language Environment Runtime Messages for additional information about this message.

2. Note the sequence of the calls in the call chain:
   a. DIVZERO called AFHLCNLR, which is a Fortran library subroutine.
b. AFHCLNR called DIVZEROSUB.

Note: When a program-unit name is longer than 7 characters, the name as it appears in the dump consists of the first 4 and last 3 characters concatenated together.

c. DIVZEROSUB attempted a divide-by-zero operation at statement 5.
d. This resulted in a call to CEEHDSP, a Language Environment condition handling routine.

3. Locate statement 5 in the Fortran listing for the DIVZEROSUB subroutine in Figure 112 on page 263. This is an instruction to divide the contents of DIVIDEND(3) by DIVISOR.

4. Since DIVISOR is a parameter of subroutine DIVZEROSUB, go to the Parameters section of the dump shown in Figure 112 on page 263. The parameter DIVISOR shows a value of 0.

5. Since DIVISOR contains the value passed to DIVZEROSUB, check its value. ANY_NUMBER is the actual argument passed to DIVZEROSUB, and the dump and listing of DIVZERO indicate that ANY_NUMBER had value 0 when passed to DIVZEROSUB, leading to the divide-by-zero exception.
Chapter 7. Debugging PL/I for MVS & VM routines

This section contains information that can help you debug applications that contain one or more PL/I for MVS & VM routines. Following a discussion about potential errors in PL/I for MVS & VM routines, the first topic discusses how to use compiler-generated listings to obtain information about PL/I for MVS & VM routines, and how to use PLIDUMP to generate a Language Environment dump of a PL/I for MVS & VM routine. The last part of this section provides examples of PL/I for MVS & VM routines and explains how to debug them using information contained in the traceback information provided in the dump.

Determining the source of errors in PL/I for MVS & VM routines

Most errors in PL/I for MVS & VM routines can be identified by the information provided in PL/I runtime messages, which begin with the prefix IBM. For a list of these messages, see the z/OS Language Environment Runtime Messages.

A malfunction in running a PL/I for MVS & VM routine can be caused by:
- Logic errors in the source routine
- Invalid use of PL/I for MVS & VM
- Unforeseen errors
- Invalid input data
- Compiler or runtime routine malfunction
- System malfunction
- Unidentified routine malfunction
- Overlaid storage

Logic errors in the source routine

Errors of this type are often difficult to detect because they often appear as compiler or library malfunctions. Some common errors in source routines are:
- Incorrect conversion from arithmetic data
- Incorrect arithmetic and string manipulation operations
- Unmatched data lists and format lists

Invalid use of PL/I for MVS & VM

A misunderstanding of the language or a failure to provide the correct environment for using PL/I for MVS & VM can result in an apparent malfunction of a PL/I for MVS & VM routine. Any of the following, for example, might cause a malfunction:
- Using uninitialized variables
- Using controlled variables that have not been allocated
- Reading records into incorrect structures
- Misusing array subscripts
- Misusing pointer variables
- Incorrect conversion
- Incorrect arithmetic operations
- Incorrect string manipulation operations

Unforeseen errors

If an error is detected during run time and no ON-unit is provided in the routine to terminate the run or attempt recovery, the job terminates abnormally. However,
the status of a routine at the point where the error occurred can be recorded by using an ERROR ON-unit that contains the statements. In the following example, the statement ON ERROR SYSTEM ensures that further errors do not result in a permanent loop.

```
ON ERROR
BEGIN;
  ON ERROR SYSTEM;
  CALL PLIDUMP; /*generates a dump*/
  PUT DATA; /*displays variables*/
END;
```

**Invalid input data**

A routine should contain checks to ensure that any incorrect input data is detected before it can cause the routine to malfunction. Use the COPY option of the GET statement to check values obtained by stream-oriented input. The values are listed on the file named in the COPY option. If no file name is given, SYSPRINT is assumed.

**Compiler or runtime routine malfunction**

If you are certain that the malfunction is caused by a compiler or runtime routine error, you can either open a PMR or submit an APAR for the error. For more information about handling compiler and runtime routine malfunctions, see the IBM Enterprise PL/I for z/OS library (http://www.ibm.com/support/docview.wss?uid=swg27036735). Meanwhile, you can try an alternative way to perform the operation that is causing the trouble. A bypass is often feasible, since the PL/I for MVS & VM language frequently provides an alternative method of performing operations.

**System malfunction**

System malfunctions include machine malfunctions and operating system errors. System messages identify these malfunctions and errors to the operator.

**Unidentified routine malfunction**

In most circumstances, an unidentified routine malfunction does not occur when using the compiler. If your routine terminates abnormally without an accompanying Language Environment runtime diagnostic message, the error causing the termination might also be inhibiting the production of a message. Check for the following:

- Your job control statements might be in error, particularly in defining data sets.
- Your routine might overwrite main storage areas containing executable instructions. This can happen if you have accidentally:
  - Assigned a value to a nonexistent array element. For example:
    ```
    DCL ARRAY(10);
    ...
    DO I = 1 TO 100;
    ARRAY(I) = VALUE;
    ```
  To detect this type of error in a compiled module, set the SUBSCRIPTRANGE condition so that each attempt to access an element outside the declared range of subscript values raises the SUBSCRIPTRANGE condition. If there is no ON-unit for this condition, a diagnostic message is printed and the
ERROR condition is raised. This facility, though expensive in run time and storage space, is a valuable routine-testing aid.

- Used an incorrect locator value for a locator (pointer or offset) variable. This type of error can occur if a locator value is obtained by means of record-oriented transmission. Ensure that locator values created in one routine, transmitted to a data set, and subsequently retrieved for use in another routine, are valid for use in the second routine.

- Attempted to free a nonbased variable. This can happen when you free a based variable after its qualifying pointer value has been changed. For example:

```
DCL A STATIC,B BASED (P);
ALLOCATE B;
P = ADDR(A);
FREE B;
```

- Used the SUBSTR pseudovariable to assign a string to a location beyond the end of the target string. For example:

```
DCL X CHAR(3);
I=3
SUBSTR(X,2,I) = 'ABC';
```

To detect this type of error, enable the STRINGRANGE condition during compilation.

**Storage overlay problems**

If you suspect an error in your PL/I for MVS & VM application is a storage overlay problem, check for the following:

1. The use of a subscript outside the declared bounds (check the SUBSCRIPTRANGE condition)

2. An attempt to assign a string to a target with an insufficient maximum length (check the STRINGSIZE condition)

3. The failure of the arguments to a SUBSTR reference to comply with the rules described for the SUBSTR built-in function (check the STRINGRANGE condition)

4. The loss of significant last high-order (left-most) binary or decimal digits during assignment to an intermediate result or variable or during an input/output operation (check the SIZE condition)

5. The reading of a variable-length file into a variable

6. The misuse of a pointer variable

7. The invocation of a Language Environment callable service with fewer arguments than are required

The first four situations are associated with the listed PL/I for MVS & VM conditions, all of which are disabled by default. If you suspect one of these problems exists in your routine, use the appropriate condition prefix on the suspected statement or on the BEGIN or PROCEDURE statement of the containing block.
The fifth situation occurs when you read a data record into a variable that is too small. This type of problem only happens with variable-length files. You can often isolate the problem by examining the data in the file information and buffer.

The sixth situation occurs when you misuse a pointer variable. This type of storage overlay is particularly difficult to isolate. There are a number of ways pointer variables can be misused:

- When a READ statement runs with the SET option, a value is placed in a pointer. If you then run a WRITE statement or another READ SET option with another pointer, you overlay your storage if you try to use the original pointer.
- When you try to use a pointer to allocate storage that has already been freed, you can also cause a storage overlay.
- When you attempt to use a pointer set with the ADDR built-in function as a base for data with different attributes, you can cause a storage overlay.

The seventh situation occurs when a Language Environment callable service is passed fewer arguments than its interface requires. The following example might cause a storage overlay because Language Environment assumes that the fourth item in the argument list is the address of a feedback code, when in reality it could be residue data pointing anywhere in storage.

<table>
<thead>
<tr>
<th>Invalid calls</th>
<th>Valid calls</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCL CEEDATE ENTRY OPTIONS(ASM); CALL CEEDATE(x,y,z); /* invalid */</td>
<td>DCL CEEDATE ENTRY(<em>,</em>,<em>,</em> OPTIONAL) OPTIONS(ASM); CALL CEEDATE(x,y,z,<em>); /</em> valid */</td>
</tr>
<tr>
<td>CALL CEEDATE(x,y,z,fc); /* valid */</td>
<td></td>
</tr>
</tbody>
</table>

Using PL/I for MVS & VM compiler listings

The following sections explain how to generate listings that contain information about your routine. PL/I for MVS & VM listings show machine instructions, constants, and external or internal addresses that the linkage editor resolves. This information can help you find other information, such as variable values, in a dump of a PL/I for MVS & VM routine. The PL/I compiler listings included in the following sections are from the PL/I for MVS & VM product.

Generating PL/I for MVS & VM listings and maps

Table 43 shows compiler-generated listings that you might find helpful when you use information in dumps to debug PL/I for MVS & VM routines. For more information about supported compiler options that generate listings, reference the IBM Enterprise PL/I for z/OS library (http://www.ibm.com/support/docview.wss?uid=swg27036735).

Table 43. Compiler-generated PL/I for MVS & VM listings and their contents

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
<th>Compiler Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source program</td>
<td>Source program statements</td>
<td>SOURCE</td>
</tr>
<tr>
<td>Cross reference</td>
<td>Cross reference of names with attributes</td>
<td>XREF and ATTNIBUITES</td>
</tr>
<tr>
<td>Aggregate table</td>
<td>Names and layouts of structures and arrays</td>
<td>AGGREGATE</td>
</tr>
<tr>
<td>Variable map</td>
<td>Offsets of automatic and static internal variables from their defining base</td>
<td>MAP</td>
</tr>
</tbody>
</table>
Table 43. Compiler-generated PL/I for MVS & VM listings and their contents (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
<th>Compiler Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object code</td>
<td>Contents of the program control section in hexadecimal notation and translated into a pseudo-assembler format. To limit the size of the object code listing, specify a certain statement or range of statements to be listed; for example, LIST(20) or LIST(10,30).</td>
<td>LIST</td>
</tr>
<tr>
<td>Variable map, object code, static storage</td>
<td>Same as MAP and LIST options, plus contents of static internal and static external control sections in hexadecimal notation with comments</td>
<td>MAP and LIST</td>
</tr>
</tbody>
</table>

Finding information in PL/I for MVS & VM listings

Figure 113 shows an example PL/I for MVS & VM routine that was compiled with LIST and MAP.

```
*PROCESS SOURCE, LIST, MAP;

SOURCE LISTING

STMT

1 | EXAMPLE: PROC OPTIONS(MAIN);
2 |   DCL EXTR ENTRY EXTERNAL;
3 |   DCL A FIXED BIN(31);
4 |   DCL B(2,2) FIXED BIN(31) STATIC EXTERNAL INIT((4)0);
5 |   DCL C CHAR(20) STATIC INIT('SAMPLE CONSTANT');
6 |   DCL D FIXED BIN(31) STATIC;
7 |   DCL E FIXED BIN(31);
8 |   FETCH EXTR;
9 |   CALL EXTR(A,B,C,D,E);
10 |   DISPLAY(C);
11 | END;
```

Figure 113. PL/I for MVS & VM routine compiled with LIST and MAP

Figure 114 on page 270 shows the output generated by the LIST and MAP options for this routine, including the static storage map, variable storage map, and the object code listing. The sections following this example describe the contents of each type of listing.
**STATIC INTERNAL STORAGE MAP**

<table>
<thead>
<tr>
<th>Offset</th>
<th>Hex</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>000000</td>
<td>000000EB</td>
<td>PROGRAM ADCON</td>
</tr>
<tr>
<td>000004</td>
<td>00000008</td>
<td>PROGRAM ADCON</td>
</tr>
<tr>
<td>000008</td>
<td>00000096</td>
<td>PROGRAM ADCON</td>
</tr>
<tr>
<td>00000C</td>
<td>00000096</td>
<td>PROGRAM ADCON</td>
</tr>
<tr>
<td>000010</td>
<td>00000096</td>
<td>PROGRAM ADCON</td>
</tr>
<tr>
<td>000014</td>
<td>00000100</td>
<td>A..IBMMSJDA</td>
</tr>
<tr>
<td>000018</td>
<td>00000100</td>
<td>A..IBMSPFRA</td>
</tr>
<tr>
<td>00001C</td>
<td>00000100</td>
<td>A..STATIC</td>
</tr>
<tr>
<td>000020</td>
<td>00000044</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>000024</td>
<td>00000000</td>
<td>LOCATOR..C</td>
</tr>
<tr>
<td>000028</td>
<td>00000000</td>
<td>CONSTANT</td>
</tr>
<tr>
<td>000032</td>
<td>00000000</td>
<td>FCB..EXTR</td>
</tr>
<tr>
<td>000036</td>
<td>00000000</td>
<td>DESCRIPTOR</td>
</tr>
<tr>
<td>000040</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>000044</td>
<td>00000000</td>
<td>LOCATOR..C</td>
</tr>
<tr>
<td>000048</td>
<td>00000000</td>
<td>LOCATOR..A</td>
</tr>
<tr>
<td>00004C</td>
<td>00000000</td>
<td>LOCATOR..A</td>
</tr>
<tr>
<td>000050</td>
<td>00000000</td>
<td>LOCATOR..A</td>
</tr>
<tr>
<td>000054</td>
<td>00000000</td>
<td>LOCATOR..A</td>
</tr>
<tr>
<td>000058</td>
<td>00000000</td>
<td>LOCATOR..A</td>
</tr>
<tr>
<td>00005C</td>
<td>00000000</td>
<td>LOCATOR..A</td>
</tr>
<tr>
<td>000060</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>000064</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>000068</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>00006C</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>000070</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>000074</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>000078</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>00007C</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>000080</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>000084</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>000088</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
<tr>
<td>00008C</td>
<td>00000000</td>
<td>LOCATOR..B</td>
</tr>
</tbody>
</table>

**STATIC EXTERNAL CSECTS**

<table>
<thead>
<tr>
<th>Offset</th>
<th>Hex</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>000000</td>
<td>00000000</td>
<td>CSECT FOR EXTERNAL VARIABLE</td>
</tr>
</tbody>
</table>

**VARIABLE STORAGE MAP**

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Level</th>
<th>Offset</th>
<th>(Hex)</th>
<th>Class</th>
<th>Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>1</td>
<td>184</td>
<td>BB</td>
<td>AUTO</td>
<td>EXAMPLE</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>160</td>
<td>AO</td>
<td>STATIC</td>
<td>EXAMPLE</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>136</td>
<td>BB</td>
<td>STATIC</td>
<td>EXAMPLE</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td>188</td>
<td>BC</td>
<td>AUTO</td>
<td>EXAMPLE</td>
</tr>
</tbody>
</table>

**OBJECT LISTING**

```
* STATEMENT NUMBER 1
000000 DC C'EXAMPLE' 000002 47 70 2 01E BNE CL.5
000007 DC ALL(7) 000006 41 10 3 040 LA 1,64(0,3)
00000A 58 FB 3 018 L 15,A..IBMSPFRA
* PROCEDURE EXAMPLE 00000E 05 EF BALR 14,15
000080 58 FB 0 000 L 15,PR..EXTR
* REAL ENTRY 000084 CL.5 EQU *
```

Figure 114. Compiler-generated listings from example PL/I for MVS & VM routine
Static internal storage map
To get a complete variable storage map and static storage map, but not a complete
LIST, specify a single statement for LIST to minimize the size of the listing; for
example, LIST(1).

Each line of the static storage map contains the following information:
1. Six-digit hexadecimal offset.
2. Hexadecimal text, in 8-byte sections where possible.
3. Comment, indicating the type of item to which the text refers. The comment
   appears on the first line of the text for an item. Table 44 lists some typical
   comments you might find in a static storage listing.

| Table 44. Typical comments in a PL/I for MVS & VM static storage listing |
|-----------------------------------------------|-----------------|
| Comment                      | Explanation                  |
| A..xxx                        | Address constant for xxx     |
| COMPIlER LABEL CL..n          | Compiler-generated label n   |
| CONDITION CSECt              | Control section for programmer-named condition |
| CONSTANT                      | Constant                      |
| CSECt FOR EXTERNAL VARIABLE   | Control section for external variable |
| D..xxx                        | Descriptor for xxx           |
| DED..xxx                      | Data element descriptor for xxx |
| DESCRIPTOR                    | Data descriptor               |
| ENVB                          | Environment control block    |
| FECB..xxx                     | Fetch control block for xxx   |
| DCLCB                         | Declare control block        |
| FED..xxx                      | Format element descriptor for xxx |

* PROCEDURE BASE              * END PROGRAM

Figure 115. Compiler-generated listings from example PL/I for MVS & VM routine (continued)
Table 44. Typical comments in a PL/I for MVS & VM static storage listing (continued)

<table>
<thead>
<tr>
<th>Comment</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>KD..xxx</td>
<td>Key descriptor for xxx</td>
</tr>
<tr>
<td>LOCATOR..xxx</td>
<td>Locator for xxx</td>
</tr>
<tr>
<td>ONCB</td>
<td>ON statement control block</td>
</tr>
<tr>
<td>PICTURED DED..xxx</td>
<td>Pictured data element descriptor for xxx</td>
</tr>
<tr>
<td>PROGRAM ADCON</td>
<td>Program address constant</td>
</tr>
<tr>
<td>RD..xxx</td>
<td>Record descriptor for xxx</td>
</tr>
<tr>
<td>SYMBOL TABLE ELEMENT</td>
<td>Symbol table address</td>
</tr>
<tr>
<td>SYMBOL TABLE..xxx</td>
<td>Symbol table for xxx</td>
</tr>
<tr>
<td>SYMTAB DED..xxx</td>
<td>Symbol table DED for xxx</td>
</tr>
<tr>
<td>USER LABEL..xxx</td>
<td>Source program label for xxx</td>
</tr>
<tr>
<td>xxx</td>
<td>Variable with name xxx. If the variable is not initialized, no text appears against the comment. There is also no static offset if the variable is an array (the static offset can be calculated from the array descriptor, if required).</td>
</tr>
</tbody>
</table>

**Variable storage map**

For automatic and static internal variables, the variable storage map contains the following information:
- PL/I for MVS & VM identifier name
- Level
- Storage class
- Name of the PL/I for MVS & VM block in which it is declared
- Offset from the start of the storage area, in both decimal and hexadecimal form

If the LIST option is also specified, a map of the static internal and external control sections, called the static storage map, is also produced.

**Object code listing**

The object code listing consists of the machine instructions and a translation of these instructions into a form that resembles assembler and includes comments, such as source program statement numbers.

The machine instructions are formatted into blocks of code, headed by the statement or line number in the PL/I for MVS & VM source program listing.

Generally, only executable statements appear in the listing. DECLARE statements are not normally included. The names of PL/I for MVS & VM variables, rather than the addresses that appear in the machine code, are listed. Special mnemonics are used to refer to some items, including test hooks, descriptors, and address constants.

Statements in the object code listing are ordered by block, as they are sequentially encountered in the source program. Statements in the external procedure are given first, followed by the statements in each inner block. As a result, the order of statements frequently differs from that of the source program.

Every object code listing begins with the name of the external procedure. The actual entry point of the external procedure immediately follows the heading comment REAL ENTRY. The subsequent machine code is the prolog for the block, which performs block activation. The comment PROCEDURE BASE marks the end of
the prolog. Following this is a translation of the first executable statement in the PL/I for MVS & VM source program. Table 45 summarizes the comment used in the listing.

Table 45. Comments in a PL/I for MVS & VM object code listing

<table>
<thead>
<tr>
<th>Comment</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEGIN BLOCK xxx</td>
<td>Indicates the start of the begin block with label xxx</td>
</tr>
<tr>
<td>BEGIN BLOCK NUMBER n</td>
<td>Indicates the start of the begin block with number n</td>
</tr>
<tr>
<td>CALCULATION OF COMMONED</td>
<td>Indicates that an expression used more than once in the routine is calculated at this point</td>
</tr>
<tr>
<td>EXPRESSION FOLLOWS</td>
<td></td>
</tr>
<tr>
<td>CODE MOVED FROM STATEMENT</td>
<td>Indicates object code moved by the optimization process to a different part of the routine and gives the number of the statement from which it originated</td>
</tr>
<tr>
<td>NUMBER n</td>
<td></td>
</tr>
<tr>
<td>COMPILER GENERATED SUBROUTINE xxx</td>
<td>Indicates the start of compiler-generated subroutine xxx</td>
</tr>
<tr>
<td>CONTINUATION OF PREVIOUS</td>
<td>Identifies the point at which addressing from the previous routine base recomences</td>
</tr>
<tr>
<td>REGION xxx</td>
<td></td>
</tr>
<tr>
<td>END BLOCK</td>
<td>Indicates the end of a begin block</td>
</tr>
<tr>
<td>END INTERLANGUAGE PROCEDURE xxx</td>
<td>Identifies the end of an ILC procedure xxx</td>
</tr>
<tr>
<td>END OF COMMON CODE</td>
<td>Identifies the end of code used in running more than one statement</td>
</tr>
<tr>
<td>END OF COMPILER GENERATED SUBROUTINE</td>
<td>Indicates the end of the compiler-generated subroutine</td>
</tr>
<tr>
<td>END PROCEDURE</td>
<td>Identifies the end of a procedure</td>
</tr>
<tr>
<td>END PROGRAM</td>
<td>Indicates the end of the external procedure</td>
</tr>
<tr>
<td>INITIALIZATION CODE FOR xxx</td>
<td>Indicates the start of initialization code for variable xxx</td>
</tr>
<tr>
<td>INITIALIZATION CODE FOR OPTIMIZED LOOP FOLLOWS</td>
<td>Indicates that some of the code that follows was moved from within a loop by the optimization process</td>
</tr>
<tr>
<td>INTERLANGUAGE PROCEDURE xxx</td>
<td>Identifies the start of an implicitly generated ILC procedure xxx</td>
</tr>
<tr>
<td>METHOD OR ORDER OF CALCULATING EXPRESSIONS</td>
<td>Indicates that the order of the code following was changed to optimize the object code</td>
</tr>
<tr>
<td>CHANGED</td>
<td></td>
</tr>
<tr>
<td>ON-UNIT BLOCK NUMBER n</td>
<td>Indicates the start of an ON-unit block with number n</td>
</tr>
<tr>
<td>ON-UNIT BLOCK END</td>
<td>Indicates the end of the ON-unit block</td>
</tr>
<tr>
<td>PROCEDURE xxx</td>
<td>Identifies the start of the procedure labeled xxx</td>
</tr>
<tr>
<td>PROCEDURE BASE</td>
<td>Identifies the address loaded into the base register for the procedure</td>
</tr>
<tr>
<td>PROGRAM ADDRESSABILITY REGION BASE</td>
<td>Identifies the address where the routine base is updated if the routine size exceeds 4096 bytes and consequently cannot be addressed from one base</td>
</tr>
<tr>
<td>PROLOGUE BASE</td>
<td>Identifies the start of the prolog code common to all entry points into that procedure</td>
</tr>
<tr>
<td>REAL ENTRY</td>
<td>Precedes the actual executable entry point for a procedure</td>
</tr>
<tr>
<td>STATEMENT LABEL xxx</td>
<td>Identifies the position of source program statement label xxx</td>
</tr>
<tr>
<td>STATEMENT NUMBER n</td>
<td>Indicates the start of code generated for statement number n in the source listing</td>
</tr>
</tbody>
</table>

In certain cases, the compiler uses mnemonics (see Table 46 on page 274) to identify the type of operand in an instruction and, where applicable, follows the mnemonic by the name of a PL/I for MVS & VM variable.
Table 46. PL/I for MVS & VM mnemonics

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A_.xxx</td>
<td>Address constant for xxx</td>
</tr>
<tr>
<td>ADD_.xxx</td>
<td>Aggregate descriptor for xxx</td>
</tr>
<tr>
<td>BASE_.xxx</td>
<td>Base address of variable xxx</td>
</tr>
<tr>
<td>BLOCK.n</td>
<td>Identifier created for an otherwise unlabeled block</td>
</tr>
<tr>
<td>CL.n</td>
<td>Compiler-generated label number n</td>
</tr>
<tr>
<td>D_.xxx</td>
<td>Descriptor for xxx</td>
</tr>
<tr>
<td>DED_.xxx</td>
<td>Data element descriptor for xxx</td>
</tr>
<tr>
<td>HOOK..ENTRY</td>
<td>Debugging tool block entry hook</td>
</tr>
<tr>
<td>HOOK..BLOCK-EXIT</td>
<td>Debugging tool block exit hook</td>
</tr>
<tr>
<td>HOOK..PGM-EXIT</td>
<td>Debugging tool program exit hook</td>
</tr>
<tr>
<td>HOOK..PRE-CALL</td>
<td>Debugging tool pre-call hook</td>
</tr>
<tr>
<td>HOOK..INFO</td>
<td>Additional pre-call hook information</td>
</tr>
<tr>
<td>HOOK..POST-CALL</td>
<td>Debugging tool post call hook</td>
</tr>
<tr>
<td>HOOK..STMT</td>
<td>Debugging tool statement hook</td>
</tr>
<tr>
<td>HOOK..IF-TRUE</td>
<td>Debugging tool IF true hook</td>
</tr>
<tr>
<td>HOOK..IF-FALSE</td>
<td>Debugging tool ELSE hook</td>
</tr>
<tr>
<td>HOOK..WHEN</td>
<td>Debugging tool WHEN true hook</td>
</tr>
<tr>
<td>HOOK..OTHERWISE</td>
<td>Debugging tool OTHERWISE true hook</td>
</tr>
<tr>
<td>HOOK..LABEL</td>
<td>Debugging tool label hook</td>
</tr>
<tr>
<td>HOOK..DO</td>
<td>Debugging tool iterative DO hook</td>
</tr>
<tr>
<td>HOOK..ALLOC</td>
<td>Debugging tool ALLOCATE controlled hook</td>
</tr>
<tr>
<td>WSP.n</td>
<td>Workspace, followed by identifying number n</td>
</tr>
<tr>
<td>L_.xxx</td>
<td>Length of variable xxx</td>
</tr>
<tr>
<td>PR_.xxx</td>
<td>Pseudoregister vector slot for xxx</td>
</tr>
<tr>
<td>LOCATOR_.xxx</td>
<td>Locator for xxx</td>
</tr>
<tr>
<td>RKD_.xxx</td>
<td>Record or key descriptor for xxx</td>
</tr>
<tr>
<td>VO_.xxx</td>
<td>Virtual origin for xxx (the address where element 0 is held for a one-dimensional array, element 0,0 for a two-dimensional array, and so on)</td>
</tr>
</tbody>
</table>

Generating a Language Environment dump of a PL/I for MVS & VM routine

To generate a dump of a PL/I for MVS & VM routine, you can call either the Language Environment callable service CEE3DMP or PLIDUMP. For information about calling CEE3DMP, see "Generating a Language Environment dump with CEE3DMP" on page 37.

PLIDUMP syntax and options

PLIDUMP calls intermediate PL/I for MVS & VM library routines, which convert most PLIDUMP options to CEE3DMP options. The following list contains PLIDUMP options and the corresponding CEE3DMP option, if applicable.
Some PLIDUMP options do not have corresponding CEE3DMP options, but continue to function as PL/I for MVS & VM default options. The list following the syntax diagram provides a description of those options.

PLIDUMP now conforms to National Language Support standards.

PLIDUMP can supply information across multiple Language Environment enclaves. If an application running in one enclave fetches a main procedure (an action that creates another enclave), PLIDUMP contains information about both procedures.

The syntax and options for PLIDUMP are shown below.

```
Syntax

PLIDUMP (char.-string-exp 1, char.-string-exp 2)
```

**char.-string-exp 1**

A dump options character string consisting of one or more of the following values. T, F, C, and A are the default options.

- **A** All. Results in a dump of all tasks including the ones in the WAIT state.
- **B** BLOCKS (PL/I for MVS & VM hexadecimal dump). Dumps the control blocks used in Language Environment and member language libraries. For PL/I for MVS & VM, this includes the DSA for every routine on the call chain and PL/I for MVS & VM “global” control blocks, such as Tasking Implementation Appendage (TIA), Task Communication Area (TCA), and the PL/I Tasking Control Block (PTCB). PL/I file control blocks and file buffers are also dumped if the F option is specified.
- **C** Continue. The routine continues after the dump.
- **E** Exit. The enclave terminates after the dump. In a multitasking environment, if PLIDUMP is called from the main task, the enclave terminates after the dump. If PLIDUMP is called from a subtask, the subtask and any subsequent tasks created from the subtask terminate after the dump. In a multithreaded environment, if PLIDUMP is called from the Initial Process Thread (IPT), the enclave terminates after the dump. If PLIDUMP is called from a non-IPT, only the non-IPT terminates after the dump.
- **F** FILE INFORMATION. A set of attributes for all open files is given. The contents of the file buffers are displayed if the B option is specified.
- **H** STORAGE in hexadecimal. A SNAP dump of the region is produced. A ddname of CEESNAP must be provided to direct the CEESNAP dump report.
- **K** BLOCKS (when running under CICS). The Transaction Work Area is included.

  **Note:** This option is not supported under Enterprise PL/I.

- **NB** NOBLOCKS.
NF  NOFILES.
NH  NOSTORAGE.
NK  NOBLOCKS (when running under CICS).
NT  NOTRACEBACK.
O   THREAD(CURRENT). Results in a dump of only the current task or current thread (the invoker of PLIDUMP).
S   Stop. The enclave terminates after the dump. In a multitasking environment, regardless of whether PLIDUMP is called from the main task or a subtask, the enclave terminates after the dump. In a multithreaded environment, regardless of whether PLIDUMP is called from the IPT or a non-IPT, the enclave terminates after the dump (in which case there is no fixed order as to which thread terminates first).
T   TRACEBACK. Includes a traceback of all routines on the call chain.

The traceback shows transfers of control from either calls or exceptions. BEGIN blocks and ON-units are also control transfers and are included in the trace. The traceback extends backwards to the main program of the current thread.

char.-string-exp 2
A user-identified character string up to 80 characters long that is printed as the dump header.

PLIDUMP usage notes
If you use PLIDUMP, the following considerations apply:

• If a routine calls PLIDUMP a number of times, use a unique user-identifier for each PLIDUMP invocation. This simplifies identifying the beginning of each dump.
• In MVS or TSO, you can use ddnames of CEEDUMP, PLIDUMP, or PL1DUMP to direct dump output. If no ddname is specified, CEEDUMP is used.
• The data set defined by the PLIDUMP, PL1DUMP, or CEEDUMP DD statement should specify a logical record length (LRECL) of at least 131 to prevent dump records from wrapping.
• When you specify the H option in a call to PLIDUMP, the PL/I for MVS & VM library issues an OS SNAP macro to obtain a dump of virtual storage. The first invocation of PLIDUMP results in a SNAP identifier of 0. For each successive invocation, the ID is increased by one to a maximum of 256, after which the ID is reset to 0.
• Support for SNAP dumps using PLIDUMP is provided only under MVS. SNAP dumps are not produced in a CICS environment.
  – If the SNAP does not succeed, the CEE3DMP DUMP file displays the message:
    Snap was unsuccessful
    Failure to define a CEESNAP data set is the most likely cause of an unsuccessful CEESNAP.
  – If the SNAP is successful, CEE3DMP displays the message:
    Snap was successful; snap ID = nnn
    where nnn corresponds to the SNAP identifier described above. An unsuccessful SNAP does not result in an incrementation of the identifier.
• To ensure portability across system platforms, use PLIDUMP to generate a dump of your PL/I for MVS & VM routine.
Finding PL/I for MVS & VM information in a dump

The following sections discuss PL/I-specific information located in the following sections of a Language Environment dump:

- Traceback
- Control Blocks for Active Routines
- Control Block Associated with the Thread
- File Status and Attributes

**Traceback**

Examine the traceback section of the dump, shown in Figure 116, for condition information about your routine and information about the statement number and address where the exception occurred.
# PL/I for MVS & VM task traceback

A task traceback table is produced for multitasking programs showing the task invocation sequence (trace). For each task, the thread ID, CAA address (identified by TCA address in the dump), event variable address, task variable address, and absolute priority appear in the traceback table. An example is shown in Figure 117.

![Figure 117. Task traceback section](image-url)
Condition information

If the dump was called from an ON-unit, the type of ON-unit is identified in the traceback as part of the entry information. For ON-units, the values of any relevant condition built-in functions (for example, ONCHAR and ONSOURCE for conversion errors) appear. In cases where the cause of entry into the ON-unit is not stated, usually when the ERROR ON-unit is called, the cause of entry appears in the condition information.

Statement number and address where error occurred

This information, which is the point at which the condition that caused entry to the ON-unit occurred, can be found in the traceback section of the dump.

If the condition occurs in compiled code, and you compiled your routine with either GOSTMT or GONUMBER, the statement numbers appear in the dump. To identify the assembler instruction that caused the error, use the traceback information in the dump to find the program unit (PU) offset of the statement number in which the error occurred. Then find that offset and the corresponding instruction in the object code listing.

Control blocks for active routines

This section shows the stack frames for all active routines, and the static storage. Use this section of the dump to identify variable values, determine the contents of parameter lists, and locate the timestamp. Figure 119 on page 280 shows this section of the dump.
Control Blocks for Active Routines:

### DSA for CEEKKMRA: 20845888

<table>
<thead>
<tr>
<th>Flags</th>
<th>Member</th>
<th>Offset</th>
<th>BKC</th>
<th>NFC</th>
<th>20846080</th>
<th>R14</th>
<th>A0F90C3E</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>RLS15</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
<td>A0F90C3E</td>
</tr>
<tr>
<td>+000110</td>
<td>R15</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
<td>A0F90C3E</td>
</tr>
<tr>
<td>+000224</td>
<td>R4</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
<td>A0F90C3E</td>
</tr>
<tr>
<td>+000338</td>
<td>R9</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
<td>A0F90C3E</td>
</tr>
</tbody>
</table>

### DSA for IBMKKOM: 20025670

<table>
<thead>
<tr>
<th>Flags</th>
<th>Member</th>
<th>Offset</th>
<th>BKC</th>
<th>NFC</th>
<th>20846080</th>
<th>R14</th>
<th>A0F90C3E</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>RLS15</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
<td>A0F90C3E</td>
</tr>
<tr>
<td>+000110</td>
<td>R15</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
<td>A0F90C3E</td>
</tr>
<tr>
<td>+000224</td>
<td>R4</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
<td>A0F90C3E</td>
</tr>
<tr>
<td>+000338</td>
<td>R9</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
<td>A0F90C3E</td>
</tr>
</tbody>
</table>

### Library Work Space: 00256700

<table>
<thead>
<tr>
<th>Flags</th>
<th>Offset</th>
<th>BKC</th>
<th>NFC</th>
<th>20846080</th>
<th>R14</th>
<th>A0F90C3E</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>RLS15</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
<tr>
<td>+000110</td>
<td>R15</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
<tr>
<td>+000224</td>
<td>R4</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
<tr>
<td>+000338</td>
<td>R9</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
</tbody>
</table>

### Dynamic save area (ERR On-unit): 20845888

<table>
<thead>
<tr>
<th>Flags</th>
<th>Offset</th>
<th>BKC</th>
<th>NFC</th>
<th>20846080</th>
<th>R14</th>
<th>A0F90C3E</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>RLS15</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
<tr>
<td>+000110</td>
<td>R15</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
<tr>
<td>+000224</td>
<td>R4</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
<tr>
<td>+000338</td>
<td>R9</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
</tbody>
</table>

### Static for procedure EXAMPLE

<table>
<thead>
<tr>
<th>Flags</th>
<th>Offset</th>
<th>BKC</th>
<th>NFC</th>
<th>20846080</th>
<th>R14</th>
<th>A0F90C3E</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>RLS15</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
<tr>
<td>+000110</td>
<td>R15</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
<tr>
<td>+000224</td>
<td>R4</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
<tr>
<td>+000338</td>
<td>R9</td>
<td>20846588</td>
<td>20845888</td>
<td>20845888</td>
<td>20845888</td>
<td>R14</td>
</tr>
</tbody>
</table>

---

Figure 119. Control blocks for active routines section of the dump (Part 1 of 3)
Figure 120. Control blocks for active routines section of the dump (Part 2 of 3)
Automatic variables
To find automatic variables, use an offset from the stack frame of the block in
which they are declared. This information appears in the variable storage map
generated when the MAP compiler option is in effect. If you have not used the
MAP option, you can determine the offset by studying the listing of compiled code
instructions.

Static variables
If your routine is compiled with the MAP option, you can find static variables by
using an offset in the variable storage map. If the MAP option is not in effect, you
can determine the offset by studying the listing of compiled code.

Based variables
To locate based variables, use the value of the defining pointer. Find this value by
using one of the methods described above to find static and automatic variables. If
the pointer is itself based, you must find its defining pointer and follow the chain
until you find the correct value. The following is an example of typical code for X
BASED (P), with P AUTOMATIC:

```
58 60 D 0C8  L 6,P
58 E0 6 000  L 14,X
```
P is held at offset 'X'C8' from register 13. This address points to X.

Take care when examining a based variable to ensure that the pointers are still
valid.

Area variables
Area variables are located using one of the methods described above, according to
their storage class. The following is an example of typical code: for an area variable
A declared AUTOMATIC:

```
41 60 D 0F8  LA 6,A
```
The area starts at offset X'F8' from register 13.

Variables in areas
To find variables in areas, locate the area and use the offset to find the variable.

Contents of parameter lists
To find the contents of a passed parameter list, first find the register 1 value in the save area of the calling routine’s stack frame. Use this value to locate the parameter list in the dump. If R1=0, no parameters passed. For additional information about parameter lists, see the IBM Enterprise PL/I for z/OS library (http://www.ibm.com/support/docview.wss?uid=swg27036735).

Timestamp
If the TSTAMP compiler installation option is in effect, the date and time of compilation appear within the last 32 bytes of the static internal control section. The last three bytes of the first word give the offset to this information. The offset indicates the end of the timestamp. Register 3 addresses the static internal control section. If the BLOCK option is in effect, the timestamp appears in the static storage section of the dump.

Control blocks associated with the thread
This section of the dump, shown in Figure 122 on page 284, includes information about PL/I for MVS & VM fields of the CAA and other control block information.
Figure 122. Control blocks associated with the thread section of the dump (Part 1 of 2)
CAA address

The address of the CAA control block appears in this section of the dump. If the BLOCK option is in effect, the complete CAA (including the PL/I for MVS & VM implementation appendage) appears separately from the body of the dump. Register 12 addresses the CAA.

File status and attribute information

This part of the dump includes the following information:

- The default and declared attributes of all open files
- Buffer contents of all file buffers
- The contents of FCBs, DCBs, DCLCBs, IOCBs, and control blocks for the process or enclave

PL/I for MVS & VM contents of the Language Environment trace table

Language Environment provides three PL/I for MVS & VM trace table entry types that contain character data:

- Trace entry 100 occurs when a task is created.
- Trace entry 101 occurs when a task that contains the tasking CALL statements is terminated.
• Trace entry 102 occurs when a task that does not contain a tasking CALL statement is terminated.

The format for trace table entries 100, 101, and 102 is shown below. For more information about the Language Environment trace table format, see "Understanding the trace table entry (TTE)" on page 154.

```plaintext
(100) NameOfCallingTask NameOfCalledTask OffsetOfCallStmt
    UserAgrPtr CalledTaskPtr TaskVarPtr EventVarPtr
    PriorityPtr CallingR2-R5 CallingR12-R14

(101) NameOfReturnTask ReturnerR2-R5 ReturnerR12-R14

(102) NameOfReturnTask
```

### Debugging example of PL/I for MVS & VM routines

This section contains examples of PL/I for MVS & VM routines and instructions for using information in the Language Environment dump to debug them. Important areas in the source code and in the dump for each routine are highlighted.

#### Subscript range error

[Figure 124] illustrates an error caused by an array subscript value outside the declared range. In this example, the declared array value is 10. This routine was compiled with the options LIST, TEST, GOSTMT, and MAP. It was run with the TERMTHDACT(TRACE) option to generate a traceback for the condition.

```plaintext
5688-235 IBM PL/I for MVS & VM  Ver 1 Rel 1 Mod 1          27 FEB 07 11:45:18  PAGE 1
OPTIONS SPECIFIED
+PROCESS GOSTMT LIST S STG TEST MAP NOOPTIONS;
5688-235 IBM PL/I for MVS & VM  EXAMPLE: PROC OPTIONS(MAIN);
SOURCE LISTING

STMT
  1 EXAMPLE: PROC OPTIONS(MAIN);
  2      DCL Array(10) Fixed bin(31);
  3      DCL [I,Array_End] Fixed bin[31];
  4     On error Begin;
  5       On error system;
  6        Call plidump('tbnfs','Plidump called from error On-unit');
  7       End;
  8     (subrg): /* Enable subscriptrange condition */
       Labl1: Begin;
  9       Array_End = 20;
 10      Do I = 1 to Array_End; /* Loop to initialize array */
 11      Array(I) = 2; /* Set array elements to 2 */
 12     End;
 13     End Labl1;
 14    End Example;

5688-235 IBM PL/I for MVS & VM  EXAMPLE: PROC OPTIONS(MAIN);
VARIABLE STORAGE MAP

<table>
<thead>
<tr>
<th>IDENTIFIER</th>
<th>LEVEL</th>
<th>OFFSET</th>
<th>CLASS</th>
<th>BLOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1</td>
<td>200</td>
<td>CB</td>
<td>AUTO</td>
</tr>
<tr>
<td>ARRAY_END</td>
<td>1</td>
<td>204</td>
<td>CC</td>
<td>AUTO</td>
</tr>
<tr>
<td>ARRAY</td>
<td>1</td>
<td>208</td>
<td>DD</td>
<td>AUTO</td>
</tr>
</tbody>
</table>

5688-235 IBM PL/I for MVS & VM  EXAMPLE: PROC OPTIONS(MAIN);

Figure 124. Example of moving a value outside an array range
```
Figure 125 shows sections of the dump generated by a call to PLIDUMP.

Figure 125. Sections of the Language Environment dump (Part 1 of 2)
To debug this routine, use the following steps:

1. In the dump, PLIDUMP was called by the ERROR ON-unit in statement 6. The traceback information in the dump shows that the exception occurred following statement 11.

2. Locate the Original Condition message in the Condition Information for Active Routines section of the dump. The message is IBM0421S ONCODE=520 The SUBSCRIPTRANGE condition was raised. This message indicates that the exception occurred when an array element value exceeded the subscript range value (in this case, 10). For more information about this message, see z/OS Language Environment Runtime Messages.

3. Locate statement 9 in the routine in Figure 124 on page 286. The instruction is `DO I=1 TO Array_End`. Since the previous instruction (statement 9) specified that `Array_End = 20`, the loop in statement 10 should run until `I` reaches a 20 value.
The instruction in statement 2, however, declared a 10 value for the array range. Therefore, when the I value reached 11, the SUBSCRIPTRANGE condition was raised.

The following steps provide another method for finding the value that raised the SUBSCRIPTRANGE condition.

1. Locate the offset of variable I in the variable storage map in Figure 124 on page 286. Use this offset to find the I value at the time of the dump. In this example, the offset is X'C8'.
2. Now, find offset X'C8' from the start of the stack frame for the entry EXAMPLE in Figure 125 on page 287.

The block located at this offset contains the value that exceeded the array range, X'B' or 11.

Calling a nonexistent subroutine

Figure 127 demonstrates the error of calling a nonexistent subroutine. This routine was compiled with the LIST, MAP, and GOSTMT compiler options. It was run with the TERMTHDACT(DUMP) runtime option to generate a traceback.

Figure 127. Example of calling a nonexistent subroutine

Figure 128 on page 290 shows the traceback and condition information from the dump.
CEE3DMP V1 R12.0: Plidump called from error On-unit 04/10/10 11:45:20 AM Page: 1

ASID: 00B5 Job ID: JOB21952 Job name: LEDGSMP2 Step name: GO UserID: HEALY

CEE3845I CEEDUMP Processing started.
PLIDUMP was called from statement number 5 at offset +000000D6 from ERR ON-unit with entry address 20900DF4

Information for enclave EXAMPLE1

Information for thread 8000000000000000

Traceback:

<table>
<thead>
<tr>
<th>DSA</th>
<th>Entry</th>
<th>E Offset</th>
<th>Statement</th>
<th>Load Mod</th>
<th>Program Unit</th>
<th>Service</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CEEKKMRA</td>
<td>+0000081C</td>
<td>CEEPLPKA</td>
<td>CEEKKMRA</td>
<td>D1908</td>
<td>Call</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>IBMRKDM</td>
<td>+000000C2</td>
<td>IBMRREV10</td>
<td>IBMRKDM</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ERR ON-unit</td>
<td>+000000D6</td>
<td>EXAMPLE1</td>
<td>EXAMPLE1</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>IBMRERPL</td>
<td>+0000006A</td>
<td>IBMRMLIB1</td>
<td>IBMRERPL</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CEEVEY010</td>
<td>+0000013A</td>
<td>IBMREV10</td>
<td>CEEVEY010</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CEEHDP</td>
<td>+00000051E</td>
<td>IBMRMLIB1</td>
<td>IBMRHDP</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>EXAMPLE1</td>
<td>-20900D2C</td>
<td>EXAMPLE1</td>
<td>EXAMPLE1</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>IBMRPMIA</td>
<td>+00000051E</td>
<td>IBMRLIB1</td>
<td>IBMRPMIA</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>CEEV010</td>
<td>+000000310</td>
<td>IBMREV10</td>
<td>CEEV010</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>CEEBEXT</td>
<td>+0000001B6</td>
<td>CEEMLIB1</td>
<td>CEEBEXT</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DSA DSA Addr  E Addr  PU Addr  PU Offset  Comp Date  Compile Attributes

1  20B458D0  20B458D0  20B458D0  +0000081C  20061214  CEL
2  00025670  00025670  00025670  +000000C2  ******** OS PL/I
3  20B457D0  20B457D0  20B457D0  +000001AA  ******** OS PL/I
4  20B45598  20B45598  20B45598  +0000065A  20061213  LIBRARY
5  20B45510  20B45510  20B45510  +0000013A  20061213  LIBRARY
6  20B423F0  20B423F0  20B423F0  +000017D0  20061215  CEL
7  20B42330  20B42330  20B42330  +000000E0  20061215  CEL
8  20B42178  20B42178  20B42178  +0000051E  20061214  LIBRARY
9  20B420F0  20B420F0  20B420F0  +00000310  20061213  LIBRARY
10 20B42030  20B42030  20B42030  +000000B8  20061215  CEL

Condition Information for Active Routines

Condition Information for EXAMPLE1 (DSA address 20B42330)

CIB Address: 20B42D10
Current Condition: CEE3201S The system detected an operation exception (System Completion Code=0C1).
Location: Program Unit: EXAMPLE1 Entry: EXAMPLE1 Statement: Offset: -20900D2C
Possible Bad Branch: Statement: 7 Offset: +000000C0
Machine State:
ILC..... 0002 Interruption Code..... 0001
PSW..... 078D0E00 80000002
GPR0..... 00000000_20B423F0 GPR1..... 00000000_00000000 GPR2..... 00000000_A0900DD4 GPR3..... 00000000_20900EE0
GPR4..... 00000000_00000001 GPR5..... 00000000_00000000 GPR6..... 00000000_20B423E8 GPR7..... 00000000_00000005
GPR8..... 00000000_20900F50 GPR9..... 00000000_00000008 GPR10.... 00000000_20900F80 GPR11.... 00000000_2090100C
GPR12.... 00000000_20900E9C0 GPR13.... 00000000_20B42330 GPR14.... 00000000_A0900DE2 GPR15.... 00000000_00000000

Storage dump near condition, beginning at location: 00000000

+000000 00000000 Inaccessible storage.

GPREG STORAGE:

Storage around GPR0 (20B423F0)

-000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 |..|..|..|..|..|..|..|..|

Storage around GPR1 (00000000)

+00000000 Inaccessible storage.

Storage around GPR2 (20900004)

-000 20900004 00000000 00000000 00000000 00000000 00000000 00000000 00000000 |..|..|..|..|..|..|..|..|

Storage around GPR3 (209000E0)

+000 209000E0 00000000 00000000 00000000 00000000 00000000 00000000 00000000 |..|..|..|..|..|..|..|..|

Storage around GPR4 (00000001)

-0001 00000000 Inaccessible storage.

Figure 128. Sections of the Language Environment dump (Part 1 of 2)
To understand the traceback and debug this example routine, use the following steps:

1. Find the Current Condition message in the Condition Information for Active Routines section of the dump. The message is CEE3201S. The system detected an Operation exception. For more information about this message, see \textit{z/OS Language Environment Runtime Messages}.

   This section of the dump also provides such information as the name of the active routine and the current statement number at the time of the dump. The Location section indicates that the exception occurred at offset X’-20900D2C’ within entry EXAMPLE1 and that there might have been a bad branch from offset X’+000000C0’ statement 7 within entry EXAMPLE1.

2. Locate statement 7 in the routine (Figure 127 on page 289). This statement calls subroutine Prog01. The message CEE3201S, which indicates an operations exception, was generated because of an unresolved external reference.

3. Check the linkage editor output for error messages.

**Divide-by-zero error**

Figure 130 on page 292 demonstrates a divide-by-zero error. In this example, the main PL/I for MVS & VM routine passed bad data to a PL/I for MVS & VM subroutine. The bad data in this example is 0, and the error occurred when the
subroutine SUB1 attempted to use this data as a divisor.

Since variables are not normally displayed in a PLIDUMP dump, this routine included a PUT DATA statement, which generated a listing of arguments and variables used in the routine. Figure 131 shows this output.

Figure 130. PL/I for MVS & VM routine with a divide-by-zero error

Figure 131. Variables from routine SAMPLE

The routine in Figure 130 was compiled with the LIST compiler option, which generated the object code listing shown in Figure 132 on page 293.
**Figure 132. Object code listing from example PL/I for MVS & VM routine**

*STATEMENT NUMBER 15*

<table>
<thead>
<tr>
<th>Address</th>
<th>Operation</th>
<th>Mode</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>0003A2</td>
<td>58 80 0 0CB</td>
<td>L</td>
<td>11,200(0,13)</td>
</tr>
<tr>
<td>0003A6</td>
<td>58 40 0 004</td>
<td>L</td>
<td>4,4(0,11)</td>
</tr>
<tr>
<td>0003AA</td>
<td>58 90 3 0B4</td>
<td>L</td>
<td>9,188(0,3)</td>
</tr>
<tr>
<td>0003AE</td>
<td>5C 00 4 004</td>
<td>M</td>
<td>8,4(0,4)</td>
</tr>
<tr>
<td>0003B2</td>
<td>58 70 3 004</td>
<td>L</td>
<td>7,232(0,3)</td>
</tr>
<tr>
<td>0003B6</td>
<td>5C 60 4 004</td>
<td>M</td>
<td>6,4(0,4)</td>
</tr>
<tr>
<td>0003BA</td>
<td>58 80 0 0C0</td>
<td>L</td>
<td>8,192(0,13)</td>
</tr>
<tr>
<td>0003BE</td>
<td>58 60 8 000</td>
<td>L</td>
<td>6,0(0,11)</td>
</tr>
<tr>
<td>0003C2</td>
<td>5F 60 4 000</td>
<td>SL</td>
<td>6,0(0,4)</td>
</tr>
<tr>
<td>0003C6</td>
<td>5E E7 6 000</td>
<td>L</td>
<td>14,00..ARRAY1(7)</td>
</tr>
<tr>
<td>0003CA</td>
<td>8C EO 0 020</td>
<td>SRDA</td>
<td>14,32</td>
</tr>
<tr>
<td>0003CE</td>
<td>5D EO 0 000</td>
<td>D</td>
<td>14,0..DIVISOR</td>
</tr>
<tr>
<td>0003D2</td>
<td>50 F9 6 000</td>
<td>ST</td>
<td>15,00..ARRAY1(9)</td>
</tr>
</tbody>
</table>

---

*Figure 133 on page 294 shows the Language Environment dump for routine SAMPLE.*
CEE3845I CEEDEMP Processing started.
PLIDUMP was called from statement number 4 at offset +000000D6 from ERR ON-unit with entry address 2090022C

Information for enclave SAMPLE

Traceback:

<table>
<thead>
<tr>
<th>DSA</th>
<th>Entry</th>
<th>E Offset</th>
<th>Statement</th>
<th>Load Mod</th>
<th>Program Unit</th>
<th>Service</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CEEKKMRA</td>
<td>+0000081C</td>
<td>CEEPLPKA</td>
<td>CEEKKMRA</td>
<td>D1908</td>
<td>Call</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>IBMREXM</td>
<td>+000000C2</td>
<td>IBMREV10</td>
<td>IBMREXM</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ERR ON-unit</td>
<td>+000000D6</td>
<td>SAMPLE</td>
<td>SAMPLE</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>IBMREPL</td>
<td>+0000005A</td>
<td>IBMRLIB1</td>
<td>IBMREPL</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CEEEV010</td>
<td>+0000013A</td>
<td>IBMREV10</td>
<td>CEEEV010</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CEEDSP</td>
<td>+00000170</td>
<td>CEEPLPKA</td>
<td>CEEHDP</td>
<td>D1908</td>
<td>Call</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>SUB1</td>
<td>+000000EE</td>
<td>SAMPLE</td>
<td>SAMPLE</td>
<td>Exception</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SAMPLE</td>
<td>+00000154</td>
<td>SAMPLE</td>
<td>SAMPLE</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>IBMRSMPnia</td>
<td>+0000051E</td>
<td>IBMRLIB1</td>
<td>IBMRSMPnia</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>CEEEV010</td>
<td>+00000310</td>
<td>IBMREV10</td>
<td>CEEEV010</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>CEEBBEXT</td>
<td>+00000186</td>
<td>CEEPLPKA</td>
<td>CEEBBEXT</td>
<td>D1908</td>
<td>Call</td>
<td></td>
</tr>
</tbody>
</table>

DSA DSA Addr | E Addr | PU Addr | PU Offset | Comp Date | Compile Attributes |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 20845468</td>
<td>209F0420</td>
<td>209F0420</td>
<td>+0000081C</td>
<td>20061214</td>
<td>CEL</td>
</tr>
<tr>
<td>2 00025670</td>
<td>20B1C0A0</td>
<td>20B1C0A0</td>
<td>+000000C2</td>
<td>20061214</td>
<td>CEL</td>
</tr>
<tr>
<td>3 20845940</td>
<td>2090022C</td>
<td>2090022C</td>
<td>+000000D6</td>
<td>20061214</td>
<td>CEL</td>
</tr>
<tr>
<td>4 20845700</td>
<td>0019F50</td>
<td>0019F50</td>
<td>+0000005A</td>
<td>20061214</td>
<td>CEL</td>
</tr>
<tr>
<td>5 20845680</td>
<td>20802998</td>
<td>20802998</td>
<td>+0000013A</td>
<td>20061214</td>
<td>CEL</td>
</tr>
<tr>
<td>6 20842560</td>
<td>208F0F68</td>
<td>208F0F68</td>
<td>+00001700</td>
<td>20061214</td>
<td>CEL</td>
</tr>
<tr>
<td>7 20842460</td>
<td>20900360</td>
<td>20900360</td>
<td>+00000310</td>
<td>20061214</td>
<td>CEL</td>
</tr>
<tr>
<td>8 20842330</td>
<td>20900880</td>
<td>20900880</td>
<td>+00000154</td>
<td>20061214</td>
<td>CEL</td>
</tr>
<tr>
<td>9 20842178</td>
<td>00020100</td>
<td>00020100</td>
<td>+0000051E</td>
<td>20061214</td>
<td>CEL</td>
</tr>
<tr>
<td>10 208420F0</td>
<td>20802998</td>
<td>20802998</td>
<td>+00000310</td>
<td>20061214</td>
<td>CEL</td>
</tr>
<tr>
<td>11 20842030</td>
<td>20900880</td>
<td>20900880</td>
<td>+00000186</td>
<td>20061214</td>
<td>CEL</td>
</tr>
</tbody>
</table>

Condition Information for Active Routines

Condition Information for SAMPLE (DSA address 20842460)

CIB Address: 20842460

Current Condition:
IBM0281S A prior condition was promoted to the ERROR condition.

Original Condition:
CEE3209S The system detected a fixed-point divide exception (System Completion Code=0C9).

Location:
Program Unit: SAMPLE Entry: SUB1 Statement: 15 Offset: +000000EE

Machine State:
ILC..... 0004 Interruption Code..... 0009
PSW..... 078D2E00 A0900452

GPR0..... 00000000_20842560 GPR1..... 00000000_20842538 GPR2..... 00000000_090043E4 GPR3..... 00000000_208004E8
GPR4..... 00000000_2080056C GPR5..... 00000000_000000E0 GPR6..... 00000000_20842330 GPR7..... 00000000_20800404
GPR8..... 00000000_20842400 GPR9..... 00000000_000000E0 GPR10..... 00000000_208420B0 GPR11..... 00000000_208423F8
GPR12..... 00000000_208009C0 GPR13..... 00000000_20842460 GPR14..... 00000000_00000000 GPR15..... 00000000_00000000

Figure 133. Language Environment dump from example PL/I for MVS & VM routine (Part 1 of 3)
Figure 134. Language Environment dump from example PL/I for MVS & VM routine (Part 2 of 3)
**Figure 135. Language Environment dump from example PL/I for MVS & VM routine (Part 3 of 3)**

To understand the dump information and debug this routine, use the following steps:

1. Notice the title of the dump: PLIDUMP called from error ON-unit. This was the title specified when PLIDUMP was invoked, and it indicates that the ERROR condition was raised and PLIDUMP was called from within the ERROR ON-unit.

2. Locate the messages in the Condition Information section of the dump.
   - There are two messages. The current condition message indicates that a prior condition was promoted to the ERROR condition. The promotion of a condition occurs when the original condition is left unhandled (no PL/I for MVS & VM ON-units are assigned to gain control). The original condition message is CEE3209S. The system detected a Fixed Point divide exception. The original condition usually indicates the actual problem. For more information about this message, see z/OS Language Environment Runtime Messages.
   - In the traceback section, note the sequence of calls in the call chain. SAMPLE called SUB1 at statement 11, and SUB1 raised an exception at statement 15, PU offset X'3CE'.

3. Find the statement in the listing for SUB1 that raised the ZERODIVIDE condition. If SUB1 was compiled with GOSTMT and SOURCE, find statement 15 in the source listing.

Since the object listing was generated in this example, you can also locate the actual assembler instruction causing the exception at offset X'3CE' in the object...
listing for this routine, shown in Figure 132 on page 293. Either method shows that divisor was used as the divisor in a divide operation.

5. You can see from the declaration of SUB1 that divisor is a parameter passed from SAMPLE. Because of linkage conventions, you can infer that register 1 in the SAMPLE save area points to a parameter list that was passed to SUB1. divisor is the first parameter in the list.

6. In the SAMPLE DSA, the R1 value is X'20900590'. This is the address of the parameter list, which is located in static storage.

7. Find the parameter list in the stack frame; the address of the first parameter is X'20B42400' and the value of the first parameter is X'00000000'. Thus, the exception occurred when SAMPLE passed a 0 value used as a divisor in subroutine SUB1.
Chapter 8. Debugging Enterprise PL/I routines

This topic contains information that can help you debug applications that contain one or more Enterprise PL/I routines. Following a discussion about potential errors in Enterprise PL/I routines, the first part of this information discusses how to use compiler-generated listings to obtain information about Enterprise PL/I routines, and how to use PLIDUMP to generate a Language Environment dump of an Enterprise PL/I routine. The last part of the chapter provides examples of Enterprise PL/I routines and explains how to debug them using information contained in the traceback information provided in the dump.

Determining the source of errors in Enterprise PL/I routines

Most errors in Enterprise PL/I routines can be identified by the information provided in Enterprise PL/I runtime messages, which begin with the prefix IBM. For a list of these messages, see z/OS Language Environment Runtime Messages.

A malfunction in running an Enterprise PL/I routine can be caused by:
- Logic errors in the source routine
- Invalid use of Enterprise PL/I
- Unforeseen errors
- Invalid input data
- Compiler or runtime routine malfunction
- System malfunction
- Unidentified routine malfunction
- Overlaid storage

Logic errors in the source routine

Errors of this type are often difficult to detect because they often appear as compiler or library malfunctions. Some common errors in source routines are:
- Incorrect conversion from arithmetic data
- Incorrect arithmetic and string manipulation operations
- Unmatched data lists and format lists

Invalid use of Enterprise PL/I

A misunderstanding of the language or a failure to provide the correct environment for using Enterprise PL/I can result in an apparent malfunction of an Enterprise PL/I routine. Any of the following, for example, might cause a malfunction:
- Using uninitialized variables
- Using controlled variables that have not been allocated
- Reading records into incorrect structures
- Misusing array subscripts
- Misusing pointer variables
- Incorrect conversion
- Incorrect arithmetic operations
- Incorrect string manipulation operations

Unforeseen errors

If an error is detected during run time and no ON-unit is provided in the routine to terminate the run or attempt recovery, the job terminates abnormally. However,
the status of a routine at the point where the error occurred can be recorded by using an ERROR ON-unit that contains the following statements. ON ERROR SYSTEM ensures that further errors do not result in a permanent loop.

```
ON ERROR
BEGIN;
  ON ERROR SYSTEM;
  CALL PLIDUMP; /*generates a dump*/
  PUT DATA; /*displays variables*/
END;
```

**Invalid input data**

A routine should contain checks to ensure that any incorrect input data is detected before it can cause the routine to malfunction. Use the COPY option of the GET statement to check values obtained by stream-oriented input. The values are listed on the file named in the COPY option. If no file name is given, SYSPRINT is assumed.

**Compiler or runtime routine malfunction**

If you are certain that the malfunction is caused by a compiler or runtime routine error, you can either open a PMR or submit an APAR for the error. Meanwhile, you can try an alternative way to perform the operation that is causing the trouble. A bypass is often feasible, since the Enterprise PL/I language frequently provides an alternative method of performing operations.

**System malfunction**

System malfunctions include machine malfunctions and operating system errors. System messages identify these malfunctions and errors to the operator.

**Unidentified routine malfunction**

In most circumstances, an unidentified routine malfunction does not occur when using the compiler. If your routine terminates abnormally without an accompanying Language Environment runtime diagnostic message, the error causing the termination might also be inhibiting the production of a message. Check for the following:

- Your job control statements might be in error, particularly in defining data sets.
- Your routine might overwrite main storage areas containing executable instructions. This can happen if you have accidentally:
  - Assigned a value to a nonexistent array element. For example:
    ```
    DCL ARRAY(10);
    ;
    DO I = 1 TO 100;
    ARRAY(I) = VALUE;
    ```

condition so that each attempt to access an element outside the declared range of subscript values raises the SUBSCRIPTRANGE condition. If there is no ON-unit for this condition, a diagnostic message is printed and the ERROR condition is raised. This facility, though expensive in run time and storage space, is a valuable routine-testing aid.
- Used an incorrect locator value for a locator (pointer or offset) variable. This type of error can occur if a locator value is obtained by means of record-oriented transmission. Ensure that locator values created in one routine, transmitted to a data set, and subsequently retrieved for use in another routine, are valid for use in the second routine.

- Attempted to free a nonbased variable. This can happen when you free a based variable after its qualifying pointer value has been changed. For example:

```
DCL A STATIC,B BASED (P);
ALLOCATE B;
P = ADDR(A);
FREE B;
```

- Used the SUBSTR pseudovariable to assign a string to a location beyond the end of the target string. For example:

```
DCL X CHAR(3);
I=3
SUBSTR(X,2,I) = 'ABC';
```

To detect this type of error, enable the STRINGRANGE condition during compilation.

**Storage overlay problems**

If you suspect an error in your Enterprise PL/I application is a storage overlay problem, check for the following:

1. The use of a subscript outside the declared bounds (check the SUBSCRIPTRANGE condition)
2. An attempt to assign a string to a target with an insufficient maximum length (check the STRINGSIZE condition)
3. The failure of the arguments to a SUBSTR reference to comply with the rules described for the SUBSTR built-in function (check the STRINGRANGE condition)
4. The loss of significant last high-order (left-most) binary or decimal digits during assignment to an intermediate result or variable or during an input/output operation (check the SIZE condition)
5. The reading of a variable-length file into a variable
6. The misuse of a pointer variable
7. The invocation of a Language Environment callable service with fewer arguments than are required

The first four situations are associated with the listed Enterprise PL/I conditions, all of which are disabled by default. If you suspect one of these problems exists in your routine, use the appropriate condition prefix on the suspected statement or on the BEGIN or PROCEDURE statement of the containing block.

The fifth situation occurs when you read a data record into a variable that is too small. This type of problem only happens with variable-length files. You can often isolate the problem by examining the data in the file information and buffer.
The sixth situation occurs when you misuse a pointer variable. This type of storage overlay is particularly difficult to isolate. There are a number of ways pointer variables can be misused:

- When a READ statement runs with the SET option, a value is placed in a pointer. If you then run a WRITE statement or another READ SET option with another pointer, you overlay your storage if you try to use the original pointer.
- When you try to use a pointer to allocate storage that has already been freed, you can also cause a storage overlay.
- When you attempt to use a pointer set with the ADDR built-in function as a base for data with different attributes, you can cause a storage overlay.

The seventh situation occurs when a Language Environment callable service is passed fewer arguments than its interface requires. The following example might cause a storage overlay because Language Environment assumes that the fourth item in the argument list is the address of a feedback code, when in reality it could be residue data pointing anywhere in storage.

<table>
<thead>
<tr>
<th>Invalid calls</th>
<th>Valid calls</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCL CEEDATE ENTRY OPTIONS(ASM);</td>
<td>DCL CEEDATE ENTRY(<em>,</em>,<em>,</em> OPTIONAL) OPTIONS(ASM);</td>
</tr>
<tr>
<td>CALL CEEDATE(x,y,z); /* invalid */</td>
<td>CALL CEEDATE(x,y,z,<em>); /</em> valid */</td>
</tr>
<tr>
<td>CALL CEEDATE(x,y,z,f); /* valid */</td>
<td>CALL CEEDATE(x,y,z,f); /* valid */</td>
</tr>
</tbody>
</table>

**Using Enterprise PL/I compiler listings**

The following sections explain how to generate listings that contain information about your routine. Enterprise PL/I listings show machine instructions, constants, and external or internal addresses that the linkage editor resolves. This information can help you find other information, such as variable values, in a dump of an Enterprise PL/I routine.

**Note:** Enterprise PL/I shares a common compiler back-end with C/C++. The Enterprise PL/I assembler listing will, consequently, have a similar form to those from the XL C/C++ compiler.

The compiler listings included below are from the Enterprise PL/I product.

**Generating Enterprise PL/I listings and maps**

Table 47 shows compiler-generated listings that you might find helpful when you use information in dumps to debug Enterprise PL/I routines.

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
<th>Compiler Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source program</td>
<td>Source program statements</td>
<td>SOURCE</td>
</tr>
<tr>
<td>Cross reference</td>
<td>Cross reference of names with attributes</td>
<td>XREF and ATTRIBUTES</td>
</tr>
<tr>
<td>Aggregate table</td>
<td>Names and layouts of structures and arrays</td>
<td>AGGREGATE</td>
</tr>
<tr>
<td>Variable map</td>
<td>Offsets of automatic and static internal variables</td>
<td>MAP</td>
</tr>
<tr>
<td></td>
<td>(from their defining base)</td>
<td></td>
</tr>
<tr>
<td>Object code</td>
<td>Contents of the program control section in hexadecimal notation and translated into a pseudo-assembler format.</td>
<td>LIST</td>
</tr>
</tbody>
</table>
Table 47. Compiler-generated PL/I listings and their contents (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Contents</th>
<th>Compiler Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable map, object code, static</td>
<td>Same as MAP and LIST options above, plus contents of static internal and static external control sections in hexadecimal notation with comments</td>
<td>MAP and LIST</td>
</tr>
<tr>
<td>storage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finding information in Enterprise PL/I listings

Figure 136 shows the first two pages of an example Enterprise PL/I routine that was compiled with the LIST, MAP and SOURCE options.

Figure 136 on page 304 shows the output generated by the LIST and MAP options for this routine, including the pseudo-assembly listing, the external symbol dictionary and reference, the storage offset listing and the static and automatic storage maps. The sections following this example describe the contents of each type of listing.
### Timestamp and Version Information

- **Compiled Year:** `C'2007'
- **Compiled Date MMDD:** `0201`
- **Compiled Time HHMMSS:** `153250`
- **Compiler Version:** `030600`

### Service String

- String: `20070122`

---

### OFFSET OBJECT CODE LINE# FILE# PSEUDO ASSEMBLY LISTING

<table>
<thead>
<tr>
<th>Offset</th>
<th>Line#</th>
<th>File#</th>
<th>Pseudo Assembly Listing</th>
</tr>
</thead>
<tbody>
<tr>
<td>000000</td>
<td>000003</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000004</td>
<td>B 36(,r15)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000008</td>
<td>L r15,796(,r12)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000010</td>
<td>LR r4,r14</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000012</td>
<td>BALR r14,r15</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000014</td>
<td>A 0</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000018</td>
<td>L r14,76(,r13)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000020</td>
<td>LA r0,200(,r14)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000024</td>
<td>CL r0,788(,r12)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000028</td>
<td>A 0</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000030</td>
<td>LA r14,708(,r12)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000032</td>
<td>STM r14,r0,72(r14)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000035</td>
<td>MVI 0(r14),16</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000039</td>
<td>ST r13,4(,r14)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>00003D</td>
<td>LR r13,r14</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000040</td>
<td>L r6,=A(EXAMPLE)(,r3,2)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000044</td>
<td>L r0,=A(B)(,r3,10)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>000048</td>
<td>L r0,=A(C)(,r3,40)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
<tr>
<td>00004C</td>
<td>L r0,=A(D)(,r3,10)</td>
<td>EXAMPLE</td>
<td>DS 0D</td>
</tr>
</tbody>
</table>

---

**Figure 137. Compiler-generated listings from example Enterprise PL/I routine (Part 1 of 4)**
Figure 138. Compiler-generated listings from example Enterprise PL/I routine (Part 2 of 4)
*** General purpose registers used: 1111111100011111
*** Floating point registers used: 1111111100000000
*** Size of register spill area: 512(max) 0(used)
*** Size of dynamic storage: 200
*** Size of executable code: 350
*** CSECT Offset: 72 : 0x48

0001BC 0000 0000

Constant Area

5655-H31 IBM(R) Enterprise PL/I for z/OS

OFFSET OBJECT CODE LINE# FILE# PSEUDO ASSEMBLY LISTING

PPA1: Entry Point Constants

000000 ICCEA166 =F'483303782' Flags
000004 00001CB =A(PPA2-EXAMPLE) No PPA
000008 00000000 =F'0' No EPD
000010 FFE00000 =F'-2097152' Register save mask
000014 00000000 =F'0' Member flags
000018 90 =AL1(144) Flags
000019 00000000 =AL3(0) Callee's DSA use/8
00001C 90 =AL4(144) Flags
00001D 00000000 =AL5(0) State variable location
000020 00000000 =F'0' No primary
000024 500000AF =F'1342177455' CDF function length/2
000028 FFFFEB00 =F'-304' CDF function EP offset
00002C 38280000 =F'94214553' CDF prolog
000030 40000A07 =F'1074266279' CDF epilog
000034 00000000 =F'0' CDF end
000038 0007 **** AL2(7), C'EXAMPLE'

PPA1 End

PPA2: Compile Unit Block

000000 0800 3203 =F'184562179' Flags
000004 FFFFD800 =A(CESSTART-PPA2) Flags
000008 0000 0000 =F'0' No PPA
00000C FFFFD800 =A(TIMESTAMP-PPA2) No primary
000010 0000 0000 =F'0' No primary
000014 0200 0000 =F'33554432' Flags

PPA2 End

5655-H31 IBM(R) Enterprise PL/I for z/OS

EXTERNAL SYMBOL DICTIONARY

<table>
<thead>
<tr>
<th>NAME</th>
<th>TYPE</th>
<th>ID</th>
<th>ADDR</th>
<th>LENGTH</th>
<th>NAME</th>
<th>TYPE</th>
<th>ID</th>
<th>ADDR</th>
<th>LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXAMPLE1</td>
<td>SD</td>
<td>1</td>
<td>000000</td>
<td>000028</td>
<td>EXAMPLE2</td>
<td>SD</td>
<td>2</td>
<td>000000</td>
<td>00005C</td>
</tr>
<tr>
<td>EXAMPLE</td>
<td>SD</td>
<td>3</td>
<td>000000</td>
<td>000004</td>
<td>B</td>
<td>SD</td>
<td>4</td>
<td>000000</td>
<td></td>
</tr>
<tr>
<td>EXAMPLE</td>
<td>LD</td>
<td>0</td>
<td>000000</td>
<td>000000</td>
<td>CEEESG01</td>
<td>ER</td>
<td>5</td>
<td>000000</td>
<td></td>
</tr>
<tr>
<td>MQFREG</td>
<td>ER</td>
<td>6</td>
<td>000000</td>
<td></td>
<td>MQJDSB</td>
<td>ER</td>
<td>7</td>
<td>000000</td>
<td></td>
</tr>
<tr>
<td>MQFREG</td>
<td>ER</td>
<td>8</td>
<td>000000</td>
<td></td>
<td>CEEESTART</td>
<td>ER</td>
<td>9</td>
<td>000000</td>
<td></td>
</tr>
<tr>
<td>CEEESG01</td>
<td>SD</td>
<td>10</td>
<td>000000</td>
<td>000000C</td>
<td>IBMPINPL</td>
<td>ER</td>
<td>11</td>
<td>000000</td>
<td></td>
</tr>
</tbody>
</table>

5655-H31 IBM(R) Enterprise PL/I for z/OS

EXTERNAL SYMBOL CROSS REFERENCE

<table>
<thead>
<tr>
<th>ORIGINAL NAME</th>
<th>EXTERNAL SYMBOL NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXAMPLE1</td>
<td>EXAMPLE1</td>
</tr>
<tr>
<td>EXAMPLE2</td>
<td>EXAMPLE2</td>
</tr>
<tr>
<td>EXAMPLE</td>
<td>EXAMPLE</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>EXAMPLE</td>
<td>EXAMPLE</td>
</tr>
<tr>
<td>CEEESG01</td>
<td>CEEESG01</td>
</tr>
<tr>
<td>MQFREG</td>
<td>MQFREG</td>
</tr>
<tr>
<td>MQJDSB</td>
<td>MQJDSB</td>
</tr>
<tr>
<td>MQFREG</td>
<td>MQFREG</td>
</tr>
<tr>
<td>CEEESTART</td>
<td>CEEESTART</td>
</tr>
<tr>
<td>CEEESG01</td>
<td>CEEESG01</td>
</tr>
<tr>
<td>IBMPINPL</td>
<td>IBMPINPL</td>
</tr>
</tbody>
</table>

Figure 139. Compiler-generated listings from example Enterprise PL/I routine (Part 3 of 4)
Pseudo assembly listing

The pseudo assembly listing consists of the machine instructions and a translation of these instructions into a form that resembles assembler code. This listing always starts with a small section of non-executable data that records the date and time when the object was produced as well as the version of the compiler used to produce the object. This section ends with a service string which in the listing is followed by the build date for the compiler back-end that generated this part of the listing (and this date may be different from the build date for the compiler front-end that generated the first pages of the listing).

The majority of the pseudo assembly listing consists of the object code arranged in columns that specify for each instruction:
- Its offset.
- the instruction in object code format.
- Its associated line number.
- Its associated file number if non-zero (for example, if from an include file).
• the instruction in mnemonic format.

**External symbol dictionary**
The external symbol dictionary lists all the external symbols generated for this compilation. For each symbol, it also lists its linkage type and size (in hex).

**External symbol cross reference**
The external symbol dictionary cross reference shows for each external symbol the name that will be visible externally to the linker.

**Storage offset listing**
Each line of the storage offset listing contains the following information for each user variable:
• Its name.
• the number of the block in which it was declared.
• the number of the file in which it was declared.
• the number of the line in which it was declared.
• Its class (automatic, static, etc).
• Its location (as appropriate for its class).
• Its byte length in decimal.

This list is sorted by block number and then by name within each block.

**Static map**
Each line of the static storage map contains the following information for each internal static variable:
• Its hexadecimal offset.
• Its byte length in hex.
• Its name.

This list is sorted by the offset of the variables in static. This list of variables may also include compiler-generated variables.

**Automatic map**
Each line of the automatic storage map contains the following information, grouped by named block, for each automatic variable in that block:
• Its hexadecimal offset.
• Its byte length in hex.
• Its name.

These lists are sorted by the offset of the variables in automatic for each block. These lists of variables may also include compiler-generated variables.

---

**Generating a Language Environment dump of an Enterprise PL/I routine**

To generate a dump of an Enterprise PL/I routine, you can call either the Language Environment callable service CEE3DMP or PLIDUMP. For information about calling CEE3DMP, see “Generating a Language Environment dump with CEE3DMP” on page 37.

**PLIDUMP syntax and options**

PLIDUMP calls intermediate Enterprise PL/I library routines, which convert most PLIDUMP options to CEE3DMP options. The following list contains PLIDUMP options and the corresponding CEE3DMP option, if applicable. Some PLIDUMP
options do not have corresponding CEE3DMP options, but continue to function as Enterprise PL/I default options. The list following the syntax diagram provides a description of those options.

PLIDUMP conforms to National Language Support standards. PLIDUMP can supply information across multiple Language Environment enclaves. If an application running in one enclave fetches a main procedure (an action that creates another enclave), PLIDUMP contains information about both procedures. The syntax and options for PLIDUMP are shown below.

**Syntax**

```
$ PLIDUMP (char.-string-exp 1, char.-string-exp 2)
```

*char.-string-exp 1*

A dump options character string consisting of one or more of the following values. T, F, C, and A are the default options.

- **A** All. Results in a dump of all tasks including the ones in the WAIT state.
- **B** BLOCKS (Enterprise PL/I hexadecimal dump). Dumps the control blocks used in Language Environment and member language libraries. For Enterprise PL/I, this includes the DSA for every routine on the call chain and Enterprise PL/I "global" control blocks, such as Tasking Implementation Appendage (TIA), Task Communication Area (TCA), and the PL/I Tasking Control Block (PTCB). Enterprise PL/I file control blocks and file buffers are also dumped if the F option is specified.
- **C** Continue. The routine continues after the dump.
- **E** Exit. The enclave terminates after the dump. In a multitasking environment, if PLIDUMP is called from the main task, the enclave terminates after the dump. If PLIDUMP is called from a subtask, the subtask and any subsequent tasks created from the subtask terminate after the dump. In a multithreaded environment, if PLIDUMP is called from the Initial Process Thread (IPT), the enclave terminates after the dump. If PLIDUMP is called from a non-IPT, only the non-IPT terminates after the dump.
- **F** FILE INFORMATION. A set of attributes for all open files is given. The contents of the file buffers are displayed if the B option is specified.
- **H** STORAGE in hexadecimal. A SNAP dump of the region is produced. A ddname of CEESNAP must be provided to direct the CEESNAP dump report.
- **K** BLOCKS (when running under CICS). The Transaction Work Area is included.

**Note:** This option is not supported under Enterprise PL/I.

- **NB** NOBLOCKS.
- **NF** NOFILES.
- **NH** NOSTORAGE.
**NK** NOBLOCKS (when running under CICS).

**NT** NOTRACEBACK.

**O** THREAD(CURRENT). Results in a dump of only the current task or current thread (the invoker of PLIDUMP).

**S** Stop. The enclave terminates after the dump. In a multitasking environment, regardless of whether PLIDUMP is called from the main task or a subtask, the enclave terminates after the dump. In a multithreaded environment, regardless of whether PLIDUMP is called from the IPT or a non-IPT, the enclave terminates after the dump (in which case there is no fixed order as to which thread terminates first).

**T** TRACEBACK. Includes a traceback of all routines on the call chain. The traceback shows transfers of control from either calls or exceptions. BEGIN blocks and ON-units are also control transfers and are included in the trace. The traceback extends backwards to the main program of the current thread.

`char-string-exp 2`

A user-identified character string up to 80 characters long that is printed as the dump header.

**PLIDUMP usage notes**

If you use PLIDUMP, the following considerations apply:

- If a routine calls PLIDUMP a number of times, use a unique user-identifier for each PLIDUMP invocation. This simplifies identifying the beginning of each dump.
- In MVS or TSO, you can use ddnames of CEEDUMP, PLIDUMP, or PL1DUMP to direct dump output. If no ddname is specified, CEEDUMP is used.
- The data set defined by the PLIDUMP, PL1DUMP, or CEEDUMP DD statement should specify a logical record length (LRECL) of at least 131 to prevent dump records from wrapping.
- When you specify the H option in a call to PLIDUMP, the Enterprise PL/I library issues an OS SNAP macro to obtain a dump of virtual storage. The first invocation of PLIDUMP results in a SNAP identifier of 0. For each successive invocation, the ID is increased by one to a maximum of 256, after which the ID is reset to 0.
- Support for SNAP dumps using PLIDUMP is provided only under MVS. SNAP dumps are not produced in a CICS environment.
  - If the SNAP does not succeed, the CEE3DMP DUMP file displays the message:
    `Snap was unsuccessful`
    Failure to define a CEESNAP data set is the most likely cause of an unsuccessful CEESNAP.
  - If the SNAP is successful, CEE3DMP displays the message, where `nnn` corresponds to the SNAP identifier described above. An unsuccessful SNAP does not result in an incrementation of the identifier.
    `Snap was successful; snap ID = nnn`
- To ensure portability across system platforms, use PLIDUMP to generate a dump of your Enterprise PL/I routine.
Finding Enterprise PL/I information in a dump

The following sections discuss Enterprise PL/I-specific information located in the following sections of a Language Environment dump:

- Traceback
- Control Blocks for Active Routines
- Control Block Associated with the Thread
- File Status and Attributes

Traceback

Examine the traceback section of the dump, shown in Figure 141 on page 312, for condition information about your routine and information about the statement number and address where the exception occurred.
Condition information

If the dump was called from an ON-unit, the type of ON-unit is identified in the traceback as part of the entry information. For ON-units, the values of any relevant condition built-in functions (for example, ONCHAR and ONSOURCE for conversion errors) appear. In cases where the cause of entry into the ON-unit is not stated, usually when the ERROR ON-unit is called, the cause of entry appears in the condition information.
Statement number and address where error occurred
This information, which is the point at which the condition that caused entry to the ON-unit occurred, can be found in the traceback section of the dump. If the condition occurs in compiled code, and you compiled your routine with either GOSTMT or GONUMBER, the statement numbers appear in the dump. To identify the assembler instruction that caused the error, use the traceback information in the dump to find the program unit (PU) offset of the statement number in which the error occurred. Then find that offset and the corresponding instruction in the object code listing.

Control blocks for active routines
This section shows the stack frames for all active routines, and the static storage. Use this section of the dump to identify variable values, determine the contents of parameter lists, and locate the timestamp. [Figure 142 on page 314] shows this section of the dump.
Automatic variables
To find automatic variables, use an offset from the stack frame of the block in which they are declared. This information appears in the variable storage map generated when the MAP compiler option is in effect. If you have not used the MAP option, you can determine the offset by studying the listing of compiled code instructions.

Static variables
If your routine is compiled with the MAP option, you can find static variables by using an offset in the variable storage map. If the MAP option is not in effect, you can determine the offset by studying the listing of compiled code.
Based variables
To locate based variables, use the value of the defining pointer. Find this value by using one of the methods described above to find static and automatic variables. If the pointer is itself based, you must find its defining pointer and follow the chain until you find the correct value.

The following is an example of typical code for X BASED (P), with P AUTOMATIC. P is held at offset X'C8' from register 13. This address points to X.

| 58 60 0 C8 | L 6,P |
| 58 E0 6 000 | L 14,X |

Take care when examining a based variable to ensure that the pointers are still valid.

Area variables
Area variables are located using one of the methods described above, according to their storage class.

The following is an example of typical code: for an area variable A declared AUTOMATIC. The area starts at offset X'F8' from register 13.

| 41 60 D 0F8 | LA 6,A |

Variables in areas
To find variables in areas, locate the area and use the offset to find the variable.

Contents of parameter lists
To find the contents of a passed parameter list, first find the register 1 value in the save area of the calling routine’s stack frame. Use this value to locate the parameter list in the dump. If R1=0, no parameters passed.

Control blocks associated with the thread
This section of the dump, shown in Figure 143 on page 316 includes information about Enterprise PL/I fields of the CAA and other control block information.
Figure 143. Control blocks associated with the thread section of the dump (Enterprise PL/I) (Part 1 of 2)
CAA address
The address of the CAA control block appears in this section of the dump. If the BLOCK option is in effect, the complete CAA (including the Enterprise PL/I implementation appendage) appears separately from the body of the dump. Register 12 addresses the CAA.

File status and attribute information
This part of the dump includes the following information:
- The default and declared attributes of all open files
- Buffer contents of all file buffers
- The contents of FCBs, DCBs, DCLCBs, IOCBs, and control blocks for the process or enclave

Figure 144. Control blocks associated with the thread section of the dump (Enterprise PL/I) (Part 2 of 2)
Enterprise PL/I contents of the Language Environment trace table

Language Environment provides three Enterprise PL/I trace table entry types that contain character data:

- Trace entry 100 occurs when a task is created.
- Trace entry 101 occurs when a task that contains the tasking CALL statements is terminated.
- Trace entry 102 occurs when a task that does not contain a tasking CALL statement is terminated.

The format for trace table entries 100, 101, and 102 follows. For more information about the Language Environment trace table format, see "Understanding the trace table entry (TTE)" on page 154.

```
---(100) NameOfCallingTask NameOfCalledTask OffsetOfCallStmt
      UserAgrPtr CalledTaskPtr TaskVarPtr EventVarPtr
      PriorityPtr CallingR2-R5 CallingR12-R14
---(101) NameOfReturnTask ReturnerR2-R5 ReturnerR12-R14
---(102) NameOfReturnTask
```

Debugging example of Enterprise PL/I routines

This section contains examples of Enterprise PL/I routines and instructions for using information in the Language Environment dump to debug them. Important areas in the source code and in the dump for each routine are highlighted.

Subscript range error

Figure 145 on page 319 illustrates an error caused by an array subscript value outside the declared range. In this example, the declared array value is 10. This routine was compiled with the options LIST, TEST, GONUMBER, and MAP. It was run with the TERMTHDACT(TRACE) option to generate a traceback for the condition.
Figure 146 on page 320 shows sections of the dump generated by a call to PLIDUMP.
PLIDUMP was called from statement number 9 at offset +000000D2 from _ON_Begin_7_Blk_2 with entry address 11200240

Information for enclave EXAMPLE

Information for thread 8000000000000000

Traceback:

<table>
<thead>
<tr>
<th>DSA</th>
<th>Entry</th>
<th>E Offset</th>
<th>Statement</th>
<th>Load Mod</th>
<th>Program Unit</th>
<th>Service</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IBMPDUMP</td>
<td>+0000002AE</td>
<td></td>
<td></td>
<td>IBMPEV11</td>
<td>P07B386</td>
<td>Call</td>
</tr>
<tr>
<td>2</td>
<td>_ON_Begin_7_Blk_2</td>
<td>+000000D2</td>
<td>9</td>
<td>EXAMPLE</td>
<td>_Begin_12_Blk_3</td>
<td>Call</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>IBMPSOR</td>
<td>+0000002A2</td>
<td></td>
<td></td>
<td>IBMPEV11</td>
<td>P07B426</td>
<td>Call</td>
</tr>
<tr>
<td>4</td>
<td>IBMPEPOP</td>
<td>+0000004DC</td>
<td></td>
<td></td>
<td>IBMPEV11</td>
<td>LE19BAS</td>
<td>Call</td>
</tr>
<tr>
<td>5</td>
<td>CEEV011</td>
<td>+000001700</td>
<td></td>
<td></td>
<td>CEEPLPKA</td>
<td>CEEHDSP</td>
<td>D1908</td>
</tr>
<tr>
<td>7</td>
<td>IBMESSR</td>
<td>+0000000AA</td>
<td></td>
<td></td>
<td>IBMPEV11</td>
<td>LE19BAS</td>
<td>Call</td>
</tr>
<tr>
<td>8</td>
<td>ERR_RAISE_COND</td>
<td>+00000090</td>
<td></td>
<td>IBMPEV11</td>
<td></td>
<td>LE19BAS</td>
<td>Call</td>
</tr>
<tr>
<td>9</td>
<td>IBMPERSU</td>
<td>+0000000B2</td>
<td></td>
<td></td>
<td>IBMPEV11</td>
<td>LE19BAS</td>
<td>Call</td>
</tr>
<tr>
<td>10</td>
<td>_Begin_12_Blk_3</td>
<td>+00000100</td>
<td>16</td>
<td>EXAMPLE</td>
<td>_Begin_12_Blk_3</td>
<td>Call</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>EXAMPLE</td>
<td>+0000008B0</td>
<td></td>
<td></td>
<td>EXAMPLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>IBMMMINV</td>
<td>+0000004DE</td>
<td></td>
<td></td>
<td>IBMPEV11</td>
<td>IBMPPMINV</td>
<td>Call</td>
</tr>
<tr>
<td>13</td>
<td>CEEV011</td>
<td>+00000202</td>
<td></td>
<td></td>
<td>IBMPEV11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>CEEBBEXT</td>
<td>+000001B6</td>
<td></td>
<td></td>
<td>CEEPLPKA</td>
<td>CEEBBEXT</td>
<td>D1908</td>
</tr>
</tbody>
</table>

Condition Information for Active Routines

Condition Information for (DSA address 11A36E68):

CIB Address: 11A3B178

Current Condition:

IBMO2815 A prior condition was promoted to the ERROR condition.

Original Condition:

IBMO4215 UNCOND=520 The SUBSCRIPTRANGE condition was raised.

Location:

Program Unit: Entry: IBMBERRI Statement: Offset: +000000AA

Storage dump near condition, beginning at location: 114AAAB2

Condition Information for Active Routines:

Condition Information for (DSA address 11A36E68):

CIB Address: 11A3B178

Current Condition:

IBMO2815 A prior condition was promoted to the ERROR condition.

Original Condition:

IBMO4215 UNCOND=520 The SUBSCRIPTRANGE condition was raised.

Location:

Program Unit: Entry: IBMBERRI Statement: Offset: +000000AA

Storage dump near condition, beginning at location: 114AAAB2

Figure 146. Sections of the Language Environment dump (Part 1 of 2)
Figure 147. Sections of the Language Environment dump (Part 2 of 2)

To debug this routine, use the following steps:

1. In the dump, PLIDUMP was called by the ERROR ON-unit in statement 9. The traceback information in the dump shows that the exception occurred following statement 16.

Chapter 8. Debugging Enterprise PL/I routines
Note: In the Language Environment dumps, the columns and messages refer to "statements", but the numbers are actually (for Enterprise PL/I) the line numbers from the source file.

2. Locate the Original Condition message in the Condition Information for Active Routines section of the dump. The message is IBM0421S ONCODE=520 The SUBSCRIPTRANGE condition was raised. This message indicates that the exception occurred when an array element value exceeded the subscript range value (in this case, 10). For more information about this message, see z/OS Language Environment Runtime Messages.

3. Locate statement 14 in the routine in Figure 145 on page 319. The instruction is Array_End = 20. This statement assigns a 20 value to the variable Array_End.

4. Statement 15 begins the DO-loop instruction Do I = 1 to Array_End. Since the previous instruction (statement 14) specified that Array_End = 20, the loop in statement 10 should run until I reaches a 20 value.

The instruction in statement 4, however, declared a 10 value for the array range. Therefore, when the I value reached 11, the SUBSCRIPTRANGE condition was raised.

The following steps provide another method for finding the value that raised the SUBSCRIPTRANGE condition.

1. Locate the offset of variable I in the storage offset listing in Figure 145 on page 319. Use this offset to find the I value at the time of the dump. In this example, the offset is X'E8'.

2. Now find offset X'E8' from the start of the stack frame for the entry EXAMPLE in Figure 146 on page 320. The block located at this offset contains the value that exceeded the array range, X'B' or 11.

Calling a nonexistent subroutine

Figure 148 on page 323 demonstrates the error of calling a nonexistent subroutine. This routine was compiled with the LIST, MAP, and GONUMBER compiler options. It was run with the TERMTHDACT(DUMP) runtime option to generate a traceback.
Figure 149 on page 324 shows the traceback and condition information sections from the dump.
CEE3DMP V1 R12.0: Plidump called from error On-unit 01/26/10 4:02:32 PM Page: 1

ASID: 0065 Job ID: J0009417 Job name: LEDGSMP2 Step name: GO UserID: BARBARA

ASID: 0065 Job ID: J0009417 Job name: LEDGSMP2 Step name: GO UserID: BARBARA

CEEDUMP Processing started.

CEE3845I CEEDUMP Processing started.

PLIDUMP was called from statement number 9 at offset +000000D2 from _ON_Begin_7_Blk_2 with entry address 0B9008A8

Information for enclave EXAMPLE1

Information for thread 8000000000000000

Traceback:

<table>
<thead>
<tr>
<th>DSA</th>
<th>Entry</th>
<th>E Offset</th>
<th>Statement</th>
<th>Load Mod</th>
<th>Program Unit</th>
<th>Service</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IBMPDUMP</td>
<td>+000002AE</td>
<td>IBMPV11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>_ON Begin_7_Blk_2</td>
<td>+000000D2</td>
<td>EXAMPLE1</td>
<td>_ON Begin_7_Blk_2</td>
<td></td>
<td>Call</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>IBMPESR</td>
<td>+000002A2</td>
<td>IBMPV11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>IBMPESIP</td>
<td>+000004DC</td>
<td>IBMPV11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CEEEV011</td>
<td>+00001700</td>
<td>CEEPLPKA</td>
<td>CEEHDSP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CEEEV011</td>
<td>-0B9009A8</td>
<td>EXAMPLE1</td>
<td>_ON Begin_7_Blk_2</td>
<td></td>
<td>Exception</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>IBMPMINV</td>
<td>+000004DE</td>
<td>IBMPV11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>CEEEV011</td>
<td>+00000202</td>
<td>IBMPV11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>CEEBBEXT</td>
<td>+00000186</td>
<td>CEEPLPKA</td>
<td>CEEBBEXT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DSA DSA Addr E Addr PU Addr PU Offset Comp Date Compile Attributes

1 0C13DA70 0BBA4E38 0BBA4E38 +000002AE 20061214 LIBRARY EBCDIC HFP
2 0C13D990 0B9008A8 0B9008A8 +000000D2 20070131 ENT PL/I EBCDIC HFP
3 0C13D7F8 0BBA7B98 0BBA7B98 +000002A2 20061214 LIBRARY EBCDIC HFP
4 0C13D628 0BBAF390 0BBAF390 +000004DC 20061214 LIBRARY EBCDIC HFP
5 0C13D598 0BB062E8 0BB062E8 +00000132 20061214 LIBRARY
6 0C13D478 0C13DA70 0C13DA70 +000002AE 20061214 LIBRARY
7 0C13D3B8 0B9C3238 0B9C3238 +00000132 20061215 CEL
8 0C13D2B8 0BBDD990 0BBDD990 +000004DE 20061214 LIBRARY
9 0C13D1B8 0BB062E8 0BB062E8 +00000202 20061214 LIBRARY
10 0C13D0B8 0B911768 0B911768 +00000186 20061215 CEL

Condition Information for Active Routines

Condition Information for _ON Begin_7_Blk_2 (DSA address 0C13A3B8)

CIB Address: 0C13AD98

Current Condition:

CEE3201S The system detected an operation exception (System Completion Code=0C1).

Location:

Program Unit: _ON Begin_7_Blk_2
Statement: Offset: -0B9009A8
Possible Bad Branch: Statement: 12 Offset: +000001AE

Machine State:

ILC..... 0002 Interruption Code..... 0001
PSW..... 078D0600 80000002
GPR0..... 00000000_0C13A3B8 GPR1..... 00000000_0B9008A8 GPR2..... 00000000_0B911768 GPR3..... 00000000_0B9009E2
GPR4..... 00000000_0C13A0D8 GPR5..... 00000000_00000000 GPR6..... 00000000_0B900DA0 GPR7..... 00000000_00000000
GPR8..... 00000000_0B911648 GPR9..... 00000000_00000008 GPR10.... 00000000_0C13A0B0 GPR11.... 00000000_0B900F1C
GPR12.... 00000000_0B9129B0 GPR13.... 00000000_0C13A3B8 GPR14.... 00000000_8B900A58 GPR15.... 00000000_00000000
FPC...... F0000000
FPR0..... 26100000 00000000 FPR1..... 00000000 00000000 FPR2..... 18000000 00000000 FPR3..... 00000000 00000000
FPR4..... 00000000 00000000 FPR5..... 00000000 00000000 FPR6..... 00000000 00000000 FPR7..... 00000000 00000000
FPR8..... 00000000 00000000 FPR9..... 00000000 00000000 FPR10.... 00000000 00000000 FPR11.... 00000000 00000000
FPR12.... 00000000 00000000 FPR13.... 00000000 00000000 FPR14.... 00000000 00000000 FPR15.... 00000000 00000000

Storage dump near condition, beginning at location: 00000000

GPREG STORAGE:

Storage around GPR0 (0C13A3B8)
-0000 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 |
+0000 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 0C13A388 |

Figure 149. Traceback and condition information of the Language Environment dump (Enterprise PL/I) (Part 1 of 2)
To understand the traceback and debug this example routine, use the following steps:

1. Find the Current Condition message in the Condition Information for Active Routines section of the dump. The message is CEE3201S The system detected an Operation exception. For more information about this message, see [Z/OS Language Environment Runtime Messages](#).

This section of the dump also provides such information as the name of the active routine and the current statement number at the time of the dump. The Location section indicates that the exception occurred at offset X'0B9009A8' within entry EXAMPLE1 and that there may have been a bad branch from offset X'0000001A' statement 12 within entry EXAMPLE1.

2. Locate statement 12 in the routine [Figure 148 on page 323](#). This statement calls subroutine Prog01. The message CEE3201S, which indicates an operations exception, was generated because of an unresolved external reference.
3. Check the linkage editor output for error messages.

**Divide-by-zero error**

Figure 151 demonstrates a divide-by-zero error. In this example, the main Enterprise PL/I routine passed bad data to an Enterprise PL/I subroutine. The bad data in this example is 0, and the error occurred when the subroutine SUB1 attempted to use this data as a divisor.

Because variables are not usually displayed in a PLIDUMP dump, this routine included a PUT DATA statement, which generated a listing of arguments and variables used in the routine. Figure 152 shows this output.

The routine in Figure 151 was compiled with the LIST compiler option, which generated the object code listing shown in Figure 153 on page 327.
Figure 153. Object code listing from example Enterprise PL/I routine

Figure 154 on page 328 shows the Language Environment dump for routine SAMPLE.
PLIDUMP was called from statement number 6 at offset +000000D4 from _ON_Begin_4_Blk_Z with entry address 11200340

Information for enclave SAMPLE

Information for thread 0000000000000000

<table>
<thead>
<tr>
<th>DSA</th>
<th>OSA Addr</th>
<th>E Addr</th>
<th>PU Addr</th>
<th>PU Offset</th>
<th>Comp Date</th>
<th>Compile Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11A3EDE40</td>
<td>11A4E5338</td>
<td>11A4E5338</td>
<td>+000000A8</td>
<td>20061214</td>
<td>LIBRARY EBCDIC HFP</td>
</tr>
<tr>
<td>2</td>
<td>11A3EB000</td>
<td>11200340</td>
<td>11200000</td>
<td>+000004A4</td>
<td>20070131</td>
<td>ENT PL/I EBCDIC HFP</td>
</tr>
<tr>
<td>3</td>
<td>11A3EA1B8</td>
<td>114A69898</td>
<td>114A69898</td>
<td>+00000A02</td>
<td>20061214</td>
<td>LIBRARY EBCDIC HFP</td>
</tr>
<tr>
<td>4</td>
<td>11A3EB0788</td>
<td>11A409390</td>
<td>11A409390</td>
<td>+00000406</td>
<td>20061214</td>
<td>LIBRARY EBCDIC HFP</td>
</tr>
<tr>
<td>5</td>
<td>11A3EB990</td>
<td>114A72E28</td>
<td>114A72E28</td>
<td>+00000132</td>
<td>20061214</td>
<td>LIBRARY</td>
</tr>
<tr>
<td>6</td>
<td>11A3EB995</td>
<td>112C42B38</td>
<td>112C42B38</td>
<td>+00000170</td>
<td>20061215</td>
<td>CEL</td>
</tr>
<tr>
<td>7</td>
<td>11A3EB338</td>
<td>11200000</td>
<td>11200000</td>
<td>+0000016C</td>
<td>20070131</td>
<td>ENT PL/I EBCDIC HFP</td>
</tr>
<tr>
<td>8</td>
<td>11A3EB338</td>
<td>1120048B</td>
<td>11200000</td>
<td>+000003B2</td>
<td>20070131</td>
<td>ENT PL/I EBCDIC HFP</td>
</tr>
<tr>
<td>9</td>
<td>11A3EB9A0</td>
<td>11A4E9900</td>
<td>11A4E9900</td>
<td>+000004DE</td>
<td>20061214</td>
<td>LIBRARY</td>
</tr>
<tr>
<td>10</td>
<td>11A3EB950</td>
<td>11A4072E8</td>
<td>11A4072E8</td>
<td>+00000202</td>
<td>20061214</td>
<td>LIBRARY</td>
</tr>
<tr>
<td>11</td>
<td>11A3EB9A0</td>
<td>11292208</td>
<td>11292208</td>
<td>+00000186</td>
<td>20061215</td>
<td>CEL</td>
</tr>
</tbody>
</table>

Condition Information for Active Routines

Original Condition:
IBMRD205 A prior condition was promoted to the ERROR condition.

Condition Information for SUB1 [OSA address 11A3B53B]
CIB Address: 11A3B598
Current Condition:
CEE3209S The system detected a fixed-point divide exception (System Completion Code=0C9).

Location:
Program Unit: SUB1 Entry: SUB1 Statement: 27 Offset: +000001C6

Machine State:
PSW..... 078D2600 91200298
FPN..... 0000000000000000
GPR0..... 0000000000000000 GPR1.... 0000000000000000 GPR2..... 0000000000000000 GPR3..... 0000000000000000 GPR4..... 0000000000000000 GPR5..... 0000000000000000 GPR6..... 0000000000000000 GPR7..... 0000000000000000 GPR8..... 0000000000000000 GPR9..... 0000000000000000 GPR10..... 0000000000000000 GPR11..... 0000000000000000 GPR12..... 0000000000000000 GPR13..... 0000000000000000 GPR14..... 0000000000000000 GPR15..... 0000000000000000 GPR16..... 0000000000000000 GPR17..... 0000000000000000 GPR18..... 0000000000000000 GPR19..... 0000000000000000 GPR20..... 0000000000000000 GPR21..... 0000000000000000 GPR22..... 0000000000000000 GPR23..... 0000000000000000 GPR24..... 0000000000000000 GPR25..... 0000000000000000 GPR26..... 0000000000000000 GPR27..... 0000000000000000 GPR28..... 0000000000000000 GPR29..... 0000000000000000 GPR30..... 0000000000000000 GPR31..... 0000000000000000

Storage dump near condition, beginning at location: 11200286
+000000 11200286 58202014C 58202008 58202000 8E800020 1DB21849 58200158 50402000 4400C1AC [...J.---------b....J.& ....A.|...

Figure 154. Language Environment dump from example Enterprise PL/I routine (Part 1 of 2)
Figure 155. Language Environment dump from example Enterprise PL/I routine (Part 2 of 2)

Chapter 8. Debugging Enterprise PL/I routines 329
To understand the dump information and debug this routine, use the following steps:

1. Notice the title of the dump: PLIDUMP called from error ON-unit. This was the title specified when PLIDUMP was invoked, and it indicates that the ERROR condition was raised and PLIDUMP was called from within the ERROR ON-unit.

2. Locate the messages in the Condition Information section of the dump. There are two messages. The current condition message indicates that a prior condition was promoted to the ERROR condition. The promotion of a condition occurs when the original condition is left unhandled (no Enterprise PL/I ON-units are assigned to gain control). The original condition message is CEE3209S The system detected a fixed-point divide exception. The original condition usually indicates the actual problem. For more information about this message, see z/OS Language Environment Runtime Messages.

3. In the traceback section, note the sequence of calls in the call chain. SAMPLE called SUB1 at statement 19, and SUB1 raised an exception at statement 27, PU offset X'1C6'.

4. Find the statement in the listing for SUB1 that raised the ZERODIVIDE condition. If SUB1 was compiled with GOSTMT and SOURCE, find statement 27 in the source listing. Since the object listing was generated in this example, you can also locate the actual assembler instruction causing the exception at offset X'1C6' in the object listing for this routine, shown in Figure 153 on page 327. Either method shows that divisor was loaded into register 2 (r2) and used as the divisor in a divide operation.

5. You can see from the declaration of SUB1 that divisor is a parameter passed from SAMPLE. Because of linkage conventions, you can infer that register 1 in the SAMPLE save area points to a parameter list that was passed to SUB1. divisor is the first parameter in the list.

6. In the SAMPLE DSA, the R1 value is X'11A3B450'. This is the address of the parameter list, which is located in static storage.

7. Find the parameter list in the stack frame; the address of the first parameter is X'11A3B484' and the value of the first parameter is X'00000000'. Thus, the exception occurred when SAMPLE passed a 0 value used as a divisor in subroutine SUB1.
Chapter 9. Debugging under CICS

This section provides information for debugging under the Customer Information Control System (CICS). The following sections explain how to access debugging information under CICS, and describe features unique to debugging under CICS.

Use the following list as a quick reference for debugging information:
- Language Environment runtime messages (CESE transient data queue)
- Language Environment traceback (CESE transient data queue)
- Language Environment dump output (CESE transient data queue)
- CICS Transaction Dump (CICS DFHDMPA or DFHDMPB data set)
- Language Environment abend and reason codes (system console)
- Language Environment return codes to CICS (system console)

If the EXEC CICS HANDLE ABEND command is active and the application, or CICS, initiates an abend or application interrupt, then Language Environment does not produce any runtime messages, tracebacks, or dumps.

If EXEC CICS ABEND NODUMP is issued, then no Language Environment dumps or CICS transaction dumps are produced.

Accessing debugging information

The following sections list the debugging information available to CICS users, and describe where you can find this information.

Under CICS, the Language Environment runtime messages, Language Environment traceback, and Language Environment dump output are written to the CESE transient data queue. The transaction identifier, terminal identifier, date, and time precede the data in the queue. For detailed information about the format of records written to the transient data queue, see [z/OS Language Environment Programming Guide](#).

The CESE transient data queue is defined in the CICS destination control table (DCT). The CICS macro DFHDCT is used to define entries in the DCT. See [CICS Resource Definition Guide](#) for a detailed explanation of how to define a transient data queue in the DCT. If you are not sure how to define the CESE transient data queue, see your system programmer.

Locating Language Environment runtime messages

Under CICS, Language Environment runtime messages are written to the CESE transient data queue. The following example shows a Language Environment message that appears when an application abends due to an unhandled condition from an EXEC CICS command.

```plaintext
P039UTV9 19910916145313 CEE3250C The System or User ABEND AEI0 was issued.
P039UTV9 19910916145313 From program unit UT9CVERI at entry point UT9CVERIT +0000011E at P039UTV9 19910916145313 at offset address 0006051E.
```
Locating the Language Environment traceback

Under CICS, the Language Environment traceback is written to the CESE transient data queue. Because Language Environment invokes your application routine, the Language Environment routines that invoked your routine appear in the traceback. Figure 156 shows an example Language Environment traceback written to the CESE transient data queue. Data unnecessary for this example has been replaced by ellipses.

Locating the Language Environment dump

Under CICS, the Language Environment dump output is written to the CESE transient data queue. For active routines, the Language Environment dump contains the traceback, condition information, variables, storage, and control block...
information for the thread, enclave, and process levels. Use the Language Environment dump with the CICS transaction dump to locate problems when operating under CICS. For a sample Language Environment dump, see “Understanding the Language Environment dump” on page 44.

Using CICS transaction dump

The CICS transaction dump is generated to the DFHDMPA or DFHDMPB data set. The offline CICS dump utility routine converts the transaction dump into formatted, understandable output.

The CICS transaction dump contains information for the storage areas and resources associated with the current transaction. This information includes the Communication Area (COMMAREA), Transaction Work Area (TWA), Exec Interface Block (EIB), and any storage obtained by the CICS EXEC commands. This information does not appear in the Language Environment dump. It can be helpful to use the CICS transaction dump with the Language Environment dump to locate problems when operating under CICS.

When the location of an error is uncertain, it can be helpful to insert EXEC CICS DUMP statements in and around the code suspected of causing the problem. This generates CICS transaction dumps close to the error for debugging reference.

For information about interpreting CICS dumps, see CICS Problem Determination Guide.

Using CICS register and program status word contents

When a routine interrupt occurs (code = ASRA) and a CICS dump is generated, CICS formats the contents of the program status word (PSW) and the registers at the time of the interrupt. This information is also contained in the CICS trace table entry marked SSRP * EXEC* – ABEND DETECTED. For the format of the information contained in this trace entry, see CICS Data Areas, KERRD - KERNEL ERROR DATA.

The address of the interrupt can be found from the second word of the PSW, giving the address of the instruction following the point of interrupt. The address of the entry point of the function can be subtracted from this address. The offset compared to this listing gives the statement that causes the interrupt.

For C routines, you can find the address of the entry point in register 3.

If register 15 is corrupted, the contents of the first load module of the active enclave appear in the program storage section of the CICS transaction dump.

Using Language Environment abend and reason codes

An application can end with an abend in two ways:

- User-specified abend (that is, an abend requested by the assembler user exit or the ABTERMENC runtime option).
- Language Environment-detected unrecoverable error (in which case there is no Language Environment condition handling).

When Language Environment detects an unrecoverable error under CICS, Language Environment terminates the transaction with an EXEC CICS abend. The abend code has a number between 4000 and 4095. A write-to-operator (WTO) is performed to write a CEE1000S message to the system console. This message
contains the abend code and its associated reason code. The WTO is performed only for unrecoverable errors detected by Language Environment. No WTO occurs for user-requested abends.

Although this type of abend is performed only for unrecoverable error conditions, an abend code of 4000–4095 does not necessarily indicate an internal error within Language Environment. For example, an application routine can write a variable outside its storage and corrupt the Language Environment control blocks.

Possible causes of a 4000–4095 abend are corrupted Language Environment control blocks and internal Language Environment errors. For more information about abend codes 4000–4095, see \textit{z/OS Language Environment Runtime Messages}. Following is a sample Language Environment abend and reason code. Abend codes appear in decimal, and reason codes appear in hexadecimal.

```
12.34.27 JO80585 IEF4501 XCEPI103 GO CEPI103 - ABEND=5000 U4094 REASON=0000002C
```

**Using Language Environment return codes to CICS**

When the Language Environment condition handler encounters a severe condition that is specific to CICS, the condition handler generates a CICS-specific return code. This return code is written to the system console. Possible causes of a Language Environment return code to CICS are:

- Incorrect region size
- Incorrect DCT
- Incorrect CSD definitions

For a list of the reason codes written only to CICS, see \textit{z/OS Language Environment Runtime Messages}. The following example shows a sample of a return code that was returned to CICS.

```
+DFHAP1200I
LEO3CC01 A CICS request to Language Environment has failed. Reason code '0012030'.
```

**Activating Language Environment feature trace records under CICS**

Activating Language Environment feature trace records under CICS will allow users to monitor and determine the activity of a transaction. By activating the feature trace records, Level 2 trace points are added inside Language Environment at these significant points:

- Event Handle
- Set anchor
- Gives R13 and parameters before call

These trace points are useful for any support personnel that needs to know what happened inside Language Environment from a CICS call.

The function will be enabled by the existing CICS transactions. A user must enable the AP domain level 2 in order to include the Language Environment trace points. For more information on activating the CICS trace, see \textit{CICS Diagnosis Reference}.

Every time CICS calls Language Environment, the feature trace is activated under the Extended Runtime Library Interface (ERTLI). The trace can be seen in CICS.
transaction dumps. Feature trace entries are formatted in a similar way to CICS trace items. There are three formats: ABBREV, SHORT & FULL. The ABBREV version [Figure 157] just formats the heading line for each trace point and is laid out in a similar way to CICS trace entries.

![Figure 157. CICS trace output in the ABBREV format.](image)

The Domain Name field is replaced with a "Feature" short name (for example, Lang.Env.) and module name (for example, CEE....) which are coded into the "Feature Trace" initialization (short name) and header formatting call (module name). See the following macro example.

The FULL version includes the heading from the ABBREV version and then dumps each captured block in Hex and Character formats. For an example, see [Figure 158 on page 336](image).
The first block is used for the feature trace information. It contains the name of the off-line formatting module and the short name used in the formatted heading line. The other 6 blocks are available for user data.

The SHORT version is a cross between the ABBREV and FULL versions.
Ensuring transaction rollback

If your application does not run to normal completion and there is no CICS transaction abend, take steps to ensure that transaction rollback (the backing out of any updates made by the malfunctioning application) takes place.

There are two ways to ensure that a transaction rollback occurs when an unhandled condition of severity 2 or greater is detected:

- Use the ABTERMENC runtime option with the ABEND suboption (ABTERMENC(ABEND))
- Use an assembler user exit that requests an abend for unhandled conditions of severity 2 or greater

The IBM-supplied assembler user exit for CICS (CEECXITA), available in the Language Environment SCEESAMP sample library, ensures that a transaction abend and rollback occur for all unhandled conditions of severity 2 or greater. For more information about the assembler user exit, see "Invoking the assembler user exit" on page 25 and z/OS Language Environment Programming Guide.

Finding data when Language Environment returns a nonzero return code

Language Environment does not write any messages to the CESE transient data queue. Table 48 shows the output generated when Language Environment returns a nonzero reason code to CICS and the location where the output appears.

Table 48. Finding data when Language Environment returns a nonzero return code

<table>
<thead>
<tr>
<th>Output Message</th>
<th>Location</th>
<th>Issued By</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFHAC2206 14:43:54 LE03CC01 Transaction UTV2 has failed with abend AEC7. Resource backout was successful.</td>
<td>User's terminal</td>
<td>CICS</td>
</tr>
<tr>
<td>DFHAP12001 LE03CC01 A CICS request to the Language Environment has failed. Reason code '0012030'.</td>
<td>System console</td>
<td>CICS</td>
</tr>
<tr>
<td>DFHAC2236 06/05/91 14:43:48 LE03CC01 Transaction UTV2 abend AEC7 in routine UT2CVER1 term P021 backout successful.</td>
<td>Transient data queue CSMT</td>
<td>CICS</td>
</tr>
</tbody>
</table>

Finding data when Language Environment abends internally

Language Environment does not write any messages to the CESE transient data queue. Table 49 shows the output generated when Language Environment abends internally and the location where the output appears:

Table 49. Finding data when Language Environment abends internally

<table>
<thead>
<tr>
<th>Output Message</th>
<th>Location</th>
<th>Issued By</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFHAC2206 14:35:24 LE03CC01 Transaction UTV8 has failed with abend 4095. Resource backout was successful.</td>
<td>User's terminal</td>
<td>CICS</td>
</tr>
<tr>
<td>CEE1000S LE INTERNAL abend. ABCODE = 00000FFF REASON = 00001234</td>
<td>System console</td>
<td>Language Environment</td>
</tr>
</tbody>
</table>
## Finding data when Language Environment abends from an EXEC CICS command

This section shows the output generated when an application abends from an EXEC CICS command and the location where the output appears. This error assumes the use of Language Environment runtime option TERMTHDACT(MSG).

### Table 50. Finding data when Language Environment abends from an EXEC CICS command

<table>
<thead>
<tr>
<th>Output Message</th>
<th>Location</th>
<th>Issued By</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFHAC2206 14:35:34 LE03CC01 Transaction UTV8 has failed with abend AEI. Resource backout was successful.</td>
<td>User's terminal</td>
<td>CICS</td>
</tr>
<tr>
<td>No message.</td>
<td>System console</td>
<td>CICS</td>
</tr>
<tr>
<td>DFHAC2236 06/05/91 14:35:17 LE03CC01 Transaction UTV9 abend AEI0 in routine UT9CVERI term P021 backout successful.</td>
<td>Transient data queue CSMT</td>
<td>CICS</td>
</tr>
<tr>
<td>P021UTV9 091156 143516 CEE3250C The System or User Abend AEI0 was issued.</td>
<td>Transient data queue CESE</td>
<td>Language Environment</td>
</tr>
</tbody>
</table>

## Displaying and modifying runtime options with the CLER transaction

The CICS transaction CLER allows you to display all the current Language Environment runtime options for a region, and to modify a subset of these options.

The CLER transaction can be used to:

- Display the current runtime options in effect for the region.
- Modify the following subset of the region runtime options:
  - ALL31(ON|OFF)
  - CBLPSHPOP(ON|OFF)
  - CHECK(ON|OFF)
  - HEAPZONES(0-1024,QUIET|MSG|TRACE|ABEND)
  - INFORMSGFILTER(ON|OFF)
  - RPTOPTS(ON|OFF)
  - RPTSTG(ON|OFF)
  - TERMTHDACT(QUIET|MSG|TRACE|DUMP|UAONLY|UATRACE|UADUMP|UAIMM)
  - TRAP(ON|OFF)
- Write the current region runtime options to the CESE queue for printing.

The CLER transaction is conversational; it presents the user with commands for the terminal display. The runtime options that can be modified with this transaction are only in effect for the duration of the running region.
The CLER transaction must be defined in the CICS CSD (CICS System Definition file). The following definitions are required, and are in the Language Environment CEECCSD job in the SCEESAMP data set. Use the CEECCSD job to activate these definitions, or you must define them dynamically with the CICS CEDA transaction.

```plaintext
DEFINE PROGRAM(CELARO) GROUP(CEE) LANGUAGE(ASSEMBLER) EXCEKEY(CICS)
DEFINE MAPSET(CELCEM) GROUP(CEE)
DEFINE MAPSET(CELCLRH) GROUP(CEE)
DEFINE TRANS(CLER) PROG(CELARO) GROUP(CEE)
```

**Note:** If the runtime option ALL31 is modified to OFF, the stack is forced to BELOW. When the stack is modified to BELOW, it will remain below for the duration of the region, even if you set ALL31 back to ON. A warning message, asking if you want to continue, is presented on the panel if the runtime option ALL31 is set to OFF or CBLPSHPOP, RPTOPTS, and RPTSTG are set to ON.

To send the runtime option report to the CESE queue for output display or printing, press PF10 on the panel which displays the runtime option report.

For detailed information on the use of CLER, select PF1 from the main menu that is displayed when the CLER transaction is invoked.
Part 3. Debugging Language Environment AMODE 64 applications

This part provides specific information for debugging applications written to make use of the memory address space above the 2 GB bar.
Chapter 10. Preparing your AMODE 64 application for debugging

This chapter describes options and features that you can use to prepare your AMODE 64 application for debugging. The following topics are covered:

- Compiler options for C, C++
- Language Environment runtime options
- Use of storage in routines
- Options for modifying exception handling
- Assembler user exits
- Enclave termination behavior
- Language Environment feedback codes and condition tokens

Setting compiler options

The following sections discuss language-specific compiler options important to debugging routines in Language Environment. These sections cover only the compiler options that are important to debugging. For a complete list of compiler options, see the appropriate HLL publications.

The use of some compiler options (such as DEBUG) can affect the performance of your routine. You must set these options before you compile. In some cases, you might need to remove the option and recompile your routine before delivering your application.

**XL C and XL C++ compiler options for AMODE 64 applications**

When compiling an application using the LP64 compiler option, you cannot use the TEST compiler option. You must instead use the DEBUG(FORMAT(DWARF)) compiler option.

When the GONUMBER compiler option is used with LP64, it will produce executables with additional debug information. This is used by Language Environment to produce statement numbers in the Language Environment dump (CEEDUMP). Statement numbers in the CEEDUMP are also produced if the DEBUG compiler option or the c89 -g option is used.


Using Language Environment runtime options

Several runtime options affect debugging in Language Environment. The TEST runtime option, for example, can be used with a debugging tool to specify the level of control in effect for the debugging tool when the routine being initialized is started. The DYNDUMP, HEAPCHK, TERMTHDACT, TRACE, and TRAP options affect exception handling. The following Language Environment runtime options affect debugging. For a more detailed discussion of these runtime options, see [z/OS Language Environment Programming Reference](https://www.ibm.com/support/docview.wss?uid=swg27050118).
Description of runtime option

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEEDUMP</td>
<td>Specifies options to control the processing of the Language Environment dump report.</td>
</tr>
<tr>
<td>DYNDUMP</td>
<td>Provides a way to obtain IPCS readable dumps of user applications that would ordinarily be lost due to the absence of a SYSMDUMP, SYSUDUMP, or SYSABEND DD statement</td>
</tr>
<tr>
<td>HEAPCHK</td>
<td>Determines whether additional heap check tests are performed.</td>
</tr>
<tr>
<td>HEAPZONES</td>
<td>Activates user heap overlay toleration and checking.</td>
</tr>
</tbody>
</table>
| INFOMSGFILTER | Filters user specified informational messages from stderr.  
Note: Affects only those messages generated by Language Environment and any routine that calls __le_msg_get_and_write(). Other routines that write to stderr, such as __le_msg_write(), do not have a filtering option. |
| PROFILE   | Controls the use of an optional profiler tool, which collects performance data for the running application. When this option is in effect, the profiler is loaded and the debugger cannot be loaded. If the TEST option is in effect when PROFILE is specified, the profiler tool will not be loaded. |
| RPTOPTS   | Causes a report to be produced which contains the runtime options in effect. See "Determining runtime options in effect" below. |
| RPTSTG    | Generates a report of the storage used by an enclave. See "Controlling storage allocation" on page 346. |
| STORAGE   | Specifies that Language Environment initializes all heap and stack storage to a user-specified value. |
| TERMTHDACT| Controls response when an enclave terminates due to an unhandled condition of severity 2 or greater. |
| TEST      | Specifies the conditions under which a debugging tool assumes control.       |
| TRACE     | Activates Language Environment runtime library tracing and controls the size of the trace table, the type of trace, and whether the trace table should be dumped unconditionally upon termination of the application. |
| TRAP      | When TRAP is set to ON, Language Environment traps routine interrupts and abends, and optionally prints trace information or invokes a user-written exception handling routine. With TRAP set to OFF, the operating system handles all interrupts and abends. You should generally set TRAP to ON, or your runtime results can be unpredictable. |

Determining runtime options in effect

The runtime options in effect at the time the routine is run can affect routine behavior. Use RPTOPTS(ON) to generate an options report in the Language Environment message file when your routine terminates. The options report lists runtime options, and indicates where they were set. Figure 159 on page 345 shows a sample options report.
Understanding the HEAPZONES and HEAPCHK runtime options

The HEAPZONES and HEAPCHK runtime options are useful for debugging overlay damage problems that occur in the user heap. Though similar in that both options can be used for debugging purposes, the runtime options activate very different behavior in the runtime when specified.

HEAPZONES is a lightweight mechanism that detects heap overlay damage only during the freeing of an element. It looks for damage in the heap check zone of the freed element only.

Selecting a non-quiet output option causes HEAPZONES to display information about the damaged heap element. When messaging is requested, the address of the damaged element along with information specific to the heap check zone are included in the message. Depending on the type of damage, the value of the heap check zone is displayed. The data area of the damaged location is displayed following any issued informational messages. This runtime option can also be used as a mechanism to tolerate heap overlay damage by simply requesting no output (QUIET).
Depending on the size of the heap check zone and the number of allocation requests, the user may notice a significant amount of extra storage being used by the application. Performance may be affected due to the overhead of examining each heap check zone.

HEAPCHK investigates the entire user heap for damage during heap related calls at a frequency based on the specified settings in the option. Because HEAPCHK will traverse the entire user heap, a slow down in application performance will occur. Information about HEAPCHK diagnostic output is discussed in Chapter 3, “Using Language Environment debugging facilities,” on page 37.

When deciding which runtime option is better suited to use with your application, consider the differences between HEAPZONES and HEAPCHK relating to performance, storage usage, and time of damage detection. Although both runtime options affect performance, an application that chooses HEAPCHK will perform slower than an application that chooses HEAPZONES. If storage usage is a concern, HEAPCHK will not consume extra amounts of storage in the manner that HEAPZONES will. Determining when heap damage has occurred may be simpler to accomplish if HEAPCHK is chosen because of the frequency and scope of its analysis.

For more information about the HEAPZONES and HEAPCHK runtime options, see z/OS Language Environment Programming Reference.

Controlling storage allocation

The following runtime options control storage allocation:

- HEAP64
- HEAPPOOLS
- HEAPPOOLS64
- IOHEAP64
- LIBHEAP64
- STACK64
- THREADSTACK64

z/OS Language Environment Programming Guide for 64-bit Virtual Addressing Mode provides useful tips to assist with the tuning process. Appropriate tuning is necessary to avoid performance problems.

To generate a report of the storage a routine (or more specifically, an enclave) used during its run, specify the RPTSTG(ON) runtime option. The storage report, generated during enclave termination provides statistics that can help you understand how space is being consumed as the enclave runs. If storage management tuning is desired, the statistics can help you set the corresponding storage-related runtime options for future runs. Figure 160 on page 347 shows a sample storage report.
STACK64 statistics:
Initial size: 1M
Increment size: 1M
Maximum used by all concurrent threads: 1M
Largest used by any thread: 1M
Number of increments allocated: 0

THREADSTACK64 statistics:
Initial size: 1M
Increment size: 1M
Maximum used by all concurrent threads: 0M
Largest used by any thread: 0M
Number of increments allocated: 0

64bit User HEAP statistics:
Initial size: 1M
Increment size: 1M
Total heap storage used: 983808
Suggested initial size: 1M
Successful Get Heap requests: 11
Successful Free Heap requests: 0
Number of segments allocated: 0
Number of segments freed: 0

31bit User HEAP statistics:
Initial size: 32768
Increment size: 32768
Total heap storage used (sugg. initial size): 243352
Successful Get Heap requests: 58
Successful Free Heap requests: 0
Number of segments allocated: 9
Number of segments freed: 0

24bit User HEAP statistics:
Initial size: 4096
Increment size: 4096
Total heap storage used (sugg. initial size): 0
Successful Get Heap requests: 0
Successful Free Heap requests: 0
Number of segments allocated: 0
Number of segments freed: 0

64bit Library HEAP statistics:
Initial size: 1M
Increment size: 1M
Total heap storage used: 3795584
Suggested initial size: 4M
Successful Get Heap requests: 304
Successful Free Heap requests: 337
Number of segments allocated: 2
Number of segments freed: 0

31bit Library HEAP statistics:
Initial size: 16384
Increment size: 8192
Total heap storage used (sugg. initial size): 0
Successful Get Heap requests: 0
Successful Free Heap requests: 0
Number of segments allocated: 0
Number of segments freed: 0

Figure 160. 64–bit storage report (Part 1 of 4)
24bit Library HEAP statistics:
- Initial size: 8192
- Increment size: 4096
- Total heap storage used (suggested initial size): 0
- Successful Get Heap requests: 0
- Successful Free Heap requests: 0
- Number of segments allocated: 0
- Number of segments freed: 0

64bit I/O HEAP statistics:
- Initial size: 1M
- Increment size: 1M
- Total heap storage used: 0
- Suggested initial size: 1M
- Successful Get Heap requests: 0
- Successful Free Heap requests: 0
- Number of segments allocated: 0
- Number of segments freed: 0

31bit I/O HEAP statistics:
- Initial size: 12288
- Increment size: 8192
- Total heap storage used (suggested initial size): 9616
- Successful Get Heap requests: 27
- Successful Free Heap requests: 19
- Number of segments allocated: 1
- Number of segments freed: 0

24bit I/O HEAP statistics:
- Initial size: 4096
- Increment size: 4096
- Total heap storage used (suggested initial size): 3032
- Successful Get Heap requests: 14
- Successful Free Heap requests: 6
- Number of segments allocated: 1
- Number of segments freed: 0

HEAPPOLS Statistics:
- Pool 1 size: 8 Get Requests: 0
- Pool 2 size: 32 Get Requests: 1
- Successful Get Heap requests: 17
- Pool 3 size: 128 Get Requests: 0
- Pool 4 size: 256 Get Requests: 0
- Pool 5.1 size: 1024 Get Requests: 225
- Pool 5.2 size: 1024 Get Requests: 0
- Pool 5.3 size: 1024 Get Requests: 0
- Successful Get Heap requests: 273
- Pool 6 size: 2048 Get Requests: 0
- Requests greater than the largest cell size: 0

HEAPPOLS Summary:

<table>
<thead>
<tr>
<th>Specified</th>
<th>Element</th>
<th>Extent</th>
<th>Cells Per Extent</th>
<th>Maximum</th>
<th>Cells In Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Size</td>
<td>Size</td>
<td>Percent</td>
<td>Extent</td>
<td>Allocated</td>
<td>Cells Used</td>
</tr>
<tr>
<td>-----------</td>
<td>---------</td>
<td>--------</td>
<td>--------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>8</td>
<td>16</td>
<td>10</td>
<td>409</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>32</td>
<td>40</td>
<td>10</td>
<td>163</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>128</td>
<td>136</td>
<td>10</td>
<td>48</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>256</td>
<td>264</td>
<td>10</td>
<td>24</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1024</td>
<td>1032</td>
<td>10</td>
<td>4</td>
<td>57</td>
<td>225</td>
</tr>
<tr>
<td>1024</td>
<td>1032</td>
<td>10</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1024</td>
<td>1032</td>
<td>10</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2048</td>
<td>2056</td>
<td>10</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Suggested Percentages for current Cell Sizes:
- HEAPP(ON,8,1,32,1,128,1,256,1,(1024,3),90,2048,1,0)
- Suggested Cell Sizes:
  - HEAPP(ON,24,,280,,2048,,0)

Figure 161. 64–bit storage report (Part 2 of 4)
HEAPPOLLS64 Statistics:

<table>
<thead>
<tr>
<th>Pool</th>
<th>Size</th>
<th>Get Requests</th>
<th>Successful Get Heap requests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pool 1</td>
<td></td>
<td>8</td>
<td>1- 8</td>
</tr>
<tr>
<td>Pool 2</td>
<td></td>
<td>32</td>
<td>9- 16 12</td>
</tr>
<tr>
<td>Pool 3</td>
<td></td>
<td>128</td>
<td>17- 24 227</td>
</tr>
<tr>
<td>Pool 4</td>
<td></td>
<td>256</td>
<td>25- 32 1</td>
</tr>
<tr>
<td>Pool 5.1</td>
<td></td>
<td>1024</td>
<td>33- 40 4</td>
</tr>
<tr>
<td>Pool 5.2</td>
<td></td>
<td>1024</td>
<td>41- 48 1</td>
</tr>
<tr>
<td>Pool 5.3</td>
<td></td>
<td>1024</td>
<td>49- 56 1</td>
</tr>
<tr>
<td>Pool 6</td>
<td></td>
<td>2048</td>
<td>57- 64 4</td>
</tr>
<tr>
<td>Pool 7</td>
<td></td>
<td>3072</td>
<td>65- 72 3</td>
</tr>
<tr>
<td>Pool 8</td>
<td></td>
<td>4096</td>
<td>73- 80 7</td>
</tr>
<tr>
<td>Pool 9</td>
<td></td>
<td>65536</td>
<td>81- 88 2</td>
</tr>
<tr>
<td>Pool 10</td>
<td></td>
<td>8192</td>
<td>89- 96 88</td>
</tr>
<tr>
<td>Pool 11</td>
<td></td>
<td>16384</td>
<td>105- 112 3</td>
</tr>
<tr>
<td>Pool 12</td>
<td></td>
<td>32768</td>
<td>113- 120 8</td>
</tr>
<tr>
<td>Pool 13</td>
<td></td>
<td>65536</td>
<td>121- 128 4</td>
</tr>
<tr>
<td>Pool 14</td>
<td></td>
<td>2048</td>
<td>129- 136 2</td>
</tr>
<tr>
<td>Pool 15</td>
<td></td>
<td>4096</td>
<td>137- 144 2</td>
</tr>
<tr>
<td>Pool 16</td>
<td></td>
<td>2048</td>
<td>145- 152 2</td>
</tr>
<tr>
<td>Pool 17</td>
<td></td>
<td>4096</td>
<td>153- 160 8</td>
</tr>
<tr>
<td>Pool 18</td>
<td></td>
<td>2048</td>
<td>161- 168 1</td>
</tr>
<tr>
<td>Pool 19</td>
<td></td>
<td>4096</td>
<td>169- 176 2</td>
</tr>
<tr>
<td>Pool 20</td>
<td></td>
<td>2048</td>
<td>177- 184 3</td>
</tr>
<tr>
<td>Pool 21</td>
<td></td>
<td>4096</td>
<td>185- 192 6</td>
</tr>
<tr>
<td>Pool 22</td>
<td></td>
<td>2048</td>
<td>193- 200 5</td>
</tr>
<tr>
<td>Pool 23</td>
<td></td>
<td>4096</td>
<td>201- 208 5</td>
</tr>
<tr>
<td>Pool 24</td>
<td></td>
<td>2048</td>
<td>209- 216 2</td>
</tr>
<tr>
<td>Pool 25</td>
<td></td>
<td>4096</td>
<td>217- 224 1</td>
</tr>
<tr>
<td>Pool 26</td>
<td></td>
<td>2048</td>
<td>225- 232 5</td>
</tr>
<tr>
<td>Pool 27</td>
<td></td>
<td>4096</td>
<td>233- 240 6</td>
</tr>
<tr>
<td>Pool 28</td>
<td></td>
<td>2048</td>
<td>249- 256 3</td>
</tr>
<tr>
<td>Pool 29</td>
<td></td>
<td>4096</td>
<td>257- 264 2</td>
</tr>
</tbody>
</table>

Requests greater than the largest cell size: 0

Figure 162. 64–bit storage report (Part 3 of 4)
Storage statistics for AMODE 64 applications

The statistics for initial and incremental allocations of storage types that have a corresponding runtime option differ from the runtime option settings when their values have been rounded up by the implementation, or when allocations larger than the amounts specified were required during execution. See the descriptions of the runtime options in z/OS Language Environment Programming Reference for information about rounding.

Stack storage statistics for AMODE 64 applications

Language Environment stack storage is managed at the thread level—each thread has its own stack-type resources.

STACK64 and THREADSTACK64 statistics:

- Initial size—the actual size of the initial stack area assigned to each thread. If a pthread-attributes-table is provided on the invocation of pthread-create, the stack size specified in the pthread-attributes-table takes precedence over the stack runtime options.
- Increment size—the size of each incremental stack area made available, as determined by the increment portion of the corresponding runtime option.
- Maximum used by all concurrent threads—the maximum amount allocated in total at any one time by all concurrently executing threads.
- Largest used by any thread—the largest amount allocated ever by any single thread.
- Number of increments allocated—the number of incremental segments allocated by all threads.

Determining the applicable threads: If the application is not a multithreading application, the STACK64 statistics are for the one and only thread that executed, and the THREADSTACK64 statistics are all zero.

---

**HEAPPOOLS64 Summary:**

<table>
<thead>
<tr>
<th>Specified Element Size</th>
<th>Cells Per Extent</th>
<th>Extents Allocated</th>
<th>Maximum Cells Used</th>
<th>Cells In Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>32</td>
<td>4000</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>32</td>
<td>48</td>
<td>2000</td>
<td>1</td>
<td>226</td>
</tr>
<tr>
<td>128</td>
<td>144</td>
<td>700</td>
<td>1</td>
<td>83</td>
</tr>
<tr>
<td>256</td>
<td>272</td>
<td>350</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1024</td>
<td>1040</td>
<td>34</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1024</td>
<td>1040</td>
<td>34</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2048</td>
<td>2064</td>
<td>50</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3072</td>
<td>3088</td>
<td>50</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4096</td>
<td>4112</td>
<td>50</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8192</td>
<td>8208</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16384</td>
<td>16400</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>32768</td>
<td>32784</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>65536</td>
<td>65552</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Suggested Cell Sizes:

HP64(ON, 40, 80, 96, 128, 168, 224, 288, 528, 720, 1648, 2112, 3688)

Largest number of threads concurrently active: 6

End of Storage Report
If the application is a multithreading application, and THREADSTACK64 was not suppressed, the STACK64 statistics are for the initial thread (IPT), and the THREADSTACK64 statistics are for the other threads. However, if THREADSTACK64 was suppressed, the STACK64 statistics are for all of the threads, initial and other.

Allocating stack storage: The allocation of the stack for each thread, including the initial processing thread (IPT), is part of a storage request to the system when the thread is first created. Other storage, not part of the stack, is also acquired at this time. These storage allocations are not shown in the storage report. The size of the stack portion of this storage is the stack maximum size plus a one megabyte (1M) guard area. After allocation, the guard area follows the stack initial size and runs through the end of the stack maximum size plus the 1M guard area. Increments to the stack for each thread do not result in additional storage requests to the system. They result in the movement of the beginning of the guard area no further than the maximum size of the stack. The stack initial, increment, and maximum sizes are controlled through the STACK64 and THREADSTACK64 runtime options.

Heap storage statistics
Language Environment heap storage is managed at the enclave level. Each enclave has its own heap type resources, which are shared by the threads that execute within the enclave. The heap resources have 64-bit, 31-bit, and 24-bit addressable areas, each of which can be tuned separately.

HEAP64, LIBHEAP64, and IOHEAP64 statistics:
- Initial size—the default initial allocation, as specified by the corresponding runtime option.
- Increment size—the minimum incremental allocation, as specified by the corresponding runtime option.
- Total heap storage used—the largest total amount used by the enclave at any one time.
- Successful Get Heap requests—the number of get heap requests.
- Successful Free Heap requests—the number of free heap requests.
- Number of segments allocated—the number of incremental segments allocated.
- Number of segments freed—the number of incremental segments individually freed.

The number of Free Heap requests could be less than the number of Get Heap requests if the pieces of heap storage acquired by individual Get Heap requests were not explicitly freed, but were freed implicitly during enclave termination. The number of incremental segments individually freed could be less than the number allocated if the segments were not explicitly freed, but were freed implicitly during enclave termination. The initial segment is included in Number of segments allocated for each 31-bit and 24-bit addressable heap resource, and for the 64-bit addressable IOHEAP64 resource. A disposition of KEEP always causes 0 to be reported for the Number of segments freed. These statistics, in all cases, specify totals for the entire enclave.

Heap pools storage statistics
The HEAPPOOLS and HEAPPOOLS64 runtime options for C/C++ applications only controls usage of the heap pools storage algorithm at the enclave level. The heap pools algorithm allows for the definition of one to twelve heap pools, each consisting of a number of storage cells of a specified length. For further details regarding heap pools storage statistics in the storage report, see “Language Environment storage report with heap pools statistics” on page 485.
Modifying exception handling behavior

Setting the exception handling behavior of your routine affects the response that occurs when the routine encounters an error. You can modify exception handling behavior in the following ways:

- Application program interfaces (API)
- User-written exception handlers
- POSIX functions (used to specifically set signal actions and signal masks)

Language Environment application program interfaces (API)

You can use the following APIs to modify exception handling:

<table>
<thead>
<tr>
<th>API Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>__cabend() Terminates an enclave using an abend.</td>
</tr>
<tr>
<td>__le_cib_get() Returns a pointer to a condition information block (CIB) associated with a given condition token. The CIB contains detailed information about the condition.</td>
</tr>
<tr>
<td>__set_exception_handler() Activates a routine to handle an exception.</td>
</tr>
<tr>
<td>__reset_exception_handler() Removes handling of an exception by any routine.</td>
</tr>
</tbody>
</table>

Language Environment runtime options

The following Language Environment runtime options can affect your routine’s exception handling behavior:

<table>
<thead>
<tr>
<th>Description of runtime option</th>
</tr>
</thead>
<tbody>
<tr>
<td>TERMTHDACT Sets the level of information that is produced when a condition of severity 2 or greater remains unhandled within the enclave. The possible parameter settings for different levels of information are:</td>
</tr>
<tr>
<td>QUIET for no information</td>
</tr>
<tr>
<td>MSG for message only</td>
</tr>
<tr>
<td>TRACE for message and a traceback</td>
</tr>
<tr>
<td>DUMP for message, traceback, and Language Environment dump</td>
</tr>
<tr>
<td>UAONLY for message and a system dump of the user address space</td>
</tr>
<tr>
<td>UATRACE for message, Language Environment dump with traceback information only, and a system dump of the user address space</td>
</tr>
<tr>
<td>UADUMP for message, traceback, Language Environment dump, and system dump</td>
</tr>
<tr>
<td>UAIMM for a system dump of the user address space of the original abend or program interrupt prior to the Language Environment condition manager processing the condition.</td>
</tr>
<tr>
<td>TRAP(ON) Fully enables the Language Environment exception handler. This causes the Language Environment exception handler to intercept error conditions and routine interrupts. When TRAP(ON, NOSPIE) is specified, Language Environment handles all program interrupts and abends through an ESTAE. Use this feature when you do not want Language Environment to issue an ESPIE macro. During normal operation, you should use TRAP(ON) when running your applications.</td>
</tr>
</tbody>
</table>
**Description of runtime option**

| TRAP(OFF) | Disables the Language Environment condition handler from handling abends and program checks/interrupts. ESPIE is not issued with TRAP(OFF).

Specify TRAP(OFF) when you do not want Language Environment to issue an ESPIE.

When TRAP(OFF), TRAP(OF:SPIE), or TRAP(OFF,NOSPIE) is specified and either a program interrupt or abend occurs, the user exit for termination is ignored.

TRAP(OFF) can cause several unexpected side effects. It is not supported in AMODE 64 production execution.

For further information, see the TRAP runtime option in [z/OS Language Environment Programming Reference](https://www.ibm.com/support/knowledgecenter/S55752_1.14.1.SCE_00055752_00055752.s jeuxpdf).

---

**Customizing exception handlers**

User-written exception handlers permit you to customize exception handling for certain conditions. You can register a user-written exception handler for the current stack frame by using the `__set_exception_handler()` API. For more information about user-written exception handlers and the Language Environment condition manager, see [z/OS XL C/C++ Programming Guide](https://www.ibm.com/support/knowledgecenter/S55752_1.14.1.SCE_00055752_00055752.s jeuxpdf).

---

**Using condition information**

If a condition that might require attention occurs while an application is running, Language Environment builds a condition token. The condition token contains 16 bytes (128 bits) of information about the condition that Language Environment or your routines can use to respond appropriately. Each condition is associated with a single Language Environment runtime message. You can use this condition information in two ways:

- To specify the feedback code parameter when calling Language Environment services (see "Using the feedback code parameter").
- To code a symbolic feedback code in a user-written exception handler (see "Using the symbolic feedback code" on page 355).

**Using the feedback code parameter**

The feedback code is an optional parameter of the Language Environment APIs. For C/C++ applications, this parameter is optional. For more information about feedback codes and condition tokens, see [z/OS Language Environment Programming Guide for 64-bit Virtual Addressing Mode](https://www.ibm.com/support/knowledgecenter/S55752_1.14.1.SCE_00055752_00055752.s jeuxpdf).

When you provide the feedback code (fc) parameter, the API in which the condition occurs sets the feedback code to a specific value called a condition token.

The condition token does not apply to asynchronous signals. For a discussion of the distinctions between synchronous signals and asynchronous signals with POSIX(ON), see [z/OS Language Environment Programming Guide for 64-bit Virtual Addressing Mode](https://www.ibm.com/support/knowledgecenter/S55752_1.14.1.SCE_00055752_00055752.s jeuxpdf).

When you do not provide the fc parameter, any nonzero condition is signaled and processed by Language Environment exception handling routines. If you have registered a user-written exception handler, Language Environment passes control...
to the handler, which determines the next action to take. If the condition remains unhandled, Language Environment writes a message to stderr. The message is the translation of the condition token into English (or another supported national language).

Language Environment provides APIs that can be used to convert condition tokens to routine variables, messages, or signaled conditions. The following table lists these Language Environment APIs and their functions. For more information on these APIs, see z/OS XL C/C++ Programming Guide.

<table>
<thead>
<tr>
<th>API Description</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>__le_msg_write()</td>
<td>Writes a message string to stderr</td>
</tr>
<tr>
<td>__le_msg_get_and_write()</td>
<td>Takes a message associated with a condition and writes it to stderr</td>
</tr>
<tr>
<td>__le_msg_get()</td>
<td>Retrieves, formats, and stores message data for a condition</td>
</tr>
<tr>
<td>__le_msg_add_insert()</td>
<td>Creates a message insert</td>
</tr>
</tbody>
</table>

There are two types of condition tokens. Case 1 condition tokens contain condition information, including the Language Environment message number. All Language Environment APIs and most application routines use case 1 condition tokens. Case 2 condition tokens contain condition information and a user-specified class and cause code. Application routines, user-written exception handlers, assembler user exits, and some operating systems can use case 2 condition tokens.

<table>
<thead>
<tr>
<th>Condition ID</th>
<th>Case Number</th>
<th>Severity Number</th>
<th>Control Code</th>
<th>Facility_ID</th>
<th>ISI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 31</td>
<td>0 - 15</td>
<td>16 - 31</td>
<td>32 - 33</td>
<td>34 - 36</td>
<td>64 - 127</td>
</tr>
</tbody>
</table>

For Case 1 condition tokens, Condition ID is:
- Condition ID: 0 - 31
- Severity Number: 0 - 15
- Message Number: 16 - 31

For Case 2 condition tokens, Condition ID is:
- Condition ID: 0 - 31
- Class Code: 0 - 15
- Cause Code: 16 - 31

A symbolic feedback code represents the first 8 bytes of a condition token. It contains the Condition_ID, Case Number, Severity Number, Control Code, and Facility_ID, whose bit offsets are indicated.

**Figure 164. Language Environment condition token**

For example, in the condition token: X'0003032D 59C3C5C5 00000000 00000000'
- X'0003' is severity.
- X'032D' is message number 813.
- X'59' are hexadecimal flags for case, severity, and control.
- X'C3C5C5' is the CEE facility ID.
- X'00000000 00000000' is the instance specific information (ISI). (In this case, no ISI was provided.)

If a Language Environment traceback or dump is generated while a condition token is being processed or when a condition exists, Language Environment writes the runtime message to the condition section of the traceback or dump. If a condition is detected when a Language Environment API is invoked without a
feedback code, the condition token is passed to the Language Environment condition manager. If a condition is severity 0 or 1, Language Environment resumes without issuing a message. For conditions of severity 2 or greater, Language Environment issues a message and terminates. For a list of Language Environment runtime messages and corrective information, see z/OS Language Environment Runtime Messages.

If a second condition is raised while Language Environment is attempting to handle a condition, the message CEE0374C CONDITION = <message no.> is displayed using a write-to-operator (WTO). The message number in the CEE0374C message indicates the original condition that was being handled when the second condition was raised. This can happen when a critical error is signaled (for example, when internal control blocks are damaged).

If the output for this error message appears several times in sequence, the conditions appear in order of occurrence. Correcting the earliest condition can cause your application to run successfully.

**Using the symbolic feedback code**

The symbolic feedback code represents the first 8 bytes of a 16-byte condition token. You can think of the symbolic feedback code as the nickname for a condition. As such, the symbolic feedback code can be used in user-written exception handlers to screen for a given condition, even if it occurs at different locations in an application. For more details on symbolic feedback codes, see z/OS Language Environment Programming Guide for 64-bit Virtual Addressing Mode.
Chapter 11. Classifying AMODE 64 application errors

This chapter describes errors that commonly occur in Language Environment AMODE 64 applications. It also explains how to use runtime messages and abend codes to obtain information about errors in your application.

Identifying problems in routines

The following sections describe how you can identify errors in Language Environment routines. Included are common error symptoms and solutions.

Language Environment module names

You can identify Language Environment-supplied module elements by any of the following three-character prefixes:

- CEE (Language Environment)
- CEL (Language Environment)
- EDC (C/C++)

Module elements or text files with other prefixes are not part of the Language Environment product for AMODE 64 applications.

Common errors in routines

These common errors have simple solutions:

- If you receive abend U4093, reason X'224' (548 decimal), then make sure you use MEMLIMIT to allow access to above the 2 GB bar. For more information, see z/OS MVS Programming: Extended Addressability Guide.

- If you do not have enough virtual storage, increase your region size or decrease your storage usage (stack size) by using the storage-related runtime options and callable services. (See "Controlling storage allocation" on page 346 for information about using storage in routines.)

- If you do not have enough disk space, increase your disk allocation.

- If executable files are not available, check your executable library to ensure that they are defined. For example, check your STEPLIB or JOBLIB definitions.

If your error is not caused by any of the items listed above, examine your routine or routines for changes since the last successful run. If there have been changes, review these changes for errors that might be causing the problem. One way to isolate the problem is to branch around or comment out recent changes and rerun the routine. If the run is successful, the error can be narrowed to the scope of the changes.

Changes in optimization levels, addressing modes, and input/output file formats can also cause unanticipated problems in your routine.

In most cases, generated condition tokens or runtime messages point to the nature of the error. The runtime messages offer the most efficient corrective action. To help you analyze errors and determine the most useful method to fix the problem, Table 51 on page 358 lists common error symptoms, possible causes, and programmer responses.
Table 51. Common error symptoms, possible causes, and programmer responses

<table>
<thead>
<tr>
<th>Error Symptom</th>
<th>Possible Cause</th>
<th>Programmer Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbered runtime message appears</td>
<td>Condition raised in routine</td>
<td>For any messages you receive, read the Programmer Response. For information about message structure, see &quot;Interpreting runtime messages&quot; below.</td>
</tr>
<tr>
<td>User abend code &lt; 4000</td>
<td>• A non-Language Environment abend occurred</td>
<td>See the Language Environment abend codes in z/OS Language Environment Runtime Messages</td>
</tr>
<tr>
<td></td>
<td>• The assembler user exit requested an abend for an unhandled condition of severity ≥2</td>
<td>Check for a subsystem-generated abend or a user-specified abend.</td>
</tr>
<tr>
<td>User abend code ≥ 4000</td>
<td>• Language Environment detected an error and could not proceed</td>
<td>For any abends you receive, read the appropriate explanation listed in the abend codes section of z/OS Language Environment Runtime Messages.</td>
</tr>
<tr>
<td></td>
<td>• An unhandled software-raised condition occurred</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The assembler user exit requested an abend for an unhandled condition of severity 4</td>
<td></td>
</tr>
<tr>
<td>System abend with TRAP(OFF)</td>
<td>Cause depends on type of malfunction</td>
<td>Respond appropriately. See the messages and codes book of the operating system.</td>
</tr>
<tr>
<td>System abend with TRAP(ON)</td>
<td>System-detected error</td>
<td>See the messages and codes book of the operating system.</td>
</tr>
<tr>
<td>No response (wait/loop)</td>
<td>Application logic failure</td>
<td>Check routine logic.</td>
</tr>
<tr>
<td>Unexpected message (message received was not from most recent service)</td>
<td>Condition caused by something related to current service</td>
<td>Generate a traceback using cdump() or ctrace().</td>
</tr>
<tr>
<td>Incorrect output</td>
<td>Incorrect file definitions, storage overlay, incorrect routine mask setting, references to uninitialized variables, data input errors, or application routine logic error</td>
<td>Correct the appropriate parameters.</td>
</tr>
<tr>
<td>No output</td>
<td>Incorrect ddname or file definitions</td>
<td>Correct the appropriate parameters.</td>
</tr>
<tr>
<td>Nonzero return code from enclave</td>
<td>The return code was issued by the application routine</td>
<td>Check the application for the meaning of the return code.</td>
</tr>
</tbody>
</table>

Interpreting runtime messages

The first step in debugging your routine is to look up any runtime messages. Runtime messages are written to the C stderr stream. Runtime messages provide users with additional information about a condition, and possible solutions for any errors that occurred. They can be issued by Language Environment common routines or language-specific runtime routines and contain a message prefix, message number, severity code, and descriptive text.

In the following example Language Environment message:

CEE3206S The system detected a specification exception (System Completion Code=0C6).

• The message prefix is CEE.
• The message number is 3206.
• The severity code is S.
The system detected a specification exception (System Completion Code=0C6).

Language Environment messages can appear even though you made no explicit calls to Language Environment services. C/C++ runtime library routines commonly use the Language Environment services. This is why you can see Language Environment messages even when the application routine does not directly call common runtime services.

**Message prefix**

The message prefix indicates the Language Environment component that generated the message. The message prefix is the first three characters of the message number and is also the facility ID in the condition token. The messages for the various components can be found in [z/OS Language Environment Runtime Messages](#).

<table>
<thead>
<tr>
<th>Message Prefix</th>
<th>Language Environment Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE</td>
<td>Common run time</td>
</tr>
<tr>
<td>EDC</td>
<td>C/C++ run time</td>
</tr>
</tbody>
</table>

**Message number**

The message number is the 4-digit number following the message prefix. Leading zeros are inserted, if the message number is less than four digits. It identifies the condition raised and references additional condition and programmer response information.

**Severity code**

The severity code is the letter following the message number and indicates the level of attention called for by the condition. Messages with severity “I” are informational messages and do not usually require any corrective action. In general, if more than one runtime message appears, the first noninformational message indicates the problem. For a complete list of severity codes, severity values, condition information, and default actions, see [z/OS Language Environment Programming Guide for 64-bit Virtual Addressing Mode](#).

**Message text**

The message text provides a brief explanation of the condition.

**Understanding abend codes**

Under Language Environment, abnormal terminations generate abend codes. There are two types of abend codes: 1) user abends (Language Environment and user-specified) and 2) system abends. User abends follow the format of Udddd, where dddd is a decimal user abend code. System abends follow the format of Shhh, where hhhh is a hexadecimal abend code. Language Environment abend codes are usually in the range of 4000 to 4095. However, some subsystem abend codes can also fall in this range. User-specified abends use the range of 0 to 3999.

Example abend codes are:

- User (Language Environment) abend code: U4041
- User-specified abend code: U0005
- System abend code: S80A
The Language Environment API `__cabend()` terminates your application with an abend. You can set the `clean_up` parameter value to determine how the abend is processed and how Language Environment handles the raised condition. For more information about `__cabend()` and `clean_up`, see the z/OS XL C/C++ Runtime Library Reference.

**User abends**

If you receive a Language Environment abend code, see the z/OS Language Environment Runtime Messages for a list of abend codes, error descriptions, and programmer responses.

**System abends**

If you receive a system abend code, look up the code and the corresponding information in the publications for the system you are using. When a system abend occurs, the operating system can generate a system dump. System dumps are written to ddname SYSMDUMP, SYSABEND, or SYSUDUMP. If the DYNDUMP runtime option is used in combination with the TERMTHDACT runtime option, the system dump can be written without the ddname specified. System dumps show the memory state at the time of the condition. See "Generating a system dump" on page 378 for more information about system dumps.
Chapter 12. Using Language Environment AMODE 64 debugging facilities

This section describes methods of debugging AMODE 64 routines in Language Environment. Currently, most problems in Language Environment and member language routines can be determined through the use of a debugging tool or through information provided in the Language Environment dump.

Debugging tools

You can use `dbx` to debug Language Environment applications. `z/OS UNIX System Services Command Reference` has information on `dbx` subcommands, while `z/OS UNIX System Services Programming Tools` contains usage information.

Language Environment dumps

The following sections provide information about using the Language Environment dump service, and describe the contents of the Language Environment dump.

Generating a Language Environment dump with TERMTHDACT

The TERMTHDACT runtime option produces a dump during program checks or abnormal terminations. You must use TERMTHDACT(DUMP) in conjunction with TRAP(ON) to generate a Language Environment dump. You can use TERMTHDACT to produce a traceback, Language Environment dump, or user address space dump when a thread ends abnormally because of an unhandled condition of severity 2 or greater. If this is the last thread in the process, the enclave goes away. A thread terminating in a non-POSIX environment is analogous to an enclave terminating. For information on enclave termination, see `z/OS Language Environment Programming Guide for 64-bit Virtual Addressing Mode`.

The TERMTHDACT suboptions QUIET, MSG, TRACE, DUMP, UAONLY, UATRACE, UADUMP, and UAIMM control the level of information available. Following are the suboptions, the levels of information produced, and the destination of each.

<table>
<thead>
<tr>
<th>Suboption</th>
<th>Level of Information</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUIET</td>
<td>No information</td>
<td>No destination.</td>
</tr>
<tr>
<td>MSG</td>
<td>Message</td>
<td>Stderr</td>
</tr>
<tr>
<td>TRACE</td>
<td>Message and Language Environment dump containing only a traceback</td>
<td>Message goes to stderr. Traceback goes to CEEDEMP file.</td>
</tr>
<tr>
<td>DUMP</td>
<td>Message and complete Language Environment dump</td>
<td>Message goes to stderr. Language Environment dump goes to CEEDEMP file.</td>
</tr>
</tbody>
</table>
### Table 52. TERMTHDACT suboptions, level of information, and destinations (continued)

<table>
<thead>
<tr>
<th>Suboption</th>
<th>Level of Information</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAONLY</td>
<td>SYSMDUMP, SYSABEND dump, or SYSUDUMP depending on the DD card used in the JCL in z/OS. You will get a system dump of your user address space if the appropriate DD statement is used. Note: A Language Environment dump is not generated.</td>
<td>Language Environment generates a U4039 abend which allows a system dump of the user address space to be generated. For z/OS, the system dump is written to the ddname specified.</td>
</tr>
<tr>
<td>UATRACE</td>
<td>Message, Language Environment dump containing only a traceback, and a system dump of the user address space</td>
<td>Message goes to stderr. Traceback goes to CEE_DUMP file. Language Environment generates a U4039 abend which allows a system dump of the user address space to be generated. For z/OS, the system dump is written to the ddname specified.</td>
</tr>
<tr>
<td>UADUMP</td>
<td>Message, Language Environment dump, and SYSMDUMP, SYSABEND dump, or SYSUDUMP depending on the DD card used in the JCL in z/OS.</td>
<td>Message goes to stderr. Language Environment dump goes to CEE_DUMP file. Language Environment generates a U4039 abend which allows a system dump of the user address space to be generated. For z/OS, the system dump is written to the ddname specified.</td>
</tr>
<tr>
<td>UAIMM</td>
<td>Language Environment generates a system dump of the original abend/program interrupt of the user address space. You will get a system dump of your user address space if the appropriate DD statement is used. After the dump is taken by the operating system, Language Environment condition manager continues processing.</td>
<td>Message goes to stderr. User address space dump goes to ddname specified for z/OS.</td>
</tr>
</tbody>
</table>

The TRACE and UATRACE suboptions of TERMTHDACT use these dump options:
- CONDITION
- ENCLAVE(ALL)
- FILES
- FNAME(CEEDUMP)
- GENOPTS
- NOBLOCKS
- NOENTRY
- NOSTORAGE
- STACKFRAME(ALL)
- THREAD(ALL)
- TRACEBACK
- VARIABLES

The DUMP and UADUMP suboptions of TERMTHDACT use these dump options:
- BLOCKS
- CONDITION
- ENCLAVE(ALL)
- FILES
- FNAME(CEEDUMP)
- GENOPTS
- NOENTRY
- STACKFRAME(ALL)
- STORAGE
- THREAD(ALL)
Considerations for setting TERMTHDACT options
Review the following considerations before setting TERMTHDACT runtime options. For more information, see z/OS Language Environment Programming Reference.

z/OS UNIX Considerations
- The TERMTHDACT option applies when a thread terminates abnormally. Abnormal termination of a single thread causes termination of the entire enclave. If an unhandled condition of severity 2 or higher percolates beyond the first routine's stack frame, the enclave terminates abnormally.
- If an enclave terminates due to a POSIX default signal action, then TERMTHDACT applies to conditions that result from software signals, program checks, or abends.
- If running under a shell and Language Environment generates a system dump, then a core dump is generated to a file based on the kernel environment variable, _BPXK_MDUMP.

Preinitialized Environments for Authorized Programs Considerations
- The TERMTHDACT suboptions TRACE, DUMP, UADUMP, UATRACE are overridden to UAONLY.
- For UAONLY, a U4039 abend is generated and an SVC dump of the U4039 abend with the following title is taken:

```
COMPON=CEL,COMPID=568819801,ISSUER=CELAFRR ,MODULE=CELAEICT+????,
ABEND=U4039,REASON=00000000
```

- For UAIMM, an SVC dump of the original abend/program interrupt with the following title is taken (the ABEND and REASON values are those of the original abend/program interrupt):

```
COMPON=CEL,COMPID=568819801,ISSUER=CELAFRR ,MODULE=CELAEICT+????,
ABEND=500C9,REASON=00000009
```

Generating a Language Environment dump with language-specific functions
C/C++ routines can use the functions cdump(), csnap(), and ctrace() to produce a Language Environment dump. For more information on these functions, see "Generating a Language Environment dump of a C/C++ routine" on page 460.

Understanding the Language Environment dump
The Language Environment dump service generates output of data and storage from the Language Environment runtime environment on an enclave basis. This output contains the information needed to debug most basic routine errors.

Figure 168 on page 366 illustrates a dump for enclave main. The example shows full use of the TERMTHDACT dump options. Ellipses are used to summarize some sections of the dump and information regarding unhandled conditions may not be present at all. Sections of the dump are numbered to correspond with the descriptions given in "Sections of the Language Environment dump" on page 374.
The CEE3DMP was generated by the C program CELQSAMP shown in Figure 165. CELQSAMP uses the DLL CELQDLL shown in Figure 167 on page 365.

```c
#pragma options(SERVICE("1.8"),NOOPT,GONUM)
#pragma runopts(TERMTHDACT(UADUMP),POSIX(ON))
#pragma runopts(TRACE(ON,IM,NOUM,L=1),HEAPCHK(ON))
#pragma runopts(RPTSTG(ON))
#define _OPEN_THREADS
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#include <dll.h>
typedef void* FUNC(void *);
pthread_mutex_t mut;
pthread_t thread[2];
int threads_joined = 0;
char t1 = "Thread 1";
char t2 = "Thread 2";
/*********************************************************************/
/* thread_func: Invoked via pthread_create. */
/*********************************************************************/
void *thread_func(void *parm)
{
    printf(">>> Thread_func: \%s locking mutex\n",parm);
    pthread_mutex_lock(&mut);
    pthread_mutex_unlock(&mut);
    printf(">>> Thread_func: \%s exitting\n",parm);
    pthread_exit(NULL);
}
/*********************************************************************/
/* Start of Main function. */
/*********************************************************************/
main()
{
    dllhandle * handle;
    FUNC * fp;
    FILE *fp1;
    FILE *fp2;
    printf("Load DLL...\n");
    handle = dllload("CELQDLL");
    if (handle == NULL) {
        perror("Could not load DLL CELQDLL");
        exit(106);
    }
    printf("Query DLL...\n");
    fp = (FUNC *)dllqueryfn(handle,"div_zero");
    if (fp == NULL) {
        perror("Could not find thread_func");
        exit(107);
    }
    printf("Init MUTEX...\n");
    if (pthread_mutex_init(&mut, NULL) == -1) {
        perror("Init of mut failed");
        exit(101);
    }
    printf("Lock Mutex Lock...\n");
    if (pthread_mutex_lock(&mut) == -1) {
        perror("Lock of mut failed");
        exit(102);
    }
    printf("Load DLL...\n");
    handle = dllload("CELQDLL");
    if (handle == NULL) {
        perror("Could not load DLL CELQDLL");
        exit(106);
    }
    printf("Query DLL...\n");
    fp = (FUNC *)dllqueryfn(handle,"div_zero");
    if (fp == NULL) {
        perror("Could not find thread_func");
        exit(107);
    }
    printf("Init MUTEX...\n");
    if (pthread_mutex_init(&mut, NULL) == -1) {
        perror("Init of mut failed");
        exit(101);
    }
    printf("Lock Mutex Lock...\n");
    if (pthread_mutex_lock(&mut) == -1) {
        perror("Lock of mut failed");
        exit(102);
    }
}
```

Figure 165. The C program CELQSAMP (AMODE 64) (Part 1 of 2)
printf("Create 1st thread...
");
if (pthread_create(&thread[0],NULL,thread_func,(void *)t1) == -1) {
  perror("Could not create thread #1");
  exit(103);
}

printf("Create 2nd thread...
");
if (pthread_create(&thread[1],NULL,thread_func,(void *)t2) == -1) {
  perror("Could not create thread #2");
  exit(104);
}

printf("Write to some files...
");
fp1 = fopen("myfile.data", "w");
if (!fp1) {
  perror("Could not open myfile.data for write");
  exit(109);
}

fprintf(fp1, "record 1\n");
fprintf(fp1, "record 2\n");
fprintf(fp1, "record 3\n");

fp2 = fopen("memory.data", "wb,type=memory");
if (!fp2) {
  perror("Could not open memory.data for write");
  exit(112);
}

fprintf(fp2, "some data");
fprintf(fp2, "some more data");
fprintf(fp2, "even more data");

printf("Call div_zero...
");
fp(NULL);

printf("Error -- Should not get here\n");
exit(110);

Figure 166. The C program CELQSAMP (AMODE 64) (Part 2 of 2)

/* DLL containing div_zero */
#pragma options(SERVICE("1.8"), NOOPT, GONUM)
#pragma export(div_zero)
#include <stdio.h>
#include <stdlib.h>
 ريَب وَيَنَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب رَيَب R *
/* div_zero: Cause divide by zero exception */
/**************************************************************************/
void *div_zero(void *parm)
{
  int i = 0;

  printf("Divide by zero...
");
  i = 1/i;
  printf("Error -- Should not get here. i=%d\n",i);
  exit(110);
}

Figure 167. The C DLL CELQDLL (AMODE 64)

For easy reference, the sections of the following dump are numbered to correspond with the descriptions in "Sections of the Language Environment dump" on page 574.
Figure 168. Example dump using CEE3DMP (AMODE 64) (Part 1 of 9)
Figure 169. Example dump using CEE3DMP (AMODE 64) (Part 2 of 9)
Figure 170. Example dump using CEE3DMP (AMODE 64) (Part 3 of 9)
Figure 171. Example dump using CEE3DMP (AMODE 64) (Part 4 of 9)
Figure 172. Example dump using CEE3DMP (AMODE 64) (Part 5 of 9)
Control Blocks Associated with the Thread:

Enclave Control Blocks:
- Header(0000000108FC0090)
- CELQDSNF(00000001083A0430 00000000258C4000 253E019000000000 00000001 CELQDSNF)
- CELQDLL(0000000108371090 000000002575B000 253E019000000000 00000001 CELQDLL)
- main(0000000108300050 00000001 main)

DLL Information:

Thread Synchronization Enclave Latch Table (EPALT)(0000000108910B00)
- MEML(00000001000068F8)
- EDB(0000000100005340)
- CAA(00000001114013C8)

Figure 173. Example dump using CEE3DMP (AMODE 64) (Part 6 of 9)
Language Environment Trace Table:

<table>
<thead>
<tr>
<th>Displacement</th>
<th>Trace Entry in Hexadecimal</th>
<th>Trace Entry in EBCDIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>Time 21.19.55.717555 Date 2007.01.17 Thread ID... 253E019000000000</td>
<td>CEEPKK ....................-....</td>
</tr>
<tr>
<td>+000010</td>
<td>Member ID.... 01 Flags..... 000000 Entry Type..... 00001000</td>
<td></td>
</tr>
<tr>
<td>+000020</td>
<td>40404040 40404040 40404040 40404040 40404040 40404040 40404040 40404040</td>
<td></td>
</tr>
<tr>
<td>+000078</td>
<td>40404040 40404040</td>
<td></td>
</tr>
<tr>
<td>+000100</td>
<td>Time 21.19.55.717821 Date 2007.01.17 Thread ID... 253E019000000000</td>
<td>CEEPKK ....................-....</td>
</tr>
<tr>
<td>+000110</td>
<td>Member ID.... 01 Flags..... 000000 Entry Type..... 00001011</td>
<td></td>
</tr>
<tr>
<td>+000118</td>
<td>253E10A0 00000002 00000000 7F7547D8 00000000 257669A0 00001660 00000000</td>
<td></td>
</tr>
<tr>
<td>+000128</td>
<td>00000001 11400000 00000000 000024D0 00000001 11400360 00000001 114013C8</td>
<td></td>
</tr>
<tr>
<td>+000178</td>
<td>24000000 00000000</td>
<td></td>
</tr>
<tr>
<td>+000190</td>
<td>Time 21.19.55.717823 Date 2007.01.17 Thread ID... 253E019000000000</td>
<td>CEEPKK ....................-....</td>
</tr>
<tr>
<td>+000198</td>
<td>00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000</td>
<td></td>
</tr>
<tr>
<td>+000268</td>
<td>00000001 11401738 00000001 11402010 00000001 08300060 00000000 25000658</td>
<td></td>
</tr>
<tr>
<td>+000278</td>
<td>24000000 00000000</td>
<td></td>
</tr>
<tr>
<td>+000300</td>
<td>Time 21.19.55.717845 Date 2007.01.17 Thread ID... 253E019000000000</td>
<td>CEEPKK ....................-....</td>
</tr>
<tr>
<td>+000310</td>
<td>Member ID.... 01 Flags..... 000000 Entry Type..... 00001011</td>
<td></td>
</tr>
<tr>
<td>+000318</td>
<td>253E1FB0 00000002 00000000 7F7547D8 00000000 257689A0 00001660 00000000</td>
<td></td>
</tr>
<tr>
<td>+000328</td>
<td>00000001 11400000 00000000 000024D0 00000001 11400360 00000001 114013C8</td>
<td></td>
</tr>
<tr>
<td>+000378</td>
<td>24000000 00000000</td>
<td></td>
</tr>
<tr>
<td>+000390</td>
<td>Time 21.19.55.717874 Date 2007.01.17 Thread ID... 253E019000000000</td>
<td>CEEPKK ....................-....</td>
</tr>
<tr>
<td>+000408</td>
<td>00000001 19000000 00000000 00000000 00000000 00000000 00000000 00000000</td>
<td></td>
</tr>
<tr>
<td>+000478</td>
<td>24000000 00000000</td>
<td></td>
</tr>
<tr>
<td>+000500</td>
<td>Time 21.19.55.718015 Date 2007.01.17 Thread ID... 253E019000000000</td>
<td>CEEPKK ....................-....</td>
</tr>
<tr>
<td>+000510</td>
<td>Member ID.... 01 Flags..... 000000 Entry Type..... 00001000</td>
<td></td>
</tr>
<tr>
<td>+000518</td>
<td>40404040 40404040 40404040 40404040 40404040 40404040 40404040 40404040</td>
<td></td>
</tr>
<tr>
<td>+000528</td>
<td>40404040 40404040 40404040 40404040 40404040 40404040 40404040 40404040</td>
<td></td>
</tr>
<tr>
<td>+000578</td>
<td>40404040 40404040</td>
<td></td>
</tr>
</tbody>
</table>

Figure 174. Example dump using CEE3DMP (AMODE 64) (Part 7 of 9)
Figure 175. Example dump using CEE3DMP (AMODE 64) (Part 8 of 9)
Sections of the Language Environment dump

The sections of the dump listed in Table 53 appear independently of the Language Environment-conforming languages used.

Table 53. Contents of the Language Environment dump - AMODE 64

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
</table>
| [1] Page Heading          | The page heading section appears on the top of each page of the dump and contains:  
|                           | • CEE3DMP identifier  
|                           | • Title  
|                           | For dumps generated as a result of an unhandled condition, the title is “Condition processing resulted in the Unhandled condition.”  
|                           | • Product abbreviation of Language Environment  
|                           | • Version number  
|                           | • Release number  
|                           | • Date  
|                           | • Time  
|                           | • Page number |
| [2] CEE3845I CEEDUMP Processing started. | Identifies the start of the Language Environment dump processing. Similarly, message CEE3845I identifies the end of the dump processing. Message number CEE3845I can be used to locate the start of the next CEEDUMP report when scanning forward in a data set that contains several CEEDUMP reports. |
| [3] Enclave Identifier     | Names the enclave for which information in the dump is provided. |
| [4] - [10] Thread Information: | These sections show information that is specific to a thread. When multiple threads are dumped, these sections will appear for each thread. |
| [4] Information for thread | Shows the system identifier for the thread. Each thread has a unique identifier. |
Table 53. Contents of the Language Environment dump - AMODE 64 (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[5] Traceback</td>
<td>For all active routines in a particular thread, the traceback section shows routine information in three parts. The first part contains:</td>
</tr>
<tr>
<td></td>
<td>• DSA number: A number assigned to the information for this active routine by dump processing. The number is used to associate information from the first part of the traceback with information in the second and third parts of the traceback.</td>
</tr>
<tr>
<td></td>
<td>• Entry : For C/C++ routines, this is the function name. If a function name or entry point was not specified for a particular routine, then the string ‘** NoName **’ will appear.</td>
</tr>
<tr>
<td></td>
<td>• Entry point offset</td>
</tr>
<tr>
<td></td>
<td>• Statement number: Refers to the line number in the source code (program unit) in which a call was made or an exception took place. The statement number appears only if your routine was compiled with the options required to generate statement numbers. These options are described under &quot;XL C and XL C++ compiler options for AMODE 64 applications&quot; on page 343.</td>
</tr>
<tr>
<td></td>
<td>• Load module: The load module name displayed can be a partitioned data set member or an UNIX executable file. The load module name is also displayed in the third part of the traceback (see below for details).</td>
</tr>
<tr>
<td></td>
<td>• Program unit: The primary entry point of the external procedure. For C routines, this is the compile unit name. For Language Environment-conforming assemblers, this is the ENNAME = value on the CELQPRLG macro.</td>
</tr>
<tr>
<td></td>
<td>If your routine was compiled with the compile options to generate statement numbers then the program unit name displayed under this column will appear as follows:</td>
</tr>
<tr>
<td></td>
<td>– If your compiled routine is in a partitioned data set then only the member will be output.</td>
</tr>
<tr>
<td></td>
<td>– If your compiled routine is in a sequential data set then only the last qualifier will be shown.</td>
</tr>
<tr>
<td></td>
<td>– If your compiled routine is in an UNIX filename then only what fits of the filename will be displayed in a line.</td>
</tr>
<tr>
<td></td>
<td>Look for the complete name of the program unit in the Fully Qualified Names section of the traceback, if your routine was compiled using compile options to generate statement numbers.</td>
</tr>
<tr>
<td></td>
<td>• Service level : The latest service level applied to the compile unit (for example, for IBM products, it would be the PTF number).</td>
</tr>
<tr>
<td></td>
<td>• Status: Routine status can be call or exception.</td>
</tr>
</tbody>
</table>
Table 53. Contents of the Language Environment dump - AMODE 64 (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[5] Traceback (continued)</td>
<td>The second part contains:</td>
</tr>
<tr>
<td></td>
<td>• DSA number: A number assigned to the information for this active routine by dump processing. The number is used to associate information from the first part of the traceback with information in the second and third parts of the traceback.</td>
</tr>
<tr>
<td></td>
<td>• Stack frame (DSA) address</td>
</tr>
<tr>
<td></td>
<td>• Entry point address</td>
</tr>
<tr>
<td></td>
<td>• Program unit address</td>
</tr>
<tr>
<td></td>
<td>• Program unit offset: The offset of the last instruction to run in the routine. If the offset is a negative number, zero, or a very large positive number, the routine associated with the offset probably did not allocate a save area or the routine could have been called using SVC-assisted linkage. Adding the program unit address to the offset gives you the location of the current instruction in the routine. This offset is from the starting address of the routine.</td>
</tr>
<tr>
<td></td>
<td>• Compile Date</td>
</tr>
<tr>
<td></td>
<td>• Attributes: The attributes of the compile unit including whether character data is being treated as EBCDIC or ASCII and whether floating point data is being treated as IEEE or hexadecimal.</td>
</tr>
<tr>
<td>The third part, which is also referred to as 'Fully Qualified Names' section, contains the following:</td>
<td></td>
</tr>
<tr>
<td>• DSA number</td>
<td></td>
</tr>
<tr>
<td>• Entry</td>
<td></td>
</tr>
<tr>
<td>• Program unit: Similar to the Program Unit column in part 1 except that the server name and the complete program unit (PU) name will be displayed. A PU name will appear here only if it was compiled using compile options to produce statement numbers.</td>
<td></td>
</tr>
<tr>
<td>• Load Module: The complete pathname of a load module name residing in an UNIX filename will be displayed here if available. The load module's full pathname will be displayed if the PATH environment variable is set such that the pathname of the load module's directory appears before the current directory (/). For load modules found in data sets, the same output shown in the traceback part 1 will also be displayed here.</td>
<td></td>
</tr>
<tr>
<td>[6] Condition Information for Active Routines</td>
<td>Displays the following information for all conditions currently active on the call chain:</td>
</tr>
<tr>
<td>• Statement showing failing routine and stack frame address of routine</td>
<td></td>
</tr>
<tr>
<td>• Condition information block (CIB) address</td>
<td></td>
</tr>
<tr>
<td>• Current condition, in the form of a Language Environment message for the condition raised or a Language Environment abend code, if the condition was caused by an abend</td>
<td></td>
</tr>
<tr>
<td>• Location: For the failing routine, this is the program unit, entry routine, statement number, and offset.</td>
<td></td>
</tr>
<tr>
<td>• Machine state, which shows:</td>
<td></td>
</tr>
<tr>
<td>– Instruction length counter (ILC)</td>
<td></td>
</tr>
<tr>
<td>– Interruption code</td>
<td></td>
</tr>
<tr>
<td>– Program status word (PSW)</td>
<td></td>
</tr>
<tr>
<td>– Contents of GPRs 0–15. Contents of floating point content register (FPC) and floating point registers FPR 0–15.</td>
<td></td>
</tr>
<tr>
<td>– Storage dump near condition (2 hex-bytes of storage near the PSW)</td>
<td></td>
</tr>
<tr>
<td>– Storage pointed to by General Purpose Registers</td>
<td></td>
</tr>
<tr>
<td>These values are the current values at the time the condition was raised.</td>
<td></td>
</tr>
<tr>
<td>Section Number and Heading</td>
<td>Contents</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------</td>
</tr>
</tbody>
</table>
| [7] Parameters, Registers, and Variables for Active Routines | For each active routine, this section shows:  
  - Routine name and stack frame address  
  - Saved registers: This lists the contents of GPRs 0–15 at the time the routine received control. The saved registers are those saved by the DSA-owning routine on entry. Register 7 is the return address back to the caller of the DSA-owning routine. Register 6 may be the entry point of the DSA-owning routine. (This is not true when the Branch Relative and Save instruction is used to implement the call. The non-volatile floating-point registers that are saved in the stack frame. The registers are only displayed if the program owning the stack frame saved them. Dashes are displayed in the registers when the register values are not saved.  
  - Storage pointed to by the saved registers: Treating the saved contents of each register as an address, 32 bytes before and 64 bytes after the address shown. |
| [8] Control Blocks for Active Routines | For each active routine controlled by the STACKFRAME option, this section lists contents of related control blocks. The Language Environment-conforming language determines which language-specific control blocks appear. The possible control blocks are:  
  - Stack frame  
  - Condition information block  
  - Language-specific control blocks |
| [9] Storage for Active Routines | Displays local storage for each active routine. The storage is dumped in hexadecimal, with EBCDIC translations on the right side of the page. There can be other information, depending on the language used. For C/C++ routines, this is the stack frame storage. |
| [10] Control Blocks Associated with the Thread | Lists the contents of the Language Environment common anchor area (CAA), thread synchronization queue element (SQEL) and dummy stack frame. Other language-specific control blocks can appear in this section. |
| [11] Enclave Control Blocks | Lists the contents of the Language Environment enclave data block (EDB) and enclave member list (MEML). The information presented may vary depending on which runtime options are set.  
  - If the POSIX runtime option is set to ON, this section lists the contents of the mutex and condition variable control blocks, the enclave level latch table, and the thread synchronization trace block and trace table.  
  - If DLLs have been loaded, this section shows information for each DLL including the DLL name, load address, use count, writeable static area (WSA) address, and the thread ID of the thread that loaded the DLL.  
  - If the HEAPCHK runtime option is set to ON, this section shows the contents of the HEAPCHK options control block (HCOP) and the HEAPCHK element tables (HCEL). A HEAPCHK element table contains the location and length of all allocated storage elements for a heap in the order that they were allocated.  
  - When the call-level suboption of the HEAPCHK runtime option is set, any unfreed storage, which would indicate a storage leak, would be displayed in this area. The traceback could then be used to identify the program which did not free the storage.  
  - If the TRACE runtime option is set to ON, this section shows the contents of the Language Environment trace table.  
  Other language-specific control blocks can appear in this section. |
| [12] Runtime Options Report | Lists the Language Environment runtime options in effect when the routine was executed. |
Table 53. Contents of the Language Environment dump - AMODE 64 (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>[13]</strong> Process Control Blocks</td>
<td>Lists the contents for the Language Environment process control block (PCB), process member list (MEML), and if the POSIX runtime option is set to ON, the process level latch table. Other language-specific control blocks can appear in this section.</td>
</tr>
<tr>
<td><strong>[14]</strong> CEE3846I CEEDUMP Processing completed.</td>
<td>Identifies the end of the Language Environment dump processing. Similarly, message CEE3845I identifies the start of the dump processing. Message number CEE3846I can be used to locate the end of the previous CEEDUMP report when scanning backward in a data set that contains several CEEDUMP reports.</td>
</tr>
</tbody>
</table>

## Generating a system dump

A system dump contains the storage information needed to diagnose errors. You can use Language Environment to generate a system dump through any of the following methods:

**DYNDUMP(hlg,DYNAMIC,TDUMP)**

You can use the DYNDUMP runtime option to obtain IPCS readable dumps of user applications that would ordinarily be lost due to the absence of a SYSMDUMP, SYSUDUMP, or SYSABEND DD statement.

**TERMTHDACT(UAONLY, UATRACE, or UADUMP)**

You can use these runtime options, with TRAP(ON), to generate a system dump if an unhandled condition of severity 2 or greater occurs. For further details regarding the level of dump information produced by each of the TERMTHDACT suboptions, see "Generating a Language Environment dump with TERMTHDACT" on page 361.

**TRAP(ON,NOSPIE) TERMTHDACT(UAIMM)**

TRAP(ON,NOSPIE) TERMTHDACT(UAIMM) generates a system dump of the user address space of the original abend or program interrupt prior to the Language Environment condition manager processing the condition.

**Abend Codes in Initialization Assembler User Exit**

Abend codes listed in the initialization assembler user exit are passed to the operating system. The operating system can then generate a system dump.

__cabend__()

You can use the __cabend__() API to cause the operating system to handle an abend.

See system or subsystem documentation for detailed system dump information.

The method for generating a system dump varies for each of the Language Environment runtime environments. The following sections describe the recommended steps needed to generate a system dump in batch and z/OS UNIX shell runtime environments. Other methods may exist, but these are the recommended steps for generating a system dump. For details on setting Language Environment runtime options, see [z/OS Language Environment Programming Guide](z/OS V2R1.0 Language Environment Debugging Guide).
Steps for generating a system dump in a batch runtime environment

Perform the following steps to generate a system dump in a batch runtime environment. When you are done, you have a generated system dump in a batch runtime environment.

1. Specify runtime options TERMTHDACT(UAONLY, UADUMP, UATRACE, or UAIMM), and TRAP(ON). If you specify the suboption UAIMM then you must set TRAP(ON,NOSPIE). The TERMTHDACT suboption determines the level of detail of the Language Environment formatted dump. For further details on the TERMTHDACT suboptions, see “Generating a Language Environment dump with TERMTHDACT” on page 361.

2. Decide whether to include a SYSMDUMP DD card or use the DYNDUMP runtime option.
   - Include a SYSMDUMP DD card with the desired data set name and DCB information: LRECL=4160, BLKSIZE=4160, and RECFM=FBS.
   - Specify the DYNDUMP runtime option with the following information:
     DYNDUMP (hlq,DYNAMIC,TDUMP)

3. Rerun the program.

Steps for generating a system dump in a z/OS UNIX shell

Perform the following steps to generate a system dump from a z/OS UNIX shell:

- Using _BPXK_MDUMP
  1. Specify where to write the system dump.
     - To write the system dump to a z/OS data set, issue the export _BPXK_MDUMP=*filename command, where filename is a fully qualified data set name with DCB information: LRECL=4160, BLKSIZE=4160, and RECFM=FBS.
       Example: export _BPXK_MDUMP=hlq.mydump
     - To write the system dump to an HFS file, issue the export _BPXK_MDUMP=*filename command, where filename is a fully qualified HFS filename:
       Example: export _BPXK_MDUMP=/tmp/mydump.dmp
  2. Specify Language Environment runtime options, where suboption = UAONLY, UADUMP, UATRACE, or UAIMM. If UAIMM is set, TRAP(ON,NOSPIE) must also be set. The TERMTHDACT suboption determines the level of detail of the Language Environment formatted dump. For more details regarding the TERMTHDACT suboptions, see “Generating a Language Environment dump with TERMTHDACT” on page 361.
     export _CEE_RUNOPTS="termthdact(suboption)"

3. Rerun the program.

When you are done, the system dump is written to the data set name or HFS file name specified. For additional _BPXK_MDUMP information see z/OS UNIX System Services Command Reference.

- Using DYNDUMP
  1. Specify Language Environment runtime options:
     export _CEE_RUNOPTS="termthdact(suboption),DYNDUMP(hlq,DYNAMIC,TDUMP)"
     suboption is UAONLY, UADUMP, UATRACE, or UAIMM. If UAIMM is set,
TRAP(ON,NOSPIE) must also be set. The TERMTHDACT suboption determines the level of detail of the Language Environment formatted dump. For further details regarding the TERMTHDACT suboptions, see "Generating a Language Environment dump with TERMTHDACT" on page 361.

hlq is the high level qualifier for the dump data set to be created.

2. Rerun the program.
When you are done, the system dump is written to the name generated by the DYNDUMP runtime option. For more DYNDUMP information see z/OS Language Environment Programming Reference.

Note: You can also specify the signal SIGDUMP on the kill command to generate a system dump of the user address space. For more information about the SIGDUMP signal, see z/OS UNIX System Services Command Reference.

Formatting and analyzing system dumps
You can use the Interactive Problem Control System (IPCS) to format and analyze system dumps. Language Environment provides an IPCS VERBEXIT LEDATA that can be used to format Language Environment control blocks. For more information on using IPCS, see z/OS MVS IPCS User’s Guide.

Preparing to use the Language Environment support for IPCS
Use the following guidelines before you use IPCS to format Language Environment control blocks:

- Ensure that your IPCS job can find the CEEIPCSP member.

  IPCS provides an exit control table with imbed statements to enable other products to supply exit control information. The IPCS default table, BLSCECT, normally in the SYS1.PARMLIB library, has the following entry for Language Environment:

  IMBED MEMBER(CEEIPCSP) ENVIRONMENT(IPCS)

  The Language Environment-supplied CEEIPCSP member, installed in the SYS1.PARMLIB library, contains the Language Environment-specific entries for the IPCS exit control table.

- Provide an IPCSPARM DD statement to specify the libraries containing the IPCS control tables; for example:

  //IPCSPARM DD DSN=SYS1.PARMLIB,DISP=SHR

- Ensure that your IPCS job can find the Language Environment-supplied ANALYZE exit routines installed in the SYS1.MIGLIB library.

- To aid in debugging system or address space hang situations, Language Environment mutexes, latches and condition variables can be displayed if the CEEIPCSP member you are using is updated to identify the Language Environment ANALYZE exit, by including the following statement:

  EXIT EP(CEEEANLZ) ANALYZE

Understanding Language Environment IPCS VERBEXIT – LEDATA

Purpose

Use the LEDATA verb exit to format data for Language Environment. This VERBEXIT provides information about the following topics:

- A summary of Language Environment at the time of the dump
Parameters

The following sections describe the various types of parameters you can specify for VERBEXIT LEDATA. Only hexadecimal characters can be specified as addresses provided in LEDATA parameters. Special characters cause the formatter to fail. Therefore, to specify a 64 bit address as a parameter, it must be in the form like 123456789 instead of 1_23456789.

Report type parameters
Use these parameters to select the type of report. If you omit these parameters, the default is SUMMARY.

Address space report types: Use these parameters to select a report that shows the Language Environment activity for an address space. Only one of these reports may be specified.

NTHREADS(value)
Requests a report that shows the traceback for the TCBs in the address space. value is the number of TCBs for which the traceback will be displayed. If value is specified as asterisk (*), all TCBs will be displayed. The LAA, CAA, or TCB parameter can be used to limit the display to only TCBs that are part of the same enclave.
AUTH
 Requests a report on all Preinitialized Environments for Authorized Programs
 control blocks for the address space. NTHREADS is ignored when AUTH is
 specified.

PTBL(value)
 Requests that PreInit tables be formatted according to the following values.

CURRENT
 If current is specified, the PreInit table associated with the current or
 specified TCB is displayed.

address
 If an address is specified, the PreInit table at that address is specified.

*  All active and dormant PreInit tables within the current address space are
 displayed; this option is time-consuming.

ACTIVE
 The PreInit tables for all TCBs in the address space are displayed.

Thread specific report types: Use these parameters to select reports that show
Language Environment activity for a specific TCB. These report types are ignored
if AUTH or NTHREADS is specified. You can specify as many of these reports as
you wish.

SUMmary
 Requests a summary of the Language Environment at the time of the dump.
 The following information is included:
 • TCB address
 • Address Space Identifier
 • Language Environment Release
 • Active members
 • Formatted CAA, PCB, RCB, EDB, LAA and LCA
 • Runtime Options in effect

HEAP | STACK | SM

HEAP
 Requests a report on Storage Management control blocks pertaining to
 HEAP storage, as well as a detailed report on heap segments. The detailed
 report includes information about the free storage tree in the heap
 segment, and information about each allocated storage element. It also
 specifies a heap pools report with information useful to find potential
 damaged cells.

Note: Language Environment does not provide support for alternative
Vendor Heap Manager (VHM) data.

STACK
 Requests a report on Storage Management control blocks pertaining to
 STACK storage.

SM
 Requests a report on Storage Management control blocks. This is the same
 as specifying both HEAP and STACK.

HPT(number) [ HPTTCB (address) ] [ HPTCELL(address) ] [ HPTLOC(location) ]

HPT(number)
 Requests that the heap pool trace, if available, be formatted. If the
 value is 0 or *, the trace for every heap pool ID is formatted. If the
 value is a single number (1-12), the trace for the specific heap pool ID
is formatted. If only the HPT keyword is specified with no value, the trace behaves similar to when the value is *. If no filter is specified, all of the entries are formatted for the specific pool ID.

**HPTTCB** *(address)*
Filters the heap pool trace table, if available, printing only those entries for a given TCB address *(address)*.

**HPTCELL** *(address)*
Filters the heap pool trace table, if available, printing only those entries for a given cell address *(address)*.

**HPTLOC** *(value)*
Filters the heap pool trace table, if available, and prints only those entries for a given virtual storage location *(location)*. The following values are valid:

- **31** Display entries located in virtual storage below the bar.
- **64** Display entries located in virtual storage above the bar.
- **ALL** Display entries located in virtual storage below or above the bar.

**Note:**
1. Filter options without specifying HPT implies HPT(*).
2. You can specify multiple options together, like HPTTCB and HPTCELL. All pieces of information must match the trace entry for it to be formatted. If location and cell contradict each other, such as HPTLOC(31) and HPTCELL(64bit addr), an error will be displayed.

**CM** Requests a report on Condition Management control blocks.

**MH** Requests a report on Message Handler control blocks.

**CEEdump**
Requests a CEEDUMP-like report. This includes the traceback, the Language Environment trace, and thread synchronization control blocks at process, enclave and thread levels.

**COMP** *(value)*
Requests component control blocks to be formatted according to the following values:

- **C** Requests a report on C/C++ runtime control blocks.
- **CIO** Requests a report on C/C++ I/O control blocks.
- **COBOL** Requests a report on COBOL-specific control blocks.
- **PLI** Requests a report on PL/I-specific control blocks.
- **ALL** Requests a report on all the previous control blocks.

If the value specified in COMP is not one of the values (C, CIO, COBOL, PLI, or ALL), a message is displayed and it continues executing as if COMP(ALL) was specified.
The ALL parameter for LEDATA also generates a report that includes all the component control blocks.

**ALL**
Requests all the reports listed above, as well as C/C++, COBOL, and PL/I reports.

**Data selection parameters**
Data selection parameters limit the scope of the data in the report. If no data selection parameter is selected, the default is DETAIL.

**DETAil**
Requests formatting all control blocks for the selected components. Only significant fields in each control block are formatted. For the Heap and Storage Management Reports, the DETAIL parameter will provide a detailed heap segment report for each heap segment in the dump. The detailed heap segment report includes information on the free storage tree in the heap segments, and all allocated storage elements. This report will also identify problems detected in the heap management data structures. For more information about the Heap Reports, see [“Understanding the HEAP LEDATA output” on page 399](#).

**EXCeption**
Requests validating all control blocks for the selected components. Output is only produced naming the control block and its address for the first control block in a chain that is invalid. Validation consists of control block header verification at the very least. For the Summary, CEEDUMP, C/C++ reports, the EXCEPTION parameter has not been implemented. For these reports, DETAIL output is always produced.

**Control block selection parameters**
Use these parameters to select the control blocks used as the starting points for formatting.

**CAA**(caa-address)
specifies the address of the CAA. If not specified, the CAA address is obtained from the LAA.

**DSA**(dsa-address)
specifies the address of the DSA. If not specified, the DSA address may be obtained from the TCB or the IPCS symbol REGGEN.

**TCB**(tcb-address)
specifies the address of the TCB. If not specified, the TCB address may be obtained from the CAA or the CVT.

**LAA**(laa-address)
specifies the address of the LAA. If not specified, the LAA address may be obtained from the TCB or the PSA.

**ASID**(address-space-id)
specifies the hexadecimal address space ID. If not specified, the IPCS default address space ID is used. This parameter is not needed when the dump only has one address space.

**Examples**
For examples of the output produced by LEDATA and explanation of the content, refer to [“Understanding the Language Environment IPCS VERBEXIT LEDATA output” on page 385](#).
Understanding the Language Environment IPCS VERBEXIT LEDATA output

The Language Environment IPCS VERBEXIT LEDATA generates formatted output of the Language Environment runtime environment control blocks from a system dump. The following sample illustrates the output produced when the LEDATA VERBEXIT is invoked with the ALL parameter. The system dump being formatted was obtained by specifying the TERMTHDACT(UADUMP) runtime option when running the program CELQSAMP in Figure 165 on page 364.

“Sections of the Language Environment LEDATA VERBEXIT formatted output” on page 396 describes the information in the formatted output. Ellipses are used to summarize some sections of the dump. For easy reference, the sections of the following dump are numbered to correspond with the descriptions in “Sections of the Language Environment LEDATA VERBEXIT formatted output” on page 396.
ALL

64 BIT LANGUAGE ENVIRONMENT DATA

Language Environment Product 04 V01 R09.00

[1] Information for enclave main

[2] Information for thread 253E019000000000
   TCB Address: 007FF050
   CAA Address: 00000001_00007B18
   PCB Address: 00000001_00003CA0

[3] Registers and PSW:
   GPR0..... 0000000084000000  GPR1..... 0000000084000FC7  GPR2..... 00000001082FBE00  GPR3..... 3C10000000000000
   GPR4..... 00000001082FA900  GPR5..... 00000000253C45F8  GPR6..... 00000000253C4500  GPR7..... 00000000251B9B1A
   GPR8..... 00000001082FBE00  GPR9..... 00000000253C459A  GPR10.... 00000001082FABF  GPR11.... 00000001082FBE00
   GPR12.... 00000001082FBB08  GPR13.... 00000001082FE680  GPR14.... 0000000100005DC8  GPR15.... 0000000000000000
   PSW..... 07851401 80000000 00000000 253C459A

[4] Traceback:
   DSA Entry E Offset Statement Load Mod Program Unit Service Status
   1 CEEHSDMP +0000009A CELQLIB CEEHSDMP D1908 Call
   2 CEEHDSP +00003AB8 CELQLIB CEEHDSP D1908 Call
   3 CEEOSIGJ +0000094E CELQLIB CEEOSIGJ D1908 Call
   4 CELQHROD +0000024E CELQLIB CELQHROD D1908 Call
   5 CEEOSIGG +00000000 CELQLIB CEEOSIGG D1908 Call
   6 CELQHROD +0000024E CELQLIB CELQHROD D1908 Call
   7 div_zero +00000040 CELQDLL 1.4.f Exception
   8 main +00000468 CELQSAMP 1.2.d Call
   9 CELQINIT +0000134C CELQLIB CELQINIT D1908 Call

   DSA DSA Addr E Addr PU Addr PU Offset Comp Date Compile Attributes
   1 00000001_082FA900 00000000_253C4500 00000000_253C4500 +0000009A0 20061215 CEL POSIX XPLINK EBCDIC HFP
   2 00000001_082FAAC0 00000000_251B6060 00000000_251B6060 +00003AB80 20061215 CEL POSIX XPLINK EBCDIC HFP
   3 00000001_082FD3E0 00000000_2504AAB0 00000000_2504AAB0 +0000094E0 20070109 CEL POSIX XPLINK EBCDIC HFP
   4 00000001_082FDDE0 00000000_251C9480 00000000_251C9480 +0000024E0 20061215 CEL POSIX XPLINK EBCDIC HFP
   5 00000001_082FE020 00000000_253D11F8 00000000_253D11F8 +000000000 20061215 CEL POSIX XPLINK EBCDIC HFP
   6 00000001_082FEE40 00000000_251C9480 00000000_251C9480 +0000024E0 20061215 CEL POSIX XPLINK EBCDIC HFP
   7 00000001_082FF080 00000000_2575B5A0 00000000_00000000 +2575B5E00 20070116 C/C++ POSIX XPLINK EBCDIC IEEE
   8 00000001_082FF180 00000000_250000D8 00000000_00000000 +250005400 20070116 C/C++ POSIX XPLINK EBCDIC IEEE
   9 00000001_082FF280 00000000_25005010 00000000_25005010 +0000134C0 20061215 CEL POSIX XPLINK EBCDIC HFP

[5] Control Blocks Associated with the Thread:
   Thread Synchronization Queue Element (SQEL): 00000000_257520A0

   Mutex and Condition Variable Blocks (MCVB+MHT+CHT): 00000001_089100B8

[6] Enclave Control Blocks:

   Mutex and Condition Variable Blocks (MCVB+MHT+CHT): 00000001_089100B8

Figure 177. Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 1 of 10)
Figure 178. Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 2 of 10)
Figure 179. Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 3 of 10)
Figure 180. Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 4 of 10)
Figure 181. Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 5 of 10)
Heap Storage Control Blocks

Heap pools trace available. To display: IP VERBX LEDATA 'HPT(*r)'

<table>
<thead>
<tr>
<th>ENQQ</th>
<th>EYE_CATCHER:ENQQ</th>
<th>HEAPALLOC_VAL:00000000</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>EYE_CATCHER:ENQQ</td>
<td>HEAPALLOC_VAL:00000000</td>
</tr>
<tr>
<td>+000008</td>
<td>EYE_CATCHER:ENQQ</td>
<td>HEAPALLOC_VAL:00000000</td>
</tr>
<tr>
<td>+000014</td>
<td>IPT_TOKEN:00000000</td>
<td>000000002 0000000016 0000000016 0000000016</td>
</tr>
<tr>
<td>+000024</td>
<td>HEAPLOCKWORD:00000000</td>
<td>R1_PTR:00000001 00100410</td>
</tr>
<tr>
<td>+000030</td>
<td>HEAPLOCKWORD:00000000</td>
<td>R1_PTR:00000001 00100410</td>
</tr>
<tr>
<td>+000060</td>
<td>HEAPLOCKWORD:00000000</td>
<td>R1_PTR:00000001 00100410</td>
</tr>
<tr>
<td>+000090</td>
<td>HEAPLOCKWORD:00000000</td>
<td>R1_PTR:00000001 00100410</td>
</tr>
<tr>
<td>+0000C0</td>
<td>HEAPLOCKWORD:00000000</td>
<td>R1_PTR:00000001 00100410</td>
</tr>
<tr>
<td>+0000F0</td>
<td>HEAPLOCKWORD:00000000</td>
<td>R1_PTR:00000001 00100410</td>
</tr>
<tr>
<td>+000120</td>
<td>HEAPLOCKWORD:00000000</td>
<td>R1_PTR:00000001 00100410</td>
</tr>
<tr>
<td>+000174</td>
<td>IPT_TCB:0000F0F0</td>
<td>HEAPCHK:00000000 00000000</td>
</tr>
<tr>
<td>+001188</td>
<td>STSB:00000000 00000000</td>
<td>SASB:00000000 00000000</td>
</tr>
<tr>
<td>+001198</td>
<td>TOKEN:774F7D8 00000000</td>
<td></td>
</tr>
</tbody>
</table>

To display: IP LIST 0000000108371080 LEN(X'0000000000000060') ASID(X'0028')
To display: IP LIST 000000010833F360 LEN(X'0000000000019340') ASID(X'0028')
To display: IP LIST 00000001083001C0 LEN(X'0000000000019660') ASID(X'0028')
To display: IP LIST 0000000108300040 LEN(X'0000000000000180') ASID(X'0028')

User Heap64 Control Blocks

<table>
<thead>
<tr>
<th>HPCQ</th>
<th>EYE_CATCHER:HPCQ</th>
<th>FIRST:00000000 00100580</th>
<th>LAST:00000000 001007F0</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>EYE_CATCHER:HPCQ</td>
<td>FIRST:00000000 00100580</td>
<td>LAST:00000000 001007F0</td>
</tr>
<tr>
<td>+000018</td>
<td>INITSIZE:00000000 00000001</td>
<td>INCHSIZE:00000000 00000001</td>
<td></td>
</tr>
<tr>
<td>+00002C</td>
<td>OPTIONS:00000000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WPSQ</th>
<th>EYE_CATCHER:WPSQ</th>
<th>FLG:00000000 001C3200</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>EYE_CATCHER:WPSQ</td>
<td>FLG:00000000 001C3200</td>
</tr>
<tr>
<td>+000008</td>
<td>CURR_ALLOC:00000000 00000000</td>
<td>GET_REQ:00000000 00000000</td>
</tr>
<tr>
<td>+000018</td>
<td>FREE_REQ:00000000 00000001</td>
<td>GETMEMS:00000000 00000001</td>
</tr>
<tr>
<td>+000028</td>
<td>FREEMEM:00000000 00000000</td>
<td></td>
</tr>
</tbody>
</table>

To display entire segment: IP LIST 0000000108300000 LEN(X'0000000000100000') ASID(X'0028')

Map of Heap Segment 0000000108300000

<table>
<thead>
<tr>
<th>THMQ:</th>
<th>EYE_CATCHER:THMQ</th>
<th>FLG:00000000 001007F0</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>EYE_CATCHER:THMQ</td>
<td>FLG:00000000 001007F0</td>
</tr>
<tr>
<td>+000010</td>
<td>PREV:00000000 00100138</td>
<td>HEAPID:00000000 00100138</td>
</tr>
<tr>
<td>+000020</td>
<td>SEGMENT:00000000 08300000</td>
<td>SEG_MN:00000000 00100000</td>
</tr>
</tbody>
</table>

To display entire segment: IP LIST 0000000108300000 LEN(X'0000000000100000') ASID(X'0028')

Free Storage Tree for Heap Segment 0000000108300000

<table>
<thead>
<tr>
<th>Node</th>
<th>Address</th>
<th>Node</th>
<th>Address</th>
<th>Parent</th>
<th>Address</th>
<th>Left</th>
<th>Address</th>
<th>Right</th>
<th>Address</th>
<th>Length</th>
<th>Address</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary of analysis for Heap Segment 0000000108300000:

Amounts of identified storage: Free:00030F40 Allocated:000CF080 Total:000FFFC0

Number of identified areas: Free: 1 Allocated: 12 Total: 13

00000000 bytes of storage were not accounted for.

No errors were found while processing this heap segment.

[19] Stack Storage Control Blocks

SANC: 00000001_00100000
+000000 EYE_CATCHER:SANC VERSION:0001 LENGTH:0100
+000008 SEGMENT_SIZE:00000000 00000081 ACTIVE_STACK:00000001_00200000
+000018 BOS:00000001_082FFFE0 INIT_SIZE:00000000 00000001
+000028 INCR_SIZE:00000000 00000001 USER_STACK:00000001_00200000
+000038 USER_BOS:00000001_082FFFE0 USER_FLOOR:00000001_08200000
+000048 RESERVE_STACK:00000001_08500000 SDCB:00000000_00000000
+000060 PTDATA:00000000_00000000 OCB_INCRSZ:00000000 00000001
+000070 CURR_ALLOC:00000000 00000001 FLAGS1:00000000
+00007C FLAGS2:00000000 USER_ORIGIN:00000001 00200000

DSA backchain

DSA: 00000001_082FA900
+000000 HPR4:00000000 253C45F8 HPR5:00000000 253C4550
+000010 HPR6:00000000 253C4500 HPR7:00000000 251B9B1A
+000020 HPR8:00000000 02FB8B08 HPR9:00000000 02FB8B00
+000030 HPR10:00000001 02FB8000 HPR11:00000001 02FBFE00
+000040 HPR12:00000001 02FCAB08 HPR13:00000001 02FCAB00
+000050 HPR14:00000001 00055500 HPR15:00000001 00055554
+000060 HPR16:00000000 02FC6A00 HPR17:00000000 02FC6A00
+000070 HPRENT:00000000 251181E8

Contents of DSA at Location : 00000001_082FA900

+000000 00000001_082FB100 00000001_082FCA0 00000000 02FC6A00 02FC6A00
+000010 00000001_082FB110 00000001_082FCA1 00000001_082FCA2 00000000 02FC6A00
+000020 00000001_082FB120 00000001_082FCA3 00000001_082FCA4 00000001_082FCA5
+000030 00000001_082FB130 00000001_082FCA6 00000001_082FCA7 00000001_082FCA8
+000040 00000001_082FB140 00000001_082FCA9 00000001_082FCABE 00000001_082FCABF
+000050 00000001_082FB150 00000001_082FCAC 00000001_082FCAC 00000001_082FCAC
+000060 00000001_082FB160 00000001_082FCAD 00000001_082FCAD 00000001_082FCAD
+000070 00000001_082FB170 00000001_082FC7D 00000001_082FC7D 00000001_082FC7D
+000080 00000001_082FB180 00000001_082FCAC 00000001_082FCAC 00000001_082FCAC
+000090 00000001_082FB190 00000001_082FCAC 00000001_082FCAC 00000001_082FCAC
+0000A0 00000001_082FB1A0 00000001_082FCAC 00000001_082FCAC 00000001_082FCAC
+0000B0 00000001_082FB1B0 00000001_082FCAC 00000001_082FCAC 00000001_082FCAC
+0000C0 00000001_082FB1C0 00000001_082FCAC 00000001_082FCAC 00000001_082FCAC
+0000D0 00000001_082FB1D0 00000001_082FCAC 00000001_082FCAC 00000001_082FCAC
+0000E0 00000001_082FB1E0 00000001_082FCAC 00000001_082FCAC 00000001_082FCAC
+0000F0 00000001_082FB1F0 00000000 00000000 A8A2A385 9440C396

Figure 183. Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 7 of 10)
Figure 184. Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 8 of 10)
Figure 185. Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 9 of 10)
Message Processing Control Blocks

Figure 186. Example of formatted output from LEDATA VERBEXIT (AMODE 64) (Part 10 of 10)

Chapter 12. Using Language Environment AMODE 64 debugging facilities 395
Sections of the Language Environment LEDATA VERBEXIT formatted output

Table 54 lists the sections of the LEDATA VERBEXIT output, which appear independently of the Language Environment-conforming languages used.

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] - [8] CEEDUMP Formatted Control Blocks</td>
<td>These sections are included when the CEEDUMP parameter is specified on the LEDATA invocation.</td>
</tr>
<tr>
<td>[1] - [4] NTHREADS data</td>
<td>These sections are also included, once for each thread, when the NTHREADS() parameter is specified on the LEDATA invocations. For a description of NTHREADS, see <a href="#">Report type parameters</a>.</td>
</tr>
<tr>
<td>[1] Enclave Identifier</td>
<td>Names the enclave for which information is provided.</td>
</tr>
<tr>
<td>[2] Information for thread</td>
<td>Shows the system identifier for the thread. Each thread has a unique identifier.</td>
</tr>
<tr>
<td>[3] Registers and PSW</td>
<td>Displays the register and program status word (PSW) values that were used to create the traceback. These values may come from the TCB, the RTM2 work area, a linkage stack entry or output from the BPXGMSTA service. This section is not displayed when the DSA() parameter is specified on the LEDATA invocation.</td>
</tr>
<tr>
<td>[4] Traceback</td>
<td>For all active routines in a particular thread, the traceback section shows routine information in two parts. The first part contains:</td>
</tr>
<tr>
<td></td>
<td>• DSA number: A number assigned to the information for this active routine by LEDATA. The number is only used to associate information from the first part of the traceback with information in the second part of the traceback.</td>
</tr>
<tr>
<td></td>
<td>• Entry: For C/C++ routines, this is the function name. If a function name or entry point was not specified for a particular routine, then the string &quot;NoName&quot; will appear.</td>
</tr>
<tr>
<td></td>
<td>• Entry point offset</td>
</tr>
<tr>
<td></td>
<td>• Load module</td>
</tr>
<tr>
<td></td>
<td>• Program unit: The primary entry point of the external procedure. For C routines, this is the compile unit name. For Language Environment-conforming assemblers, this is the ENTNAME = value on the CELQPRLG macro.</td>
</tr>
<tr>
<td></td>
<td>• Service level: The latest service level applied to the compile unit (for example, for IBM products, it would be the PTF number).</td>
</tr>
<tr>
<td></td>
<td>• Status: Routine status can be call, exception, or running.</td>
</tr>
<tr>
<td></td>
<td>The second part contains:</td>
</tr>
<tr>
<td></td>
<td>• DSA number: A number assigned to the information for this active routine by LEDATA. The number is only used to associate information from the first part of the traceback with information in the second part of the traceback.</td>
</tr>
<tr>
<td></td>
<td>• Stack frame (DSA) address</td>
</tr>
<tr>
<td></td>
<td>• Entry point address</td>
</tr>
<tr>
<td></td>
<td>• Program unit address</td>
</tr>
<tr>
<td></td>
<td>• Program unit offset: The offset of the last instruction to run in the routine. If the offset is a negative number, zero, or a very large positive number, the routine associated with the offset probably did not allocate a save area, or the routine could have been called using SVC-assisted linkage. Adding the program unit address to the offset gives you the location of the current instruction in the routine. This offset is from the starting address of the routine.</td>
</tr>
<tr>
<td>[5] Control Blocks Associated with the Thread</td>
<td>Lists the contents of the thread synchronization queue element (SQEL).</td>
</tr>
</tbody>
</table>
Table 54. Contents of the Language Environment LEDATA VERBEXIT formatted output (AMODE 64) (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[6] Enclave Control Blocks</td>
<td>If the POSIX runtime option was set to ON, this section lists the contents of the mutex and condition variable control blocks, the enclave level latch table, and the thread synchronization trace block and trace table. If the HEAPCHK runtime option is set to ON, this section lists the contents of the HEAPCHK options control block (HCOP) and the HEAPCHK element tables (HCEL). A HEAPCHK element table contains the location and length of all allocated storage elements for a heap in the order that they were allocated.</td>
</tr>
<tr>
<td>[7] Language Environment Trace Table</td>
<td>If the TRACE runtime option was set to ON, this section shows the contents of the Language Environment trace table.</td>
</tr>
<tr>
<td>[8] Process Control Blocks</td>
<td>If the POSIX runtime option was set to ON, this section lists the contents of the process level latch table.</td>
</tr>
<tr>
<td>[9] - [17] Summary: These sections are included when the SUMMARY parameter is specified on the LEDATA invocation.</td>
<td></td>
</tr>
</tbody>
</table>
| [9] Summary Header | The summary header section contains:  
- Address of Thread control block (TCB)  
- Release number  
- Address Space ID (ASID) |
| [10] Active Members List | Lists active members, which is extracted from the enclave member list (MEML). |
| [12] CEELCA | Formats the contents of the Language Environment library control area (LCA). See z/OS Language Environment Vendor Interfaces for a description of the fields in the LCA. |
| [13] CEECAA | Formats the contents of the Language Environment common anchor area (CAA). See z/OS Language Environment Vendor Interfaces for a description of the fields in the CAA. If there is any, DLL failure data is also formatted. |
| [14] CEEPCB | Formats the contents of the Language Environment process control block (PCB), and the process level member list. |
| [16] CEEEDB | Formats the contents of the Language Environment enclave data block (EDB), and the enclave level member list. |
| [17] Runtime Options | Lists the runtime options in effect at the time of the dump, and indicates where they were set. |
| [18] Heap Storage Control Blocks | This section is included when the HEAP or SM parameter is specified on the LEDATA invocation. It formats the Enclave-level storage management control block (ENSQ) and for each different type of heap storage:  
- Heap control block (HPCQ)  
- Chain of heap anchor blocks (HANQ). A HANQ immediately precedes each segment of heap storage.  
This section includes a detailed heap segment report for each segment in the dump. For more information about the detailed heap segment report, see “Understanding the HEAP LEDATA output” on page 399. |
| [19] Stack Storage Control Blocks | This section is included when the STACK or SM parameter is specified on the LEDATA invocation. This section formats:  
- Stack anchor (SANC)  
- Chain of dynamic save areas (DSA) |
Section Number and Heading | Contents
---|---
[20] Condition Management Control Blocks | This section is included when the CM parameter is specified on the LEDATA invocation. It formats the chain of Condition Information Block Headers (CIBH) and Condition Information Blocks. The Machine State Information Block is contained with the CIBH starting with the field labeled MCH_EYE.

[21] Message Processing Control Blocks | This section is included when the MH parameter is specified on the LEDATA invocation.

[22] Preinitialization Information | This section is included when the PTBL parameter is specified on the LEDATA invocation. It formats information related to preinitialization. See “PTBL LEDATA output” for more information. If the preinitialization service CELQPIPI was not used to initialize this environment, the message: No PIPICB associated with CAA is displayed instead.

**PTBL LEDATA output**: The Language Environment IPCS VERBEXIT LEDATA command generates formatted output of PreInit tables when the PTBL or ALL parameter are specified. If ALL is specified, PTBL defaults to CURRENT value. Figure 187 illustrates the output produced when the VERBEXIT LEDATA command is invoked with the PTBL parameter.

---

**PTBL(CURRENT)**

********************************************************************************

64 BIT LANGUAGE ENVIRONMENT DATA

********************************************************************************

Language Environment Product 04 V01 R09.00
PreInitialization Programming Interface Trace Data
CELQPIPI Environment Table Entry and Trace Entry:
Active CELQPIPI Environment (Address 00000001_00010B80)
Eyecatcher : CELQIPCB
TCB address : 008D6E88

CELQPIPI Environment:
Environment Type : MAIN
Sequence of Calls not active
Exits not established
Signal Interrupt Routines not registered
Service Routines are not active
CELQPIPI Environment Enclave Initialized
Number of CELQPIPI Table Entries = 3

CELQPIPI Table Entry Information:
CELQPIPI Table Index 0 (Entry 1)
Routine Name = ISJPPCA3
Routine Type = C/C++
Routine Entry Point = 00000000_21053000
Routine Function Pointer = 00000000_2105A808
Routine was loaded by Language Environment
Routine Address was resolved
Routine Function Descriptor was valid
Routine was valid
Routine Return Code = 0
Routine Reason Code = 0

Entry of routine in CELQPIPI Table for Index 0 [00000000_000108038]
+00000 00000000_000108038 00000000 00000000 00000000 21053000 ..........|
+00001 00000000_000108048 00000000 21053088 00000000 00000000 ..........+|
+00002 00000000_000108058 00000000 00000000 00000000 00000000 ..........|
+00003 00000000_000108068 -00000000 00000000 00000000 00000000 ..........|
+00004 00000000_000108078 00000000 21055300 00000000 00000000 ..........|
+00005 00000000_000108088 00000000 00000000 00000000 21055400 ..........2|
+00006 00000000_000108098 00000000 00000000 00000000 00000000 ..........|
+00007 00000000_0001080A8 00000000 21053380 00000000 21053300 ..........|
+00008 00000000_0001080B8 00000000 00000000 00000000 00000000 ..........|
+00009 00000000_0001080C8 40404040 40404040 00000000 00000000 ..........|

CELQPIPI Table Index 1 (Entry 2) not in use.
CELQPIPI Table Index 2 (Entry 3) not in use.

---

*Figure 187. Example of formatted PTBL output from LEDATA VERBEXIT (Part 1 of 2)*
Understanding the HEAP LEDATA output

The Language Environment IPCS VERBEXIT LEDATA generates a detailed heap segment report when the HEAP option is used with the DETAIL option, or when the SM,DETAIL option is specified. The detailed heap segment report is useful when trying to pinpoint damage because it provides specific information. The report describes the nature of the damage, and specifies where the actual damage occurred. The report can also be used to diagnose storage leaks, and to identify heap fragmentation. Figure 189 on page 400 shows the output produced by specifying the HEAP option. "Heap report sections of the LEDATA output" on page 407 describes the information in the formatted output.

For easy reference, the sections of the dump are numbered to correspond with the description of each section that follows. Ellipses are used to summarize some sections of the dump.

Note: Language Environment does not provide support for alternative Vendor Heap Manager (VHM) data. LEDATA VERBEXIT will state that an alternative VHM is in use.
HEAP

64 BIT LANGUAGE ENVIRONMENT DATA

Language Environment Product 04 V01 R09.00

Heap Storage Control Blocks

Heaps pool trace available. To display: IP VERBX LEDATA 'HPT(*)'

ENSQ: 00000001_00100108

+000000 EYE_CATCHER:ENSQ  HEAPALLOC_VAL:00000000

+000008 HEAPFREE_VAL:00000000  DSAALLOC_VAL:00000000

+000014 FLAGS1:80000000  IPT_TOKEN:000000A0 00000002 00000016 007FF050

+000020 IPT_TCB:007FF050

+000028 HEAPLOCKWORD:00000000

+000030 RPT_STOR:00000001_00100410

+000038 UHEAP64:C8D7C3D8 00000000 00000001 001005B0 00000001 001007F0

+000060 LHEAP64:C8D7C3D8 00000000 00000001 001005E0 00000001 00100670

+000080 UHEAP31:C8D7C3D8 00000000 00000001 00100198 00000001 00100198

+0000C0 LHEAP31:C8D7C3D8 00000000 00000001 001007C0 00000001 001007C0

+000100 UHEAP24:C8D7C3D8 00000000 00000001 001001F8 00000001 001001F8

+000140 LHEAP24:C8D7C3D8 00000000 00000001 00100228 00000001 00100228

+000174 IPT_TCB:007FF050

+000180 HEAPCHK:00000000_00000000

+000198 STSB:00000000_00000000  SASB:00000000_00000000

+0001A0 THDLHEAP64:C8D7C3D8 00000000 00000001 00100790 00000001 00100790

+0001D0 IOHEAP64:C8D7C3D8 00000000 00000001 00100760 00000001 00100760

+000200 IOHEAP31:C8D7C3D8 00000000 00000001 001006A0 00000001 001006A0

+000230 IOHEAP24:C8D7C3D8 00000000 00000001 001006D0 00000001 001006D0

+000260 SM_CELL_BLOCK:00000001_00100490  SPDE:00000001_00100730

User Heap64 Control Blocks

HPCQ: 00000001_00100138

+000000 EYE_CATCHER:HPCQ FIRST:00000001_001005B0 LAST:00000001_001007F0

+000010 OPTIONS:80000000

HPSQ: 00000001_00005058

+000000 BYTES_ALLOC:00000000 001C3320  CURR_ALLOC:00000000 000CF080

+000008 FREE_REQ:00000000 0000000D GET_REQ:00000000 0000000D

+000010 GETMAINS:00000000 00000001 FREEMAINS:00000000 00000000

THNQ: 00000001_001005B0

+000000 EYE_CATCHER:THNQ FLAGS:80000000

HANQ: 00000001_08300000

+000000 EYE_CATCHER:HANQ FLAGS:80000000

Figure 189. Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 1 of 8)
Figure 190. Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 2 of 8)
Figure 191. Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 3 of 8)
Figure 192. Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 4 of 8)
Free Storage Tree for Heap Segment 25773000

<table>
<thead>
<tr>
<th>Depth</th>
<th>Address</th>
<th>Length</th>
<th>Node</th>
<th>Node</th>
<th>Parent</th>
<th>Left</th>
<th>Right</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25774168</td>
<td>00002E98</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Map of Heap Segment 25773000

To display entire segment: IP LIST 25773000 LEN(X'00004000') ASID(X'0028')

25773040: Allocated storage element, length=00001128. To display: IP LIST 25773040 LEN(X'000001128') ASID(X'0028')

25773040: Allocated storage element, length=00001128. To display: IP LIST 25773040 LEN(X'000001128') ASID(X'0028')

Summary of analysis for Heap Segment 25773000:

Amounts of identified storage: Free:00002E98 Allocated:00001128 Total:00003FC0

Number of identified areas: Free: 1 Allocated: 1 Total: 2

No errors were found while processing this heap segment.

This is the last heap segment in the current heap.

User Heap24 Control Blocks

Free Storage Tree for Heap Segment 25773000

<table>
<thead>
<tr>
<th>Depth</th>
<th>Address</th>
<th>Length</th>
<th>Node</th>
<th>Node</th>
<th>Parent</th>
<th>Left</th>
<th>Right</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25774168</td>
<td>00002E98</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Map of Heap Segment 25773000

To display entire segment: IP LIST 25773000 LEN(X'00004000') ASID(X'0028')

25773040: Allocated storage element, length=00001128. To display: IP LIST 25773040 LEN(X'000001128') ASID(X'0028')

25773040: Allocated storage element, length=00001128. To display: IP LIST 25773040 LEN(X'000001128') ASID(X'0028')

Summary of analysis for Heap Segment 25773000:

Amounts of identified storage: Free:00002E98 Allocated:00001128 Total:00003FC0

Number of identified areas: Free: 1 Allocated: 1 Total: 2

No errors were found while processing this heap segment.

This is the last heap segment in the current heap.

User Heap24 Control Blocks

Free Storage Tree for Heap Segment 25773000

<table>
<thead>
<tr>
<th>Depth</th>
<th>Address</th>
<th>Length</th>
<th>Node</th>
<th>Node</th>
<th>Parent</th>
<th>Left</th>
<th>Right</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25774168</td>
<td>00002E98</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Map of Heap Segment 25773000

To display entire segment: IP LIST 25773000 LEN(X'00004000') ASID(X'0028')

25773040: Allocated storage element, length=00001128. To display: IP LIST 25773040 LEN(X'000001128') ASID(X'0028')

25773040: Allocated storage element, length=00001128. To display: IP LIST 25773040 LEN(X'000001128') ASID(X'0028')

Summary of analysis for Heap Segment 25773000:

Amounts of identified storage: Free:00002E98 Allocated:00001128 Total:00003FC0

Number of identified areas: Free: 1 Allocated: 1 Total: 2

No errors were found while processing this heap segment.

This is the last heap segment in the current heap.

Library Heap31 Control Blocks

Free Storage Tree for Heap Segment 25773000

<table>
<thead>
<tr>
<th>Depth</th>
<th>Address</th>
<th>Length</th>
<th>Node</th>
<th>Node</th>
<th>Parent</th>
<th>Left</th>
<th>Right</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25774168</td>
<td>00002E98</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Map of Heap Segment 25773000

To display entire segment: IP LIST 25773000 LEN(X'00004000') ASID(X'0028')

25773040: Allocated storage element, length=00001128. To display: IP LIST 25773040 LEN(X'000001128') ASID(X'0028')

25773040: Allocated storage element, length=00001128. To display: IP LIST 25773040 LEN(X'000001128') ASID(X'0028')

Summary of analysis for Heap Segment 25773000:

Amounts of identified storage: Free:00002E98 Allocated:00001128 Total:00003FC0

Number of identified areas: Free: 1 Allocated: 1 Total: 2

No errors were found while processing this heap segment.

This is the last heap segment in the current heap.

Library Heap31 Control Blocks

Free Storage Tree for Heap Segment 25773000

<table>
<thead>
<tr>
<th>Depth</th>
<th>Address</th>
<th>Length</th>
<th>Node</th>
<th>Node</th>
<th>Parent</th>
<th>Left</th>
<th>Right</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25774168</td>
<td>00002E98</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
</tr>
</tbody>
</table>
Figure 194. Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 6 of 8)
Free Storage Tree for Heap Segment 0000000119A00000

<table>
<thead>
<tr>
<th>Depth</th>
<th>Address</th>
<th>Length</th>
<th>Node</th>
<th>Parent</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0000000119A103C0</td>
<td>00000000000EFC40</td>
<td>0000000000000000</td>
<td>0000000000000000</td>
<td>0000000000000000</td>
<td>0000000000000000</td>
</tr>
</tbody>
</table>

Map of Heap Segment 0000000119A00000

To display entire segment: IP LIST 0000000119A00000 LEN(X'0000000000100000') ASID(X'0028')

0000000119A00040: Allocated storage element, length=0000000000000300.
To display: IP LIST 0000000119A00040 LEN(X'0000000000000300') ASID(X'0028')

0000000119A00050: 00000001 19A00120 00000000 00000001 00000000 00000000 00000000 00000000 |................................|

0000000119A00340: Allocated storage element, length=0000000000000060.
To display: IP LIST 0000000119A00340 LEN(X'0000000000000060') ASID(X'0028')

0000000119A00350: 94859496 99A84B84 81A38100 00000000 00000000 00000000 00000000 00000000 |memory.data.....................|

0000000119A003A0: Allocated storage element, length=0000000000010020.
To display: IP LIST 0000000119A003A0 LEN(X'0000000000010020') ASID(X'0028')

0000000119A003B0: A2969485 408481A3 81A29694 85409496 99854084 81A38185 A5859540 94969985 |some datasome more datamore even|

0000000119A103C0: Free storage element, length=00000000000EFC40.
To display: IP LIST 0000000119A103C0 LEN(X'00000000000EFC40') ASID(X'0028')

Summary of analysis for Heap Segment 0000000119A00000:
Amounts of identified storage: Free:000EFC40 Allocated:00010380 Total:000FFFC0
Number of identified areas : Free: 1 Allocated: 3 Total: 4
00000000 bytes of storage were not accounted for.
No errors were found while processing this heap segment.
This is the last heap segment in the current heap.

I/O Heap31 Control Blocks

HPCQ: 00000001_00100308
+000018 EYE_CATCHER:HPCQ FIRST:00000001_001006A0 LAST:00000001_001006A0
+000008 INITSIZE:00000000 00003000 INCRSIZE:00000000 00002000
+00002C OPTIONS:50000000

HPSQ: 00000001_000051A8
+000000 BYTES_ALLOC:00000000 00002490
+000008 CURR_ALLOC:00000000 00002490 GET_REQ:00000000 0000000E
+000018 FREE_REQ:00000000 00000000 GETMAINS:00000000 00000001
+000028 FREEMAINS:00000000 00000000

THNQ: 00000001_001006A0
+000018 EYE_CATCHER:THNQ FLAGS:00000000 NEXT:00000001_00100308
+000010 PREV:00000001_00100308 HEAP_ID:00000000 00000001
+000020 SEGMENT:00000000_25757000 SEG_LEN:00000000 00003000

HANQ: 00000000_25757000
+000000 EYE_CATCHER:HANQ FLAGS:00000000 HEAP_ID:00000001_00100308
+000020 SEGMENT:25757000 ROOT:257594D0 SEG_LEN:00000000 00003000
+00002C ROOT_LEN:000000000B30

This is the last heap segment in the current heap.

Free Storage Tree for Heap Segment 25757000

<table>
<thead>
<tr>
<th>Depth</th>
<th>Address</th>
<th>Length</th>
<th>Node</th>
<th>Parent</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>257594D0</td>
<td>00000B30</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
</tr>
</tbody>
</table>

Map of Heap Segment 25757000

To display entire segment: IP LIST 25757000 LEN(X'00003000') ASID(X'0028')

25757040: Allocated storage element, length=00000388.
To display: IP LIST 25757040 LEN(X'00000388') ASID(X'0028')

25757040: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000 |................................|

257573C8: Allocated storage element, length=00000070.
To display: IP LIST 257573C8 LEN(X'00000070') ASID(X'0028')

257573C8: D6E2C9D6 00007048 00000000 000077F0 000078A8 00000001 00000001 FFFFFFFF |OSIO...........0...y............|

25757438: Allocated storage element, length=00000040.
To display: IP LIST 25757438 LEN(X'00000040') ASID(X'0028')

25757440: C4C3C2C5 00380000 00007048 00000000 C0880000 80000000 00000000 00000000 |DCBE.............h..............|...

This is the last heap segment in the current heap.

Figure 195. Example formatted detailed heap segment report from LEDATA VERBEXIT (AMODE 64) (Part 7 of 8)
Heap report sections of the LEDATA output

The Heap Report sections of the LEDATA output provide information for each heap segment in the dump. The detailed heap segment reports include information on the free storage tree in the heap segments, the allocated storage elements, and the cause of heap management data structure problems.
Table 55. Contents of Heap report sections of the LEDATA output (AMODE 64)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
</table>
| [1] Free Storage Tree Report     | Within each heap segment, Language Environment keeps track of unallocated storage areas by chaining them together into a tree. Each free area represents a node in the tree. Each node contains a header, which points to its left and right child nodes. The header also contains the length of each child. The LEDATA HEAP option formats the free storage tree within each heap, and validates all node addresses and lengths within each node. Each node address is validated to ensure that it:  
  • Falls on a doubleword boundary  
  • Falls within the current heap segment  
  • Does not point to itself  
  • Does not point to a node that was previously traversed  
  Each node length is validated to ensure that it:  
  • Is a multiple of 8  
  • Is not larger than the heap segment length  
  • Does not cause the end of the node to fall outside of the current heap segment  
  • Does not cause the node to overlap another node  
  If the formatter finds a problem, then it will place an error message describing the problem directly after the formatted line of the node that failed validation |
| [2] Heap Segment Map Report      | The LEDATA HEAP option produces a report that lists all of the storage areas within each heap segment, and identifies the area as either allocated or freed. For each allocated area the contents of the first X’20’ bytes of the area are displayed in order to help identify the reason for the storage allocation. Each allocated storage element has a prefix used by Language Environment to manage the area. The prefix contains a pointer to the start of the heap segment followed by the length of the allocated storage element. For HEAP64 heaps, the prefix is 16 bytes, with 8-byte pointer and length fields. For HEAP31 and HEAP24 heaps, the pointer is 8 bytes with 4-byte pointer and length field. The formatter validates this header to ensure that its heap segment pointer is valid. The length is also validated to ensure that it:  
  • Is a multiple of 8  
  • Is not zero  
  • Is not larger than the heap segment length  
  • Does not cause the end of the element to fall outside of the current heap segment  
  • Does not cause the element to overlap a free storage node  
  If the heap_free_value of the STORAGE runtime option was specified, then the formatter also checks that the free storage within each free storage element is set to the requested heap_free_value. If a problem is found, then an error message describing the problem is placed after the formatted line of the storage element that failed validation |

Diagnosing heap damage problems

Heap storage errors can occur when an application allocates a heap storage element that is too small for it to use, and therefore, accidently overlays heap storage. If this situation occurs then some of the typical error messages generated are:  
• The node address does not represent a valid node within the heap segment  
• The length of the segment is not valid, or  
• The heap segment pointer is not valid.  

If one of the above error messages is generated by one of the reports, then examine the storage element that immediately precedes the damaged node to determine if this storage element is owned by the application program. Check the size of the storage element and ensure that it is sufficient for the program’s use. If the size of the storage element is not sufficient then adjust the allocation size.
If an error occurs indicating that the node's pointers form a circular loop within the free storage tree, then check the Free Storage Tree Report to see if such a loop exists. If a loop exists, then contact the IBM support center for assistance because this may be a problem in the Language Environment heap management routines.

Additional diagnostic information regarding heap damage can be obtained by using the HEAPCHK runtime option. This option provides a more accurate time perspective on when the heap damage actually occurred, which could help to determine the program that caused the damage. For more information on HEAPCHK, see z/OS Language Environment Programming Reference.

**Diagnosing storage leak problems**

A storage leak occurs when a program does not return storage back to the heap after it has finished using it. To determine if this problem exists, do one of the following:

- The *call-level* suboption of the HEAPCHK runtime option causes a report to be produced in the CEEDUMP. Any still-allocated (that is, not freed) storage identified by HEAPCHK is listed in the report, along with the corresponding traceback. This shows any storage that wasn't freed, as well as all the calls that were involved in allocating the storage. For more information about the HEAPCHK runtime option, see z/OS Language Environment Programming Reference.

- Examine the Heap Segment Map report to see if any data areas, within the allocated storage elements, appear more frequently than expected. If they do, then check to see if these data areas are still being used by the application program. If the data areas are not being used, then change the program to free the storage element after it is done with it.

**Diagnosing heap fragmentation problems**

Heap fragmentation occurs when allocated storage is interlaced with many free storage areas that are too small for the application to use. Heap fragmentation could indicate that the application is not making efficient use of its heap storage. Check the Heap Segment Map report for frequent free storage elements that are interspersed with the allocated storage elements.

**Understanding the heap pool LEDATA output**

The Language Environment IPCS VERBEXIT LEDATA generates a detailed heap pool report when HEAPPOOLS is ON. The detailed heap pool report is useful when trying to find potential damaged cells because it provides very specific information. Figure 197 on page 410 illustrates the details of heap pool report. "Heap pool report sections of the LEDATA output" on page 414 describes the information contained in the formatted output.
Heap Pool Report

QPCB: 00000008_08733600 NUMPOOLS: 00000010

+00008 EYECATCHER:QPCB LENGTH:00001800

+0000C LARGEST_CELL_SIZE:00001000 BIG_REQUESTS:00000000

+00018 STORAGE_HITS_ADDR:00000000_00000000 FLAGS:0400

+00022 NUMGETARRAYS:05 NUMCELLSIZES:0C

+00028 GET_POOLINFO_ARRAYS_PTR:00000008_08733800

Data for pool 1:

POOLDATA: 00000008_08733D00

+00000 POOL_INDEX:00000001 INPUT_CELL_SIZE:00000008

+00008 CELL_SIZE:00000020 INPUT_COUNT:0000000A

+00010 CELL_POOL_SIZE:00000140 CELL_POOL_NUM:0000000A

+00018 POOL_LATCH_ADDR:00000008_087117E0 POOL_EXTENTS:00000001

+00022 LAST_CELL:00000008_0862E680 NEXT_CELL:00000008_0862E580

+00028 Q_CONTROL_INFO:00000000 00000005 Q_FIRST_CELL:00000008_0862E560

+00030 POOL_NUM_GET_TOTAL:00000000 00000003

+00038 POOL_NUM_FREE:00000000 00000001 POOL_EXTENTS_ANCHOR:00000008_0862E550

+00068 POOL_INDEX_SAME_SIZE:01 POOL_INDEX_SIZE:01

+0006A POOL_TRACE_TABLE:00000008_088000E0


EXTENT: 00000008_0862E550

+00000 EYE_CATCHER:EX64 NEXT_EXTENT:00000000_00000000

To display entire pool extent: IP LIST 000000080862E550 LEN(X'00000150') ASID(X'0021')

000000080862E560: Free storage cell. To display: IP LIST 000000080862E560 LEN(X'00000020') ASID(X'0021')

[3] Verifying free chain for pool: 1...

No errors were found while processing free chain.

Summary of analysis for Pool 1:

Number of cells: Unused: 9 Free: 1 Allocated: 0 Total Used: 10

00000000 free cells were not accounted for.

No errors were found while processing this Pool.

Data for pool 2:

POOLDATA: 00000008_08733E00

+00000 POOL_INDEX:00000002 INPUT_CELL_SIZE:00000020

+00008 CELL_SIZE:00000030 INPUT_COUNT:00000004

+00010 CELL_POOL_SIZE:000000C0 CELL_POOL_NUM:00000004

+00018 POOL_LATCH_ADDR:00000008_08711808 POOL_EXTENTS:00000001

+00022 LAST_CELL:00000008_0862E750 NEXT_CELL:00000008_0862E6F0

+00028 Q_CONTROL_INFO:00000000 00000005 Q_FIRST_CELL:00000008_0862E6C0

+00030 POOL_NUM_GET_TOTAL:00000000 00000003

+00038 POOL_NUM_FREE:00000000 00000001 POOL_EXTENTS_ANCHOR:00000008_0862E6B0

+00068 POOL_INDEX_SAME_SIZE:01 POOL_INDEX_SIZE:02

+0006A POOL_TRACE_TABLE:00000008_08846110


EXTENT: 00000008_0862E6B0

+00000 EYE_CATCHER:EX64 NEXT_EXTENT:00000000_00000000

To display entire pool extent: IP LIST 000000080862E6B0 LEN(X'000000D0') ASID(X'0021')

000000080862E6C0: Free storage cell. To display: IP LIST 000000080862E6C0 LEN(X'00000030') ASID(X'0021')

[3] Verifying free chain for pool: 2...

No errors were found while processing free chain.

Summary of analysis for Pool 2:

Number of cells: Unused: 3 Free: 1 Allocated: 0 Total Used: 4

00000000 free cells were not accounted for.

No errors were found while processing this Pool.

Data for pool 3:

POOLDATA: 00000008_08733F00

+00000 POOL_INDEX:00000003 INPUT_CELL_SIZE:00000080

+00008 CELL_SIZE:00000090 INPUT_COUNT:00000004

+00010 CELL_POOL_SIZE:00000240 CELL_POOL_NUM:00000004

+00018 POOL_LATCH_ADDR:00000008_08711830 POOL_EXTENTS:00000002

+00022 LAST_CELL:00000008_0862E950 NEXT_CELL:00000008_0862E950

+00028 Q_CONTROL_INFO:00000000 00000010 Q_FIRST_CELL:00000008_0862E830

+00030 POOL_NUM_GET_TOTAL:00000000 0000000E

+00038 POOL_NUM_FREE:00000000 00000002 POOL_EXTENTS_ANCHOR:00000008_0862E790

+00068 POOL_INDEX_SAME_SIZE:01 POOL_INDEX_SIZE:03

+0006A POOL_TRACE_TABLE:00000008_0888C140

Summary of analysis for Pool 3:

No errors were found while processing free chain.

No errors were found while processing this Pool.

Figure 197. Example formatted detailed heap pool report from LEDATA VERBEXIT (AMODE 64) (Part 1 of 5)
# Heap Pool Extent Mapping

To display entire pool extent: IP LIST 00000000862E790 LEN(X'00000250') ASID(X'0021')

To display entire pool extent: IP LIST 00000000862E7A0 LEN(X'00000090') ASID(X'0021')

To display entire pool extent: IP LIST 00000000862E930 LEN(X'00000090') ASID(X'0021')

To display entire pool extent: IP LIST 00000000862E9F0 LEN(X'00000090') ASID(X'0021')

### Data for pool 4:

<table>
<thead>
<tr>
<th>POOLDATA:</th>
<th>00000000 08734000</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>POOL_INDEX:00000004</td>
</tr>
<tr>
<td>+000008</td>
<td>CELL_SIZE:00000010</td>
</tr>
<tr>
<td>+000100</td>
<td>CELL_POOL_SIZE:00000010</td>
</tr>
<tr>
<td>+000108</td>
<td>POOL_LATCH_ADDR:00000000 08711850</td>
</tr>
<tr>
<td>+000110</td>
<td>POOL_INDEX_SAME_SIZE:00000000 00000000</td>
</tr>
<tr>
<td>+000112</td>
<td>POOL_INDEX_SIZE:00000000 00000005</td>
</tr>
<tr>
<td>+000114</td>
<td>POOL_TRACE_TABLE:00000008 089181A0</td>
</tr>
</tbody>
</table>

### Data for pool 5.1:

<table>
<thead>
<tr>
<th>POOLDATA:</th>
<th>00000000 08734100</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>POOL_INDEX:00000005</td>
</tr>
<tr>
<td>+000008</td>
<td>CELL_SIZE:00000010</td>
</tr>
<tr>
<td>+000100</td>
<td>CELL_POOL_SIZE:00000010</td>
</tr>
<tr>
<td>+000108</td>
<td>POOL_LATCH_ADDR:00000000 08711860</td>
</tr>
<tr>
<td>+000110</td>
<td>POOL_INDEX_SAME_SIZE:00000000 00000000</td>
</tr>
<tr>
<td>+000112</td>
<td>POOL_INDEX_SIZE:00000000 00000005</td>
</tr>
<tr>
<td>+000114</td>
<td>POOL_TRACE_TABLE:00000008 089181A0</td>
</tr>
</tbody>
</table>

### Summary of analysis for Pool 4:

- Number of cells: Unused: 2  Free: 2  Allocated: 0  Total Used: 4
- 00000000 free cells were not accounted for.
- No errors were found while processing this Pool.

### Summary of analysis for Pool 5.1:

- Number of cells: Unused: 2  Free: 2  Allocated: 0  Total Used: 4
- 00000000 free cells were not accounted for.
- No errors were found while processing this Pool.

---

*Figure 198. Example formatted detailed heap pool report from LEDATA VERBEXIT (AMODE 64) (Part 2 of 5)*
Figure 199. Example formatted detailed heap pool report from LEDATA VERBEXIT (AMODE 64) (Part 3 of 5)
Figure 200. Example formatted detailed heap pool report from LEDATA VERBEXIT (AMODE 64) (Part 4 of 5)
As Table 56 on page 415 shows, the heap pool report provides information about the following items:

- Each cell pool.
- The free chain associated with every qpcb pool data area, and all the free and allocated cells in the extent chain.
- Errors found when the cells are validated.
Within each cell pool, Language Environment keeps track of unallocated cells by chaining them together. The LEDATA HEAP option validates the free chain within each cell pool. It verifies that the cell pointer is within a valid extent and that the cell pool number is valid. If the formatter finds a problem, it will place an error message describing the problem directly after the formatted line of the cell that failed validation.

The LEDATA HEAP option produces a report that lists all of the cells within each pool extent, and identifies the cells as either allocated or freed. For each allocated cell, the contents of the first X’20’ bytes of the area are displayed to identify the reason for the storage allocation. The formatter validates if the cell pool number in header is correct.

Understanding the heap pools trace LEDATA output

The Language Environment IPCS VERBEXIT LEDATA generates a detailed heap pools trace report when the HPT option is used (see Figure 202. The argument value is the ID of the pool to be formatted in the report. Table 57 on page 419 explains the contents of each section of the report.

Table 56. Contents of the heap pool report sections of the LEDATA output (AMODE 64)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Free Chain Validation</td>
<td>Within each cell pool, Language Environment keeps track of unallocated cells by chaining them together. The LEDATA HEAP option validates the free chain within each cell pool. It verifies that the cell pointer is within a valid extent and that the cell pool number is valid. If the formatter finds a problem, it will place an error message describing the problem directly after the formatted line of the cell that failed validation.</td>
</tr>
<tr>
<td>2 Heap Pool Extent Mapping Report</td>
<td>The LEDATA HEAP option produces a report that lists all of the cells within each pool extent, and identifies the cells as either allocated or freed. For each allocated cell, the contents of the first X’20’ bytes of the area are displayed to identify the reason for the storage allocation. The formatter validates if the cell pool number in header is correct.</td>
</tr>
</tbody>
</table>

Figure 202. Example of formatted detailed heap pools trace report from LEDATA VERBEXIT (AMODE 64) (Part 1 of 5)
Figure 203. Example of formatted detailed heap pools trace report from LEDATA VERBEXIT (AMODE 64) (Part 2 of 5)
Figure 204. Example of formatted detailed heap pools trace report from LEDATA VERBEXIT (AMODE 64) (Part 3 of 5)
Figure 205. Example of formatted detailed heap pools trace report from LEDATA VERBEXIT (AMODE 64) (Part 4 of 5)
Table 57. Contents of a detailed heap pools trace report from LEDATA VERBEXIT (AMODE 64)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] Trace Header</td>
<td>HEAPPOOLS64 trace header information.</td>
</tr>
<tr>
<td>[2] Pool Information</td>
<td>Includes the number of the pool (pool ID) that is currently being formatted, the ASID, the number of entries formatted, and the total number of entries taken. The trace wraps for each pool ID after a specific number of entries. The number of entries is controlled by the HEAPCHK runtime option.</td>
</tr>
<tr>
<td>[3] Timestamp</td>
<td>The time this trace entry was taken. The trace entries are formatted in reverse order (most recent trace entry first).</td>
</tr>
</tbody>
</table>
| [4] Trace Table Entry contents | The individual trace entry, which contains:  
  - The TYPE - GET or FREE.  
  - The Cell within the pool being acted upon.  
  - The CPU and TCB that requested or freed the cell.  
  - A traceback at the time of the request. The number of entries in this traceback is limited by the HEAPCHK runtime option. |

Understanding the C/C++-specific LEDATA output

The Language Environment IPCS VERBEXIT LEDATA generates formatted output of C/C++-specific control blocks from a system dump when the COMP(C), COMP(ALL), or ALL parameter is specified and C/C++ is active in the dump. Figure 207 on page 420 illustrates the C/C++-specific output produced. The system dump being formatted was obtained by specifying the TERMTHDACT(UADUMP) runtime option when running the program CELQSAMP. Figure 165 on page 364 describes the information contained in the formatted output. Ellipses are used to summarize some sections of the dump. For easy reference, the sections of the dump are numbered to correspond with the description of each section that follows.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>64 BIT CRTL ENVIRONMENT DATA</strong></td>
<td></td>
</tr>
</tbody>
</table>

| [1] | CGEN: 00000001_00007B18  |
|     | +000310 CGENE:00000001_00008A60  |
|     | CRENT:00000000_00000000  |
|     | +000320 CPMS:00000001_0000598  |
|     | TRACE:00000001_00008F08  |
|     | +000338 CUR_FECB:00000001_0000840  |
|     | CGEN_CPCB:00000001_00008688  |
|     | +000348 CGEN_CEDE:00000001_0000A620  |
|     | CFLG3:00000000_00000000  |

| [2] | CGENE: 00000001_0000B18  |
|     | +000000 CGENEYE:.-./  |
|     | CGENESIZE:00C200C4  |
|     | CGENEPTR:007C00C1_00C300C5  |
|     | +0000D4 CERRNO:006000A3  |
|     | TEMPLONG:00E000A6_00E200E3  |
|     | AMRC:00E400E5_00E600E7  |
|     | +0000110 STLFILE:00E800E9_00F200E3  |
|     | STDOUTFILE:00E500D9_00E200E4  |
|     | +0000110 CIO:00000001_000088D8  |
|     | CFLG3:00000000_00000000  |

| [3] | CEDB: 00000001_0000A620  |
|     | +000000 MAX_FLT:00000001_00000000  |
|     | +000010 SS1:00000000_00000000  |
|     | ADDRTBL:00000000_00000001  |

Figure 207. Example of formatted C/C++ output from LEDATA VERBEXIT (AMODE 64) (Part 1 of 10)
Figure 208. Example of formatted C/C++ output from LEDATA VERBEXIT (AMODE 64) (Part 2 of 10)
Figure 209. Example of formatted C/C++ output from LEDATA VERBEXIT (AMODE 64) (Part 3 of 10)
Figure 210. Example of formatted C/C++ output from LEDATA VERBEXIT (AMODE 64) (Part 4 of 10)
Figure 211. Example of formatted C/C++ output from LEDATA VERBEXIT (AMODE 64) (Part 5 of 10)
Figure 212. Example of formatted C/C++ output from LEDATA VERBEXIT (AMODE 64) (Part 6 of 10)
Figure 213. Example of formatted C/C++ output from LEDATA VERBEXIT (AMODE 64) (Part 7 of 10)
Figure 214. Example of formatted C/C++ output from LEDATA VERBEXIT (AMODE 64) (Part 8 of 10)
<table>
<thead>
<tr>
<th>Offset</th>
<th>Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+00100</td>
<td>LPSMMAJOR:0000000 00000000</td>
<td></td>
</tr>
<tr>
<td>+00108</td>
<td>LPSMMINOR:0000000 00000000</td>
<td></td>
</tr>
<tr>
<td>+0010A</td>
<td>OSNS: 00000001_00009DF0</td>
<td></td>
</tr>
<tr>
<td>+00200</td>
<td>OSNS_EYE:OSNS</td>
<td>READ:00000000 2131F210 WRITE:00000000 2131FDC0</td>
</tr>
<tr>
<td>+00220</td>
<td>REPOS:00000000 2131FEC0</td>
<td></td>
</tr>
<tr>
<td>+00240</td>
<td>CLOSE:00000000 2131FEC0</td>
<td>FLUSH:00000000 2131FDB0</td>
</tr>
<tr>
<td>+00260</td>
<td>UTILITY:00000000 2131FA0</td>
<td>EXITFTELL:00000000 2131FC20</td>
</tr>
<tr>
<td>+00280</td>
<td>EXITUNGTEC:00000000 2131F780 OSIUBLK:00000000 2135A3D0</td>
<td></td>
</tr>
<tr>
<td>+002A0</td>
<td>NEWLINEPTR:00000000 2135A509 RECLENGTH:00000000 00000085</td>
<td></td>
</tr>
<tr>
<td>+002B0</td>
<td>MFLAG:08400000</td>
<td></td>
</tr>
<tr>
<td>+00500</td>
<td>OSIO: 00000000_2135A3D0</td>
<td></td>
</tr>
<tr>
<td>+00520</td>
<td>DCB: 00000000_00007048</td>
<td></td>
</tr>
<tr>
<td>+00540</td>
<td>DCBRELAD:2135A440 DCBFAD:00000000 00000000</td>
<td></td>
</tr>
<tr>
<td>+00560</td>
<td>DCB:00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000</td>
<td></td>
</tr>
<tr>
<td>+005F0</td>
<td>DCBE: 00000000_000078A8</td>
<td></td>
</tr>
<tr>
<td>+00610</td>
<td>NEXTMBUF:000078A8 BUFFER:2135A480_ CHECKRESULT:00000000</td>
<td></td>
</tr>
<tr>
<td>+00630</td>
<td>MBUF: 00000000_0000070A</td>
<td></td>
</tr>
</tbody>
</table>

Figure 215. Example of formatted C/C++ output from LEDATA VERBEXIT (AMODE 64) (Part 9 of 10)

Dummy FCB encountered at location 00000000100000A0
C/C++-specific sections of the LEDATA output

Table 58 describes the contents of the LEDATA output that is specific to C/C++.

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] CGEN</td>
<td>Formats the C/C++-specific portion of the Language Environment common anchor area (CAA).</td>
</tr>
<tr>
<td>[2] CGENE</td>
<td>Formats the extension to the C/C++-specific portion of the Language Environment common anchor area (CAA).</td>
</tr>
</tbody>
</table>
### Table 58. Contents of C/C++-specific sections of the LEDATA output (AMODE 64) (continued)

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>[7] File Control Blocks</strong></td>
<td>Formats the C/C++ file control block (FCB). The FCB and its related control blocks, which are listed below, represent the information needed by each open stream.</td>
</tr>
<tr>
<td>FFIL</td>
<td>Formats the header of the C/C++ file control block (FCB).</td>
</tr>
<tr>
<td>FSCE</td>
<td>The file specific category extension control block, which represents the specific type of IO being performed. The following FSCEs may be formatted; other FSCEs will be displayed using a generic overlay.</td>
</tr>
<tr>
<td>HFSF</td>
<td>UNIX file system file</td>
</tr>
<tr>
<td>HSPF</td>
<td>Hiper-Space file</td>
</tr>
<tr>
<td>INTC</td>
<td>Intercept file</td>
</tr>
<tr>
<td>MEMF</td>
<td>Memory file</td>
</tr>
<tr>
<td>OSNS</td>
<td>OS no seek</td>
</tr>
<tr>
<td>OSFS</td>
<td>OS fixed text</td>
</tr>
<tr>
<td>OSVF</td>
<td>OS variable text</td>
</tr>
<tr>
<td>OSUT</td>
<td>OS undefined format text</td>
</tr>
<tr>
<td>TDQF</td>
<td>CICS Transient Data Queue file</td>
</tr>
<tr>
<td>TERM</td>
<td>Terminal file</td>
</tr>
<tr>
<td>VSAM</td>
<td>VSAM file</td>
</tr>
<tr>
<td>OSIO</td>
<td>The OS IO interface control block.</td>
</tr>
<tr>
<td>OSIOE</td>
<td>The OS IO extended interface control block.</td>
</tr>
<tr>
<td>DCB</td>
<td>The data control block; for more information, see <a href="http://www.ibm.com/systems/z/os/zos/bkserv/">z/OS DFSMS Macro Instructions for Data Sets</a>.</td>
</tr>
<tr>
<td>DCBE</td>
<td>The data control block extension; for more information, see <a href="http://www.ibm.com/systems/z/os/zos/bkserv/">z/OS DFSMS Macro Instructions for Data Sets</a>.</td>
</tr>
<tr>
<td>JFCB</td>
<td>The job file control block (JFCB); for more information, see <a href="http://www.ibm.com/systems/z/os/zos/bkserv/">z/OS MVS Data Areas in z/OS Internet Library at http://www.ibm.com/systems/z/os/zos/bkserv/</a>.</td>
</tr>
<tr>
<td>JFCBX</td>
<td>The job file control block extension (JFCBX).</td>
</tr>
<tr>
<td>MBUF</td>
<td>The message buffer control block (MBUF).</td>
</tr>
</tbody>
</table>

| **[8] Memory File Control Blocks** | Formats the C/C++ memory file control block (MFCB). |

### Understanding the AUTH LEDATA output

The Language Environment IPCS VERBEXIT LEDATA generates formatted output of Preinitialized Environments for Authorized Programs-specific control blocks from a system dump when the AUTH parameter is specified. Figure 217 on page 431 illustrates the output produced when the LEDATA VERBEXIT is invoked with the AUTH parameter. Ellipses are used to summarize some sections of the dump. For easy reference, the sections of the dump are numbered to correspond with the description of each section that follows.
Figure 217. Example of formatted AUTH output from LEDATA VERBEXIT (AMODE 64) (Part 1 of 4)
Figure 218. Example of formatted AUTH output from LEDATA VERBEXIT (AMODE 64) (Part 2 of 4)
Figure 219. Example of formatted AUTH output from LEDATA VERBEXIT (AMODE 64) (Part 3 of 4)
Figure 220. Example of formatted AUTH output from LEDATA VERBEXIT (AMODE 64) (Part 4 of 4)
Sections of the AUTH LEDATA VERBEXIT formatted output

Table 59 describes the contents of the AUTH LEDATA VERBEXIT formatted output.

<table>
<thead>
<tr>
<th>Section Number and Heading</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] ALEC</td>
<td>Anchor control block for all other Preinitialized Environments for Authorized Programs control blocks within the address space. The ALEC is located from the ASXB (Address Space Extension Block).</td>
</tr>
<tr>
<td>[2] Load Module Control Blocks</td>
<td>Formatted representation of a table of ALMI control blocks. Each ALMI represents a module that was loaded by Preinitialized Environments for Authorized Programs.</td>
</tr>
<tr>
<td>[3] User Managed Control Blocks</td>
<td>Control blocks for all user managed environments. A user managed environment is initialized when the CELAAUTH macro is invoked with REQUEST=USERINIT.</td>
</tr>
<tr>
<td>[4]-[5] Control Blocks for one user managed environment: These sections are repeated for each user managed environment that was initialized.</td>
<td></td>
</tr>
<tr>
<td>[5] Routine Control Blocks</td>
<td>Formatted representation of a table of ALRI control blocks. Each ALRI in this section represents a routine that was called by the user managed environment. Each ALRI appears in the table twice, once for the routine name and once for the routine address.</td>
</tr>
<tr>
<td>[6] System Managed Control Blocks</td>
<td>Control blocks for all system managed environments. A set of system managed environments is initialized when the CELAAUTH macro is invoked with REQUEST=MNGDINIT.</td>
</tr>
<tr>
<td>[7]-[11] Control Blocks for one set of system managed environments that was initialized: These sections are repeated for each set of system managed environments that was initialized.</td>
<td></td>
</tr>
<tr>
<td>[7] ALES</td>
<td>Each ALES represents a set of system managed environments.</td>
</tr>
<tr>
<td>[8]-[11] Control blocks for one environment definition entry: These sections are repeated for every environment definition entry (AEDE) that was specified when the set of system managed environments was initialized.</td>
<td></td>
</tr>
<tr>
<td>[8] ETINDEX and ALESETE</td>
<td>The ETINDEX is the environment definition entry index value and the ALESETE represents the environment definition entry.</td>
</tr>
<tr>
<td>[9] Routine Control Blocks</td>
<td>Formatted representation of a table of ALRI control blocks. Each ALRI in this section represents a routine that was called in one of the environments associated with the ETINDEX and ALESETE above. Each ALRI appears in the table twice, once for the routine name and once for the routine address.</td>
</tr>
<tr>
<td>[10]-[11] Control blocks for one system managed environment: These sections are repeated for every environment associated with the ETINDEX and ALESETE.</td>
<td></td>
</tr>
<tr>
<td>[10] ALEI</td>
<td>Each ALEI control block represents one environment. The ALEIs in this section represent system managed environments.</td>
</tr>
<tr>
<td>[11] ALRI</td>
<td>Contains the ALRI control blocks for each routine that was called in the environment identified by the ALEI. This section does not appear if the environment has not been used to call a routine.</td>
</tr>
</tbody>
</table>

Formatting individual control blocks

In addition to the full LEDATA output which contains many formatted control blocks, the IPCS Control block formatter can also format individual Language Environment control blocks. The IPCS CBF command can be invoked from the "IPCS Subcommand Entry" screen, option 6 of the "IPCS PRIMARY OPTION
For more information on using the IPCS CBF command, see the “CBFORMAT subcommand” section in z/OS MVS IPCS Commands SA23-1382.

Syntax

```plaintext
>> CBF -address- STRUCTure(-cbname-) <<
```

address

The address of the control block in the dump. This is determined by browsing the dump or running the LEDATA VERBEXIT.

cbname

The name of the control block to be formatted. The control blocks that can be individually formatted are listed in Table 60. In general, the name of each control block is similar to that used by the LEDATA VERBEXIT and is generally found in the control block’s eyecatcher field. However, all control block names are prefixed with CEE to uniquely define the Language Environment control block names to IPCS.

For example, the following command produces the output shown in Figure 221.

```plaintext
CBF 100007B18 struct(CELCAA)
```

Table 60. Language Environment control blocks that can be individually formatted

<table>
<thead>
<tr>
<th>Control Block</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CELCIB</td>
<td>Condition Information Block</td>
</tr>
<tr>
<td>CELCIBBH</td>
<td>Condition Information Block Header</td>
</tr>
<tr>
<td>CELDLLF</td>
<td>DLL Failure Control Block</td>
</tr>
</tbody>
</table>
Table 60. Language Environment control blocks that can be individually formatted (continued)

<table>
<thead>
<tr>
<th>Control Block</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CELDSA</td>
<td>Dynamic Storage Area</td>
</tr>
<tr>
<td>CELDSATR</td>
<td>XPLINK Transition Area</td>
</tr>
<tr>
<td>CELED8</td>
<td>Enclave Data Block</td>
</tr>
<tr>
<td>CELENSQ</td>
<td>Enclave Level Storage Management</td>
</tr>
<tr>
<td>CELHNQ31</td>
<td>Heap Anchor Node 31-bit</td>
</tr>
<tr>
<td>CELHCOM</td>
<td>CEL Exception Manager Communications Area</td>
</tr>
<tr>
<td>CELHPCQ</td>
<td>Thread Level Heap Control Block</td>
</tr>
<tr>
<td>CELLAA</td>
<td>Library Anchor Area</td>
</tr>
<tr>
<td>CELLCA</td>
<td>Library Communication Area</td>
</tr>
<tr>
<td>CELPCB</td>
<td>Process Control Block</td>
</tr>
<tr>
<td>CELRCB</td>
<td>Region Control Block</td>
</tr>
<tr>
<td>CELSANC</td>
<td>Storage Management Control Block</td>
</tr>
<tr>
<td>CELSTSB</td>
<td>Storage Report Statistics Block</td>
</tr>
</tbody>
</table>

Table 61. Preinitalized Environments for Authorized Programs control blocks that can be individually formatted

<table>
<thead>
<tr>
<th>Control Block</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CELALEC</td>
<td>Anchor Block</td>
</tr>
<tr>
<td>CELALEI</td>
<td>Environment Information Block</td>
</tr>
<tr>
<td>CELALES</td>
<td>System Managed Environment Set Block</td>
</tr>
<tr>
<td>CELALMI</td>
<td>Module Information Block</td>
</tr>
<tr>
<td>CELALRI</td>
<td>Routine Information Block</td>
</tr>
</tbody>
</table>

**Requesting a Language Environment trace for debugging**

Language Environment provides an in-storage, wrapping trace facility that can reconstruct the events leading to the point where a dump is taken. Language Environment produces a trace table in its dump report when the TRACE runtime option is set to ON and:

- A thread ends abnormally because of an unhandled condition of severity 2 or greater and the TERMTHDACT runtime option is set to DUMP, UADUMP, TRACE, or UATRACE.
- An application terminates normally and the TRACE runtime option is set to DUMP (the default).

For more information about recording done by the TERMTHDACT runtime option or the TRACE runtime option, see [z/OS Language Environment Programming Reference](#).

The TRACE runtime option activates Language Environment runtime library tracing and controls the size of the trace buffer, the type of trace events to record, and it determines whether a dump containing only the trace table should be...
unconditionally taken when the application (enclave) terminates. The trace table contents can be written out either upon demand or at the termination of an enclave.

The contents of the Language Environment dump depend on the values set in the TERMTHDACT runtime option. Table 62 summarizes the dump contents that are generated under abnormal termination.

Table 62. TERMTHDACT runtime option settings and dump contents produced (AMODE 64)

<table>
<thead>
<tr>
<th>TERMTHDACT value</th>
<th>Type of dump generated</th>
</tr>
</thead>
<tbody>
<tr>
<td>TERMTHDACT(QUIET)</td>
<td>Language Environment dump containing the trace table only</td>
</tr>
<tr>
<td>TERMTHDACT(MSG)</td>
<td>Language Environment dump containing the trace table only</td>
</tr>
<tr>
<td>TERMTHDACT(TRACE)</td>
<td>Language Environment dump containing the trace table and the traceback</td>
</tr>
<tr>
<td>TERMTHDACT(DUMP)</td>
<td>Language Environment dump containing thread/enclave/process storage and control blocks; the trace table is included as an enclave control block</td>
</tr>
<tr>
<td>TERMTHDACT(UAONLY)</td>
<td>System dump of the user address space and a Language Environment dump that contains the trace table</td>
</tr>
<tr>
<td>TERMTHDACT(UATRACE)</td>
<td>Language Environment dump that contains traceback information, and a system dump of the user address space</td>
</tr>
<tr>
<td>TERMTHDACT(UADUMP)</td>
<td>Language Environment dump containing thread/enclave/process storage and control blocks (the trace table is included as an enclave control block), and a user address space dump</td>
</tr>
<tr>
<td>TERMTHDACT(UAIMM)</td>
<td>System dump of the user address space of the original abend or program interrupt that occurred before the Language Environment condition manager processing the condition. Also contains a Language Environment dump, which contains the trace table.</td>
</tr>
</tbody>
</table>

TRAP(ON,NOSPIE) must be in effect. When TRAP(ON,SPIE) is in effect, UAIMM equals UAONLY results. For software raised conditions or signals, UAIMM is the same as UAONLY.

Under normal termination, with the TRACE runtime option set to DUMP, Language Environment generates a dump containing the trace table only, independent of the TERMTHDACT setting.

Language Environment quiesces all threads that are currently running except for the thread that issued the call to cdump(). When you call cdump() in a multithread environment, only the current thread is dumped. Enclave- and process-related storage could have changed from the time the dump request was issued.

**Locating the trace dump**

If your application is running under TSO or batch, and a CEEDUMP DD is not specified, Language Environment writes the CEEDUMP to the batch log (SYSOUT=* by default). You can change the SYSOUT class by specifying a CEEDUMP DD, or by setting the environment variable, _CEE_DMPTARG=SYSOUT(x), where x is the preferred SYSOUT class.

If your application is running under z/OS UNIX and is either running in a child process, or if it is invoked by one of the exec family of functions, the dump is
written to the z/OS UNIX file system. Language Environment writes the CEE DUMP to one of the following directories in the specified order:
1. The directory in environment variable _CEE_DMPTARG, if found
2. The current working directory, if the directory is not the root directory (/), the directory is writable, and the CEE DUMP path name does not exceed 1024 characters
3. The directory found in environment variable TMPDIR (an environment variable that indicates the location of a temporary directory if it is not /tmp)
4. The /tmp directory

The name of this file changes with each dump and uses the following format:

```
/path/CEEDUMP.Date.Time.Pid
```

- **path** The path determined from the above algorithm.
- **Date** The date the dump is taken, appearing in the format YYYYMMDD (such as 20040918 for September 18, 2004).
- **Time** The time the dump is taken, appearing in the format HHMMSS (such as 175501 for 05:55:01 p.m.).
- **Pid** The process ID the application is running in when the dump is taken.

### Using the Language Environment trace table format in a dump report

The Language Environment trace table is established unconditionally at enclave initialization time if the TRACE runtime option is set to ON. All threads in the enclave share the trace table; there is no thread-specific table, nor can the table be dynamically extended or enlarged.

### Understanding the trace table entry (TTE)

Each trace table entry is a fixed-length record consisting of a fixed-format portion (containing such items as the timestamp, thread ID, and member ID) and a member-specific portion. The member-specific portion has a fixed length, of which some (or all) can be unused. For information about how participating products use the trace table entry, see the product-specific documentation. The format of the trace table entry is shown in Figure 222.

```
<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Thread ID</th>
<th>Member ID and flags</th>
<th>Member entry type</th>
<th>Mbr-specific info up to a maximum of 104 bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Char (8)</td>
<td>Char (8)</td>
<td>Char (4)</td>
<td>Char (4)</td>
<td>Char (104)</td>
</tr>
</tbody>
</table>
```

*Figure 222. Format of the trace table entry (AMODE 64)*

- **Time** The 64-bit value obtained from a store clock (STCK).
- **Thread ID** The 8-byte thread ID of the thread that is adding the trace table entry.
Member ID and Flags

Contains 2 fields:

Member ID

The 1-byte member ID of the member making the trace table entry, as follows:

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>CEL</td>
</tr>
<tr>
<td>03</td>
<td>C/C++</td>
</tr>
<tr>
<td>08</td>
<td>Reserved</td>
</tr>
<tr>
<td>12</td>
<td>Sockets</td>
</tr>
</tbody>
</table>

Flags

24 flags reserved for internal use.

Member Entry Type

A number that indicates the type of the member-specific trace information that follows the field. To uniquely identify the information contained in a specific TTE, you must consider Member ID as well as Member Entry Type.

Member-Specific Information

Based on the member ID and the member entry type, this field contains the specific information for the entry, up to 104 bytes. For C/C++, the entry type of 1 is a record that records an invocation of a base C runtime library function. The entry consists of the name of the invoking function and the name of the invoked function. Entry type 2 is a record that records the return from the base library function. It contains the returned value and the value of errno.

Member-specific information in the trace table entry

Global tracing is activated by using the LE=n suboption of the TRACE runtime option. This requests all Language Environment members to generate trace records in the trace table. The settings for the global trace events are:

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No global trace</td>
</tr>
<tr>
<td>1</td>
<td>Trace all runtime library (RTL) function entry and exits</td>
</tr>
<tr>
<td>2</td>
<td>Trace all RTL mutex init/destroy and lock/unlock</td>
</tr>
<tr>
<td>3</td>
<td>Trace all RTL function entry and exits, and all mutex init/destroy and lock/unlock</td>
</tr>
<tr>
<td>8</td>
<td>Trace all RTL storage allocation/deallocation</td>
</tr>
</tbody>
</table>

When LE=1 is specified: Table 63 shows the C/C++ records that may be generated. For a detailed description of these records, see “C/C++ contents of the Language Environment trace tables” on page 469.

Table 63. LE=1 entry records (AMODE 64)

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>00000001</td>
<td>Base C Library function Entry</td>
</tr>
<tr>
<td>03</td>
<td>00000002</td>
<td>Base C Library function Exit</td>
</tr>
<tr>
<td>03</td>
<td>00000003</td>
<td>Posix C Library function Entry</td>
</tr>
<tr>
<td>03</td>
<td>00000004</td>
<td>Posix C Library function Exit</td>
</tr>
<tr>
<td>03</td>
<td>00000005</td>
<td>XPLINK Base or Posix C Library function Entry</td>
</tr>
<tr>
<td>03</td>
<td>00000006</td>
<td>XPLINK Base or Posix C Library function Exit</td>
</tr>
</tbody>
</table>
When LE=2 is specified: Table 64 shows the Language Environment records that may be generated.

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Class</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>00000101</td>
<td>LT</td>
<td>A</td>
<td>Latch Acquire</td>
</tr>
<tr>
<td>01</td>
<td>00000102</td>
<td>LT</td>
<td>R</td>
<td>Latch Release</td>
</tr>
<tr>
<td>01</td>
<td>00000103</td>
<td>LT</td>
<td>W</td>
<td>Latch Wait</td>
</tr>
<tr>
<td>01</td>
<td>00000104</td>
<td>LT</td>
<td>AW</td>
<td>Latch Acquire after Wait</td>
</tr>
<tr>
<td>01</td>
<td>00000106</td>
<td>LT</td>
<td>I</td>
<td>Latch Increment (Recursive)</td>
</tr>
<tr>
<td>01</td>
<td>00000107</td>
<td>LT</td>
<td>D</td>
<td>Latch Decrement (Recursive)</td>
</tr>
<tr>
<td>01</td>
<td>00002FC</td>
<td>LE</td>
<td>EUO</td>
<td>Latch unowned (not released)</td>
</tr>
<tr>
<td>01</td>
<td>00002FD</td>
<td>LE</td>
<td>EO</td>
<td>Latch already owned (not acquired)</td>
</tr>
<tr>
<td>01</td>
<td>0000301</td>
<td>MX</td>
<td>A</td>
<td>Mutex acquire</td>
</tr>
<tr>
<td>01</td>
<td>0000302</td>
<td>MX</td>
<td>R</td>
<td>Mutex release</td>
</tr>
<tr>
<td>01</td>
<td>0000303</td>
<td>MX</td>
<td>W</td>
<td>Mutex wait</td>
</tr>
<tr>
<td>01</td>
<td>0000304</td>
<td>MX</td>
<td>AW</td>
<td>Mutex acquire after wait</td>
</tr>
<tr>
<td>01</td>
<td>0000305</td>
<td>MX</td>
<td>B</td>
<td>Mutex busy (Trylock failed)</td>
</tr>
<tr>
<td>01</td>
<td>0000306</td>
<td>MX</td>
<td>I</td>
<td>Mutex increment (recursive)</td>
</tr>
<tr>
<td>01</td>
<td>0000307</td>
<td>MX</td>
<td>D</td>
<td>Mutex decrement (recursive)</td>
</tr>
<tr>
<td>01</td>
<td>0000315</td>
<td>MX</td>
<td>IN</td>
<td>Mutex initialize</td>
</tr>
<tr>
<td>01</td>
<td>0000316</td>
<td>MX</td>
<td>DS</td>
<td>Mutex destroy</td>
</tr>
<tr>
<td>01</td>
<td>000031D</td>
<td>MX</td>
<td>BI</td>
<td>Shared memory lock init</td>
</tr>
<tr>
<td>01</td>
<td>000031E</td>
<td>MX</td>
<td>BD</td>
<td>Shared memory lock destroy</td>
</tr>
<tr>
<td>01</td>
<td>000031F</td>
<td>MX</td>
<td>BO</td>
<td>shared memory lock obtain</td>
</tr>
<tr>
<td>01</td>
<td>0000320</td>
<td>MX</td>
<td>BC</td>
<td>Shared memory lock obtain on condition</td>
</tr>
<tr>
<td>01</td>
<td>0000321</td>
<td>MX</td>
<td>BR</td>
<td>Shared memory lock release</td>
</tr>
<tr>
<td>01</td>
<td>0000324</td>
<td>MX</td>
<td>CIN</td>
<td>Call to SMC_INIT</td>
</tr>
<tr>
<td>01</td>
<td>0000325</td>
<td>MX</td>
<td>CSD</td>
<td>Call to SMC_DESTROY</td>
</tr>
<tr>
<td>01</td>
<td>0000326</td>
<td>MX</td>
<td>CSO</td>
<td>Shared resource obtain</td>
</tr>
<tr>
<td>01</td>
<td>0000327</td>
<td>MX</td>
<td>CSR</td>
<td>Shared resource release</td>
</tr>
<tr>
<td>01</td>
<td>0000328</td>
<td>MX</td>
<td>CST</td>
<td>Call to SMC_SetupToWait</td>
</tr>
<tr>
<td>01</td>
<td>0000329</td>
<td>MX</td>
<td>CSP</td>
<td>Call to SMC_POST</td>
</tr>
<tr>
<td>01</td>
<td>00004CC</td>
<td>ME</td>
<td>FFR</td>
<td>Error - Forced release (shared mutex)</td>
</tr>
<tr>
<td>01</td>
<td>00004CD</td>
<td>ME</td>
<td>FFD</td>
<td>Error - Forced decrement (shared mutex)</td>
</tr>
<tr>
<td>01</td>
<td>00004CE</td>
<td>ME</td>
<td>FBD</td>
<td>Error - BPX_SMC(DESTROY) error return</td>
</tr>
<tr>
<td>01</td>
<td>00004CF</td>
<td>ME</td>
<td>FBU</td>
<td>Error - BPX_SMC(fail) returns EBUSY</td>
</tr>
<tr>
<td>01</td>
<td>00004D0</td>
<td>ME</td>
<td>FIV</td>
<td>Error - BPX_SMC(fail) returns EINVAL</td>
</tr>
<tr>
<td>01</td>
<td>00004D4</td>
<td>ME</td>
<td>FDU</td>
<td>Error - Destroy failed (uninitialized) (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>00004D5</td>
<td>ME</td>
<td>FP</td>
<td>Error - Program check (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>00004DB</td>
<td>ME</td>
<td>ESC</td>
<td>Error - BPX!SMC error return</td>
</tr>
</tbody>
</table>
Table 64. LE=2 entry records (AMODE 64) (continued)

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Class</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>000004DE</td>
<td>ME</td>
<td>EDL</td>
<td>Shared memory lock returns deadlock</td>
</tr>
<tr>
<td>01</td>
<td>000004DF</td>
<td>ME</td>
<td>EIV</td>
<td>Shared memory lock returns invalid</td>
</tr>
<tr>
<td>01</td>
<td>000004E0</td>
<td>ME</td>
<td>EPM</td>
<td>Shared memory lock returns eperm</td>
</tr>
<tr>
<td>01</td>
<td>000004E1</td>
<td>ME</td>
<td>EAG</td>
<td>Shared memory lock returns again</td>
</tr>
<tr>
<td>01</td>
<td>000004E2</td>
<td>ME</td>
<td>EBU</td>
<td>Shared memory lock returns ebusy</td>
</tr>
<tr>
<td>01</td>
<td>000004E3</td>
<td>ME</td>
<td>ENM</td>
<td>Shared memory lock returns enomem</td>
</tr>
<tr>
<td>01</td>
<td>000004E4</td>
<td>ME</td>
<td>EBR</td>
<td>Shared memory lock release error</td>
</tr>
<tr>
<td>01</td>
<td>000004E5</td>
<td>ME</td>
<td>EBC</td>
<td>Shared memory lock obtain condition error</td>
</tr>
<tr>
<td>01</td>
<td>000004E6</td>
<td>ME</td>
<td>EBO</td>
<td>Shared memory lock obtain error</td>
</tr>
<tr>
<td>01</td>
<td>000004E7</td>
<td>ME</td>
<td>EBD</td>
<td>Shared memory lock destroy error</td>
</tr>
<tr>
<td>01</td>
<td>000004E8</td>
<td>ME</td>
<td>EBI</td>
<td>Shared memory lock initialize error</td>
</tr>
<tr>
<td>01</td>
<td>000004E9</td>
<td>ME</td>
<td>EFR</td>
<td>Mutex forced release</td>
</tr>
<tr>
<td>01</td>
<td>000004EA</td>
<td>ME</td>
<td>EFD</td>
<td>Mutex forced decrement</td>
</tr>
<tr>
<td>01</td>
<td>000004EB</td>
<td>ME</td>
<td>EDD</td>
<td>Mutex destroy failed (damage)</td>
</tr>
<tr>
<td>01</td>
<td>000004EC</td>
<td>ME</td>
<td>EDB</td>
<td>Mutex destroy failed (busy)</td>
</tr>
<tr>
<td>01</td>
<td>000004ED</td>
<td>ME</td>
<td>EIA</td>
<td>Mutex initialize failed (attribute)</td>
</tr>
<tr>
<td>01</td>
<td>000004EE</td>
<td>ME</td>
<td>EIS</td>
<td>Mutex initialize failed (storage)</td>
</tr>
<tr>
<td>01</td>
<td>000004EF</td>
<td>ME</td>
<td>EF</td>
<td>Mutex release (forced by quiesce)</td>
</tr>
<tr>
<td>01</td>
<td>000004F0</td>
<td>ME</td>
<td>EP</td>
<td>Mutex program check</td>
</tr>
<tr>
<td>01</td>
<td>000004FA</td>
<td>ME</td>
<td>EDU</td>
<td>Mutex destroy failed (uninitialized)</td>
</tr>
<tr>
<td>01</td>
<td>000004FB</td>
<td>ME</td>
<td>EUI</td>
<td>Mutex uninitialized</td>
</tr>
<tr>
<td>01</td>
<td>000004FC</td>
<td>ME</td>
<td>EUIO</td>
<td>Mutex unowned (not released)</td>
</tr>
<tr>
<td>01</td>
<td>000004FD</td>
<td>E</td>
<td>EO</td>
<td>Mutex already owned (not acquired)</td>
</tr>
<tr>
<td>01</td>
<td>000004FE</td>
<td>ME</td>
<td>EIN</td>
<td>Mutex initialization failed (duplicate)</td>
</tr>
<tr>
<td>01</td>
<td>00000508</td>
<td>CV</td>
<td>MR</td>
<td>CV release mutex</td>
</tr>
<tr>
<td>01</td>
<td>00000509</td>
<td>CV</td>
<td>MA</td>
<td>CV reacquire mutex</td>
</tr>
<tr>
<td>01</td>
<td>0000050A</td>
<td>CV</td>
<td>MW</td>
<td>CV mutex wait</td>
</tr>
<tr>
<td>01</td>
<td>0000050B</td>
<td>CV</td>
<td>MAW</td>
<td>CV reacquire mutex after wait</td>
</tr>
<tr>
<td>01</td>
<td>0000050C</td>
<td>CV</td>
<td>CW</td>
<td>CV condition wait</td>
</tr>
<tr>
<td>01</td>
<td>0000050D</td>
<td>CV</td>
<td>CTW</td>
<td>CV condition timeout</td>
</tr>
<tr>
<td>01</td>
<td>0000050E</td>
<td>CV</td>
<td>CWP</td>
<td>CV wait posted</td>
</tr>
<tr>
<td>01</td>
<td>0000050F</td>
<td>CV</td>
<td>CWI</td>
<td>CV wait interrupted</td>
</tr>
<tr>
<td>01</td>
<td>00000510</td>
<td>CV</td>
<td>CTO</td>
<td>CV wait timeout</td>
</tr>
<tr>
<td>01</td>
<td>00000511</td>
<td>CV</td>
<td>CSS</td>
<td>CV condition signal success</td>
</tr>
<tr>
<td>01</td>
<td>00000512</td>
<td>CV</td>
<td>CSM</td>
<td>CV condition signal miss</td>
</tr>
<tr>
<td>01</td>
<td>00000513</td>
<td>CV</td>
<td>CBS</td>
<td>CV condition broadcast success</td>
</tr>
<tr>
<td>01</td>
<td>00000514</td>
<td>CV</td>
<td>CBM</td>
<td>CV condition broadcast miss</td>
</tr>
<tr>
<td>01</td>
<td>00000515</td>
<td>CV</td>
<td>IN</td>
<td>CV initialize</td>
</tr>
<tr>
<td>01</td>
<td>00000516</td>
<td>CV</td>
<td>DS</td>
<td>CV destroy</td>
</tr>
</tbody>
</table>
### Table 64. LE=2 entry records (AMODE 64) (continued)

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Class</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>00000522</td>
<td>CV</td>
<td>CIN</td>
<td>Call to SMC_INIT</td>
</tr>
<tr>
<td>01</td>
<td>00000523</td>
<td>CV</td>
<td>CSD</td>
<td>Call to SMC_DESTROY</td>
</tr>
<tr>
<td>01</td>
<td>00000529</td>
<td>CV</td>
<td>CSP</td>
<td>Call to SMC_POST</td>
</tr>
<tr>
<td>01</td>
<td>0000052A</td>
<td>CV</td>
<td>CSB</td>
<td>Call to SMC_POSTALL</td>
</tr>
<tr>
<td>01</td>
<td>0000052B</td>
<td>CV</td>
<td>CSW</td>
<td>Call to SMC_WAIT</td>
</tr>
<tr>
<td>01</td>
<td>0000052C</td>
<td>CV</td>
<td>DBM</td>
<td>Shared condition broadcast - miss</td>
</tr>
<tr>
<td>01</td>
<td>0000052D</td>
<td>CV</td>
<td>DBS</td>
<td>Shared condition broadcast - success</td>
</tr>
<tr>
<td>01</td>
<td>0000052E</td>
<td>CV</td>
<td>DDS</td>
<td>Destroy (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>0000052F</td>
<td>CV</td>
<td>DIN</td>
<td>Initialize (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>00000530</td>
<td>CV</td>
<td>DSM</td>
<td>Condition signal - miss (shared CV)</td>
</tr>
<tr>
<td>01</td>
<td>00000531</td>
<td>CV</td>
<td>DSS</td>
<td>Condition signal - success (shared CV)</td>
</tr>
<tr>
<td>01</td>
<td>00000532</td>
<td>CV</td>
<td>DWI</td>
<td>Wait interrupted (shared CV)</td>
</tr>
<tr>
<td>01</td>
<td>00000533</td>
<td>CV</td>
<td>DTO</td>
<td>Wait timeout (shared CV)</td>
</tr>
<tr>
<td>01</td>
<td>00000534</td>
<td>CV</td>
<td>DWP</td>
<td>Wait posted (shared CV)</td>
</tr>
<tr>
<td>01</td>
<td>000006CB</td>
<td>CE</td>
<td>FBT</td>
<td>Error - Invalid system TOD (shared)</td>
</tr>
<tr>
<td>01</td>
<td>000006D1</td>
<td>CE</td>
<td>FRM</td>
<td>Error - Recursive mutex (shared)</td>
</tr>
<tr>
<td>01</td>
<td>000006D2</td>
<td>CE</td>
<td>FUO</td>
<td>Error - Shared mutex unowned</td>
</tr>
<tr>
<td>01</td>
<td>000006D3</td>
<td>CE</td>
<td>FDB</td>
<td>Error - Destroy failed (busy) (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>000006D4</td>
<td>CE</td>
<td>FDU</td>
<td>Error - Destroy failed (uninitialized) (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>000006D5</td>
<td>CE</td>
<td>FP</td>
<td>Error - Program check (shared mutex/CV)</td>
</tr>
<tr>
<td>01</td>
<td>000006D6</td>
<td>CE</td>
<td>FUI</td>
<td>Error - Shared mutex or CV uninitialize</td>
</tr>
<tr>
<td>01</td>
<td>000006D7</td>
<td>CE</td>
<td>ENV</td>
<td>Error - BPX1SMC(fail) returns EINVAL</td>
</tr>
<tr>
<td>01</td>
<td>000006D8</td>
<td>CE</td>
<td>EPE</td>
<td>Error - BPX1SMC(fail) returns EPERM</td>
</tr>
<tr>
<td>01</td>
<td>000006D9</td>
<td>CE</td>
<td>EAN</td>
<td>Error - BPX1SMC(fail) returns EAGAIN</td>
</tr>
<tr>
<td>01</td>
<td>000006DA</td>
<td>CE</td>
<td>EIB</td>
<td>Error - BPX1SMC failed (EBUSY)</td>
</tr>
<tr>
<td>01</td>
<td>000006DB</td>
<td>CE</td>
<td>ESC</td>
<td>Error - BPX1SMC failed</td>
</tr>
<tr>
<td>01</td>
<td>000006EB</td>
<td>CE</td>
<td>EDD</td>
<td>CV destroy failed (damage)</td>
</tr>
<tr>
<td>01</td>
<td>000006EC</td>
<td>CE</td>
<td>EDB</td>
<td>CV destroy failed (busy)</td>
</tr>
<tr>
<td>01</td>
<td>000006ED</td>
<td>CE</td>
<td>EIA</td>
<td>CV initialization failed (attribute)</td>
</tr>
<tr>
<td>01</td>
<td>000006EE</td>
<td>CE</td>
<td>EIS</td>
<td>CV initialization failed (storage)</td>
</tr>
<tr>
<td>01</td>
<td>000006EF</td>
<td>CE</td>
<td>EF</td>
<td>CV forced by quiesce</td>
</tr>
<tr>
<td>01</td>
<td>000006F0</td>
<td>CE</td>
<td>EP</td>
<td>CV program check</td>
</tr>
<tr>
<td>01</td>
<td>000006F1</td>
<td>CE</td>
<td>EBT</td>
<td>CV invalid system TOD</td>
</tr>
<tr>
<td>01</td>
<td>000006F2</td>
<td>CE</td>
<td>EBN</td>
<td>CV invalid timespec (nanoseconds)</td>
</tr>
<tr>
<td>01</td>
<td>000006F3</td>
<td>CE</td>
<td>EBS</td>
<td>CV invalid timespec (seconds)</td>
</tr>
<tr>
<td>01</td>
<td>000006F4</td>
<td>CE</td>
<td>EPO</td>
<td>CV condition post callable service fail</td>
</tr>
<tr>
<td>01</td>
<td>000006F5</td>
<td>CE</td>
<td>ETW</td>
<td>CV condition timed wait callable service fail</td>
</tr>
<tr>
<td>01</td>
<td>000006F6</td>
<td>CE</td>
<td>EWA</td>
<td>CV condition wait callable service fail</td>
</tr>
<tr>
<td>Member ID</td>
<td>Record Type</td>
<td>Class</td>
<td>Event</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td>-------</td>
<td>-------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>01</td>
<td>000006F7</td>
<td>CE</td>
<td>ESE</td>
<td>CV condition setup callable service fail</td>
</tr>
<tr>
<td>01</td>
<td>000006F8</td>
<td>CE</td>
<td>ERM</td>
<td>CV recursive mutex</td>
</tr>
<tr>
<td>01</td>
<td>000006F9</td>
<td>CE</td>
<td>EWM</td>
<td>CV wrong mutex</td>
</tr>
<tr>
<td>01</td>
<td>000006FA</td>
<td>CE</td>
<td>EDU</td>
<td>CV destroy failed (uninitialized)</td>
</tr>
<tr>
<td>01</td>
<td>000006FB</td>
<td>CE</td>
<td>EUI</td>
<td>CV mutex or CV uninitialized</td>
</tr>
<tr>
<td>01</td>
<td>000006FC</td>
<td>CE</td>
<td>EUO</td>
<td>CV mutex unowned</td>
</tr>
<tr>
<td>01</td>
<td>000006FE</td>
<td>CE</td>
<td>EIN</td>
<td>CV initialization failed (duplicate)</td>
</tr>
<tr>
<td>01</td>
<td>00000702</td>
<td>RW</td>
<td>R</td>
<td>Release</td>
</tr>
<tr>
<td>01</td>
<td>00000704</td>
<td>RW</td>
<td>AW</td>
<td>Acquire after wait</td>
</tr>
<tr>
<td>01</td>
<td>00000706</td>
<td>RW</td>
<td>I</td>
<td>Increment (recursive)</td>
</tr>
<tr>
<td>01</td>
<td>00000707</td>
<td>RW</td>
<td>D</td>
<td>Decrement (recursive)</td>
</tr>
<tr>
<td>01</td>
<td>00000715</td>
<td>RW</td>
<td>IN</td>
<td>Initialize</td>
</tr>
<tr>
<td>01</td>
<td>00000716</td>
<td>RW</td>
<td>DS</td>
<td>Destroy</td>
</tr>
<tr>
<td>01</td>
<td>00000717</td>
<td>RW</td>
<td>RA</td>
<td>Read acquire</td>
</tr>
<tr>
<td>01</td>
<td>00000718</td>
<td>RW</td>
<td>WA</td>
<td>Write acquire</td>
</tr>
<tr>
<td>01</td>
<td>00000719</td>
<td>RW</td>
<td>RB</td>
<td>Read busy (tryread failed)</td>
</tr>
<tr>
<td>01</td>
<td>0000071A</td>
<td>RW</td>
<td>WB</td>
<td>Write busy (trywrite failed)</td>
</tr>
<tr>
<td>01</td>
<td>0000071B</td>
<td>RW</td>
<td>RW</td>
<td>Read wait</td>
</tr>
<tr>
<td>01</td>
<td>0000071C</td>
<td>RW</td>
<td>WW</td>
<td>Write wait</td>
</tr>
<tr>
<td>01</td>
<td>0000071D</td>
<td>RW</td>
<td>BI</td>
<td>Call to SLK_INIT</td>
</tr>
<tr>
<td>01</td>
<td>0000071E</td>
<td>RW</td>
<td>BD</td>
<td>Call to SLK_DESTROY</td>
</tr>
<tr>
<td>01</td>
<td>0000071F</td>
<td>RW</td>
<td>BO</td>
<td>Call to SLK_OBTAIN</td>
</tr>
<tr>
<td>01</td>
<td>00000720</td>
<td>RW</td>
<td>BC</td>
<td>Call to SLK_OBTAIN_COND</td>
</tr>
<tr>
<td>01</td>
<td>00000721</td>
<td>RW</td>
<td>BR</td>
<td>Call to SLK_RELEASE</td>
</tr>
<tr>
<td>01</td>
<td>000008DC</td>
<td>RE</td>
<td>EOW</td>
<td>Error - Already owned for write (not acquired)</td>
</tr>
<tr>
<td>01</td>
<td>000008DD</td>
<td>RE</td>
<td>EOR</td>
<td>Error - Already owned for read (not acquired)</td>
</tr>
<tr>
<td>01</td>
<td>000008DE</td>
<td>RE</td>
<td>EDL</td>
<td>Error - BPX1SLK(fail) returns EDEADLK</td>
</tr>
<tr>
<td>01</td>
<td>000008DF</td>
<td>RE</td>
<td>EIV</td>
<td>Error - BPX1SLK(fail) returns EINVAL</td>
</tr>
<tr>
<td>01</td>
<td>000008E0</td>
<td>RE</td>
<td>EPM</td>
<td>Error - BPX1SLK(fail) returns EPERM</td>
</tr>
<tr>
<td>01</td>
<td>000008E1</td>
<td>RE</td>
<td>EAG</td>
<td>Error - BPX1SLK(fail) returns EAGAIN</td>
</tr>
<tr>
<td>01</td>
<td>000008E2</td>
<td>RE</td>
<td>EBS</td>
<td>Error - BPX1SLK(fail) returns EBUSY</td>
</tr>
<tr>
<td>01</td>
<td>000008E3</td>
<td>RE</td>
<td>ENM</td>
<td>Error - BPX1SLK(fail) returns ENOMEM</td>
</tr>
<tr>
<td>01</td>
<td>000008E4</td>
<td>RE</td>
<td>EBR</td>
<td>Error - BPX1SLK(RELEASE) error return</td>
</tr>
<tr>
<td>01</td>
<td>000008E5</td>
<td>RE</td>
<td>EBC</td>
<td>Error - BPX1SLK(OBTAIN_COND) error return</td>
</tr>
<tr>
<td>01</td>
<td>000008E6</td>
<td>RE</td>
<td>EBO</td>
<td>Error - BPX1SLK(OBTAIN) error return</td>
</tr>
<tr>
<td>01</td>
<td>000008E7</td>
<td>RE</td>
<td>EBD</td>
<td>Error - BPX1SLK(DESTROY) error return</td>
</tr>
<tr>
<td>01</td>
<td>000008E8</td>
<td>RE</td>
<td>EBI</td>
<td>Error - BPX1SLK(INIT) error return</td>
</tr>
<tr>
<td>01</td>
<td>000008E9</td>
<td>RE</td>
<td>EFR</td>
<td>Error - Forced release</td>
</tr>
<tr>
<td>01</td>
<td>000008EA</td>
<td>RE</td>
<td>EFD</td>
<td>Error - Forced decrement</td>
</tr>
</tbody>
</table>
Table 64. LE=2 entry records (AMODE 64) (continued)

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Class</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>000008ED</td>
<td>RE</td>
<td>EIA</td>
<td>Error - Initialization failed (attribute)</td>
</tr>
<tr>
<td>01</td>
<td>000008EE</td>
<td>RE</td>
<td>EIS</td>
<td>Error - Initialization failed (storage)</td>
</tr>
<tr>
<td>01</td>
<td>000008EF</td>
<td>RE</td>
<td>EF</td>
<td>Error - Forced by quiesce</td>
</tr>
<tr>
<td>01</td>
<td>000008F0</td>
<td>RE</td>
<td>EP</td>
<td>Error - Program check</td>
</tr>
<tr>
<td>01</td>
<td>000008FB</td>
<td>RE</td>
<td>EUI</td>
<td>Error - Uninitialized</td>
</tr>
<tr>
<td>01</td>
<td>000008FC</td>
<td>RE</td>
<td>EUO</td>
<td>Error - Unowned (not released)</td>
</tr>
<tr>
<td>01</td>
<td>000008FD</td>
<td>RE</td>
<td>EO</td>
<td>Error - Already owned (not acquired)</td>
</tr>
<tr>
<td>01</td>
<td>000008FE</td>
<td>RE</td>
<td>EIN</td>
<td>Error - Initialization failed (duplicate)</td>
</tr>
</tbody>
</table>

Table 65 shows the format for the Mutex – Condition Variable – Latch entries in the trace table.

Table 65. Format of the mutex/CV/latch records (AMODE 64)

<table>
<thead>
<tr>
<th>Record fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
</tr>
<tr>
<td>unused</td>
</tr>
</tbody>
</table>

Class  
Two character EBCDIC representation of the trace class.

LT  Latch
LE  Latch Exception
MX  Mutex
ME  Mutex Exception
CV  Condition Variable
CE  Condition Variable Exception

Source  
One character EBCDIC representation of the event.

C  C/C++

Blank  Blank character

Event  
Two character EBCDIC representation of the event; see Table 64 on page 441

Object addr  
Fullword address of the mutex object.

Name 1  
Optional eight character field containing the name of the function or object to be recorded.

Name 2  
Optional eight character field containing the name of the function or object to be recorded.

When LE=3 is specified: The trace table will include the records generated by both LE=1 and LE=2.

When LE=8 is specified: As Table 66 on page 446 shows, the trace table will contain only storage allocation records. Currently, this is only supported by...
C/C++. For a detailed description of these records, see “C/C++ contents of the Language Environment trace tables” on page 469.

Table 66. LE=8 entry records (AMODE 64)

<table>
<thead>
<tr>
<th>Member ID</th>
<th>Record Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>00000005</td>
<td>Storage allocation entry</td>
</tr>
<tr>
<td>03</td>
<td>00000006</td>
<td>Storage allocation exit</td>
</tr>
</tbody>
</table>

Sample dump for the trace table entry

Figure 223 shows an example of a dump of the trace table when you specify the LE=1 suboption (the library call/return trace).

Requesting a UNIX System Services syscall trace for debugging

Signal SIGTRACE can be sent to a process or process group to start or stop a trace of the z/OS UNIX System Services syscalls made by the application. The signal is implemented as a toggle. With the trace turned on, the z/OS UNIX System Services kernel gathers the syscall trace records for the targeted processes. A system dump of the user address space can be generated by sending signal SIGDUMP to the same processes in order to capture the trace output. See z/OS UNIX System Services Command Reference for more information about the SIGTRACE signal.
Chapter 13. Debugging AMODE 64 C/C++ routines

This section provides specific information to help you debug AMODE 64 applications that contain one or more C/C++ routines. It includes the following topics:

- Debugging C/C++ I/O routines
- Using XL C/C++ compiler listings
- Generating a Language Environment dump of a C/C++ routine
- Finding C/C++ information in a Language Environment dump
- Debugging example of C/C++ routines

There are several debugging features that are unique to C/C++ routines. Before examining the C/C++ techniques to find errors, you might want to consider the following areas of potential problems:

- To prevent errors that may result from differences in LP64 default argument types, you should include function prototypes for all C/C++ function calls. For C/C++ runtime library functions, see z/OS XL C/C++ Runtime Library Reference.

  **Note:** malloc() is an example of a RTL function which needs this prototype to work correctly in LP64 applications.

- If you are using the `fetch()` function, see z/OS XL C/C++ Programming Guide to ensure that you are creating the fetchable module correctly.

- If you are using DLLs, see z/OS XL C/C++ Programming Guide to ensure that you are using the DLL correctly.

- Ensure that the entry point of the load module is CELQSTRT.

- If you suspect that you are using uninitialized storage, you may want to use the `STORAGE` runtime option.

- You should avoid:
  - Incorrect casting
  - Referencing an array element with a subscript outside the declared bounds
  - Copying a string to a target with a shorter length than the source string
  - Declaring but not initializing a pointer variable, or using a pointer to allocated storage that has already been freed

If a routine exception occurred and you need more information than the condition handler provided, run your routine with the following runtime options, TRAP(ON, NOSPIE) and TERMTHDACT(UAIMM). Setting these runtime options generates a system dump of the user address space of the original abend or program interrupt prior to the Language Environment condition manager processing the condition. After the system dump is taken by the operating system the Language Environment condition manager continues processing.

---

**Debugging C/C++ programs**

You can use C/C++ conventions such as `_amrc` and `perror()` when you debug C/C++ programs.
Using the __amrc and __amrc2 structures to debug input/output

__amrc, a structure defined in stdio.h, can help you determine the cause of errors resulting from an I/O operation, because it contains diagnostic information (for example, the return code from a failed VSAM operation). There are two structures:

- __amrc (defined by type __amrc_type)
- __amrc2 (defined by type __amrc2_type; this structure contains secondary information that C can provide)

Because any I/O function calls, such as printf(), can change the value of __amrc or __amrc2, make sure you save the contents into temporary structures of __amrc_type and __amrc2_type respectively, before dumping them.

Figure 224 on page 449 shows the structure as it appears in stdio.h.
typedef struct __amrctype {
    union {
        int __error;
        struct {
            unsigned short __syscode,
            __rc;
        } __abend;
        struct {
            unsigned char __fdbk_fill,
            __rc,
            __ftncd,
            __fdbk;
        } __feedback;
        struct {
            unsigned short __svc99_info,
            __svc99_error;
        } __alloc;
        union {
            int __error; /* __error2 */
            char __pad__error2[4]; /* __pad_error2[4]; */
        } __code;
        unsigned int __RBA; /* __RBA; */
        unsigned int __last_op;
        struct {
            unsigned int __len_fill; /* __len + 4 */
            unsigned int __len; /* __len */
            char __str[120]; /* __str[120]; */
            unsigned int __parmr0; /* __parmr0; */
            unsigned int __parmr1; /* __parmr1; */
            unsigned int __fill2[2]; /* __fill2[2]; */
            char __str2[64]; /* __str2[64]; */
        } __msg; /* __msg; */
        #if __EDC_TARGET >= 0x22080000  /* QSAM to BSAM switch reason */
        unsigned char __amrc_noseek_to_seek; /* __amrc_noseek_to_seek; */
        char __amrc_pad[23]; /* __amrc_pad[23]; */
        #endif /* QSAM to BSAM switch reason */
    } __amrc_type;
} __amrctype;

Figure 224. __amrc structure (AMODE 64)

Figure 225 shows the __amrc2 structure as it appears in stdio.h.

struct {
    int __error2; /* __error2 */
    char __pad__error2[4]; /* __pad_error2[4]; */
    FILE *__fileptr; /* __fileptr; */
    int __reserved[6]; /* __reserved[6]; */
}

Figure 225. __amrc2 structure (AMODE 64)

union { ... } __code

The error or warning value from an I/O operation is in __error, __abend, __feedback, or __alloc. Look at __last_op to determine how to interpret the __code union.
A structure that contains error codes for certain macros or services your application uses. Look at __last_op to determine the error codes. __syscode is the system abend code.

A structure that contains the abend code when errno is set to indicate a recoverable I/O abend. __rc is the return code. For more information on abend codes, see z/OS MVS System Codes.

A structure that is used for VSAM only. The __rc stores the VSAM register 15, __fdbk stores the VSAM error code or reason code, and __RBA stores the RBA after some operations.

A structure that contains errors during fopen or freopen calls when defining files to the system using SVC 99.

The RBA value returned by VSAM after an ESDS or KSDS record is written out. For an RRDS, it is the calculated value from the record number. In AMODE 64 applications, you can no longer use the address of __amrc._ RBA as the first argument to flocate(). Instead, __amrc._ RBA must be placed into an unsigned long in order to make it 8 bytes wide, since flocate() is updated to indicate that size of (unsigned long) must be specified as the key length (second argument).

A field containing a value that indicates the last I/O operation being performed by C/C++ at the time the error occurred. These values are shown in Table 67 on page 451.

May contain the system error messages from read or write operations emitted from the DFSMS/MVS SYNADAF macro instruction. Because the message can start with a hexadecimal address followed by a short integer, it is advisable to start printing at MSG+6 or greater so the message can be printed as a string. Because the message is not null-terminated, a maximum of 114 characters should be printed. This can be accomplished by specifying a printf format specifier as %114s.

This field contains feedback information related to a VSAM RLS failure. This is the feedback code from the IFGRPL control block.

This is the 8 byte relative byte address returned by VSAM after an ESDS or KSDS record is written out. For an RRDS, it is the calculated value from the record number. It may be used in subsequent calls to flocate().

This field contains the reason for the switch from QSAM (noseek) to BSAM with NOTE and P01NT macros requested (seek) by the XL C/C++ Runtime Library. This field is set when system-level I/O macro processing triggers an ABEND condition. The macro name values (defined in stdio.h) for this field are as follows:

<table>
<thead>
<tr>
<th>Macro</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>__AM_BSAM_NOSWITCH</td>
<td>No switch was made.</td>
</tr>
</tbody>
</table>
### Macro Definition

<table>
<thead>
<tr>
<th>Macro</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>__AM_BSAM_UPDATE</td>
<td>The data set is open for update</td>
</tr>
<tr>
<td>__AM_BSAM_BSAMWRITE</td>
<td>The data set is already open for write (or update) in the same C process.</td>
</tr>
<tr>
<td>__AM_BSAM_FBS_APPEND</td>
<td>The data set is recfm=FBS and open for append</td>
</tr>
<tr>
<td>__AM_BSAM_LRECLX</td>
<td>The data set is recfm=LRECLX (used for VBS data sets where records span the largest blocksize allowed on the device)</td>
</tr>
<tr>
<td>__AM_BSAM_PARTITIONED_DIRECTORY</td>
<td>The data set is the directory for a regular or extended partitioned data set</td>
</tr>
<tr>
<td>__AM_BSAM_PARTITIONED_INDIRECT</td>
<td>The data set is a member of a partitioned data set, and the member name was not specified at allocation</td>
</tr>
</tbody>
</table>

[12] __error2
A secondary error code. For example, an unsuccessful rename or remove operation places its reason code here.

[13] __fileptr
A pointer to the file that caused a SIGIOERR to be raised. Use an fldata() call to get the actual name of the file.

[14] __reserved
Reserved for future use.

### __last_op values
The __last_op field is the most important of the __amrc fields. It defines the last I/O operation C/C++ was performing at the time of the I/O error. You should note that the structure is neither cleared nor set by non-I/O operations, so querying this field outside of a SIGIOERR handler should only be done immediately after I/O operations. [Table 67](#) lists __last_op values you could receive and where to look for further information.

<table>
<thead>
<tr>
<th>Value</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>__IO_INIT</td>
<td>Will never be seen by SIGIOERR exit value given at initialization.</td>
</tr>
<tr>
<td>__BSAM_OPEN</td>
<td>Sets __error with return code from OS OPEN macro.</td>
</tr>
<tr>
<td>__BSAM_CLOSE</td>
<td>Sets __error with return code from OS CLOSE macro.</td>
</tr>
<tr>
<td>__BSAM_READ</td>
<td>No return code (either __abend (errno == 92) or __msg (errno == 66) filled in).</td>
</tr>
<tr>
<td>__BSAM_NOTE</td>
<td>NOTE returned 0 unexpectedly, no return code.</td>
</tr>
<tr>
<td>__BSAM_POINT</td>
<td>This will not appear as an error lastop.</td>
</tr>
<tr>
<td>__BSAM_WRITE</td>
<td>No return code (either __abend (errno == 92) or __msg (errno == 65) filled in).</td>
</tr>
<tr>
<td>__BSAM_CLOSE_T</td>
<td>Sets __error with return code from OS CLOSE TYPE=T.</td>
</tr>
<tr>
<td>__BSAM_BLDL</td>
<td>Sets __error with return code from OS BLDL macro.</td>
</tr>
<tr>
<td>__BSAM_STOW</td>
<td>Sets __error with return code from OS STOW macro.</td>
</tr>
<tr>
<td>__TGET_READ</td>
<td>Sets __error with return code from TSO TGET macro.</td>
</tr>
<tr>
<td>__TPUT_WRITE</td>
<td>Sets __error with return code from TSO TPUT macro.</td>
</tr>
</tbody>
</table>
Table 67. __last_op values and diagnosis information (AMODE 64) (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>__IO_DEVTYPE</td>
<td>Sets __error with return code from I/O DEVTYPE macro.</td>
</tr>
<tr>
<td>__IO_RDJFCB</td>
<td>Sets __error with return code from I/O RDJFCB macro.</td>
</tr>
<tr>
<td>__IO_TRKCALC</td>
<td>Sets __error with return code from I/O TRKCALC macro.</td>
</tr>
<tr>
<td>__IO_OBTAIN</td>
<td>Sets __error with return code from I/O CAMLIST OBTAIN.</td>
</tr>
<tr>
<td>__IO_LOCATE</td>
<td>Sets __error with return code from I/O CAMLIST LOCATE.</td>
</tr>
<tr>
<td>__IO_CATALOG</td>
<td>Sets __error with return code from I/O CAMLIST CAT. The associated macro is CATALOG.</td>
</tr>
<tr>
<td>__IO_UNCATALOG</td>
<td>Sets __error with return code from I/O CAMLIST UNCAT. The associated macro is CATALOG.</td>
</tr>
<tr>
<td>__IO_RNAME</td>
<td>Sets __error with return code from I/O CAMLIST RENAME.</td>
</tr>
<tr>
<td>__SVC99_ALLOC</td>
<td>Sets __alloc structure with info and error codes from SVC 99 allocation.</td>
</tr>
<tr>
<td>__SVC99_ALLOC_NEW</td>
<td>Sets __alloc structure with info and error codes from SVC 99 allocation of NEW file.</td>
</tr>
<tr>
<td>__SVC99_UNALLOC</td>
<td>Sets __unalloc structure with info and error codes from SVC 99 unallocation.</td>
</tr>
<tr>
<td>__C_TRUNCATE</td>
<td>Set when C or C++ truncates output data. Usually this is data written to a text file</td>
</tr>
<tr>
<td></td>
<td>with no newline such that the record fills up to capacity and subsequent characters</td>
</tr>
<tr>
<td></td>
<td>cannot be written. For a record I/O file this refers to an fwrite() writing more</td>
</tr>
<tr>
<td></td>
<td>data than the record can hold. Truncation is always rightmost data. There is no</td>
</tr>
<tr>
<td></td>
<td>return code.</td>
</tr>
<tr>
<td>__C_FCBCHECK</td>
<td>Set when C or C++ FCB is corrupted. This is due to a pointer corruption somewhere.</td>
</tr>
<tr>
<td></td>
<td>File cannot be used after this.</td>
</tr>
<tr>
<td>__C_DBCS_TRUNCATE</td>
<td>This occurs when writing DBCS data to a text file and there is no room left in a</td>
</tr>
<tr>
<td></td>
<td>physical record for anymore double byte characters. A new-line is not acceptable at</td>
</tr>
<tr>
<td></td>
<td>this point. Truncation will continue to occur until an SI is written or the file</td>
</tr>
<tr>
<td></td>
<td>position is moved. Cannot happen if MB_CUR_MAX is 1.</td>
</tr>
<tr>
<td>__C_DBCS_SO_TRUNCATE</td>
<td>This occurs when there is not enough room in a record to start any DBCS string or</td>
</tr>
<tr>
<td></td>
<td>else when a redundant SO is written to the file before an SI. Cannot happen if MB_</td>
</tr>
<tr>
<td></td>
<td>CUR_MAX is 1.</td>
</tr>
<tr>
<td>__C_DBCS_SI_TRUNCATE</td>
<td>This occurs only when there was not enough room to start a DBCS string and data</td>
</tr>
<tr>
<td></td>
<td>was written anyways, with an SI to end it. Cannot happen if MB_CUR_MAX is 1.</td>
</tr>
<tr>
<td>__C_DBCS_UNEVEN</td>
<td>This occurs when an SI is written before the last double byte character is completed,</td>
</tr>
<tr>
<td></td>
<td>thereby forcing C or C++ to fill in the last byte of the DBCS string with a padding</td>
</tr>
<tr>
<td></td>
<td>byte X'FE'. Cannot happen if MB_CUR_MAX is 1.</td>
</tr>
<tr>
<td>__C_CANNOT_EXTEND</td>
<td>This occurs when an attempt is made to extend a file that allows writing, but cannot</td>
</tr>
<tr>
<td></td>
<td>be extended. Typically this is a member of a partitioned data set being opened for</td>
</tr>
<tr>
<td></td>
<td>update.</td>
</tr>
<tr>
<td>__VSAM_OPEN_FAIL</td>
<td>Set when a low level VSAM OPEN fails, sets __rc and __fdbk fields in the __amrc</td>
</tr>
<tr>
<td></td>
<td>struct.</td>
</tr>
<tr>
<td>__VSAM_OPEN_ESDS</td>
<td>Does not indicate an error; set when the low level VSAM OPEN succeeds, and the file</td>
</tr>
<tr>
<td></td>
<td>type is ESDS.</td>
</tr>
<tr>
<td>__VSAM_OPEN_RRDS</td>
<td>Does not indicate an error; set when the low level VSAM OPEN succeeds, and the file</td>
</tr>
<tr>
<td></td>
<td>type is RRDS.</td>
</tr>
</tbody>
</table>
Table 67. __last_op values and diagnosis information (AMODE 64) (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>__VSAM_OPEN_KSDS</td>
<td>Does not indicate an error; set when the low level VSAM OPEN succeeds, and the file type is KSDS.</td>
</tr>
<tr>
<td>__VSAM_OPEN_ESDS_PATH</td>
<td>Does not indicate an error; set when the low level VSAM OPEN succeeds, and the file type is ESDS PATH.</td>
</tr>
<tr>
<td>__VSAM_OPEN_KSDS_PATH</td>
<td>Does not indicate an error; set when the low level VSAM OPEN succeeds, and the file type is KSDS PATH.</td>
</tr>
<tr>
<td>__VSAM_MODCB</td>
<td>Set when a low level VSAM MODCB macro fails, sets __rc and __fdbk fields in the __amrc struct.</td>
</tr>
<tr>
<td>__VSAM_TESTCB</td>
<td>Set when a low level VSAM TESTCB macro fails, sets __rc and __fdbk fields in the __amrc struct.</td>
</tr>
<tr>
<td>__VSAM_SHOWCB</td>
<td>Set when a low level VSAM SHOWCB macro fails, sets __rc and __fdbk fields in the __amrc struct.</td>
</tr>
<tr>
<td>__VSAM_GENCB</td>
<td>Set when a low level VSAM GENCB macro fails, sets __rc and __fdbk fields in the __amrc struct.</td>
</tr>
<tr>
<td>__VSAM_GET</td>
<td>Set when the last op was a low level VSAM GET; if the GET fails, sets __rc and __fdbk in the __amrc struct.</td>
</tr>
<tr>
<td>__VSAM_PUT</td>
<td>Set when the last op was a low level VSAM PUT; if the PUT fails, sets __rc and __fdbk in the __amrc struct.</td>
</tr>
<tr>
<td>__VSAM_POINT</td>
<td>Set when the last op was a low level VSAM POINT; if the POINT fails, sets __rc and __fdbk in the __amrc struct.</td>
</tr>
<tr>
<td>__VSAM_ERASE</td>
<td>Set when the last op was a low level VSAM ERASE; if the ERASE fails, sets __rc and __fdbk in the __amrc struct.</td>
</tr>
<tr>
<td>__VSAM_ENDREQ</td>
<td>Set when the last op was a low level VSAM ENDREQ; if the ENDREQ fails, sets __rc and __fdbk in the __amrc struct.</td>
</tr>
<tr>
<td>__VSAM_CLOSE</td>
<td>Set when the last op was a low level VSAM CLOSE; if the CLOSE fails, sets __rc and __fdbk in the __amrc struct.</td>
</tr>
<tr>
<td>__QSAM_GET</td>
<td>__error is not set (if abend (errno == 92), __abend is set, otherwise if read error (errno == 66), look at __msg.</td>
</tr>
<tr>
<td>__QSAM_PUT</td>
<td>__error is not set (if abend (errno == 92), __abend is set, otherwise if write error (errno == 65), look at __msg.</td>
</tr>
<tr>
<td>__QSAM_TRUNC</td>
<td>This is an intermediate operation. You will only see this if an I/O abend occurred.</td>
</tr>
<tr>
<td>__QSAM_FREEPOOL</td>
<td>This is an intermediate operation. You will only see this if an I/O abend occurred.</td>
</tr>
<tr>
<td>__QSAM_CLOSE</td>
<td>Sets __error to result of OS CLOSE macro.</td>
</tr>
<tr>
<td>__QSAM_OPEN</td>
<td>Sets __error to result of OS OPEN macro.</td>
</tr>
<tr>
<td>__CMS_OPEN</td>
<td>Sets __error to result of FSOPEN.</td>
</tr>
<tr>
<td>__CMS_CLOSE</td>
<td>Sets __error to result of FSCLOSE.</td>
</tr>
<tr>
<td>__CMS_READ</td>
<td>Sets __error to result of FSREAD.</td>
</tr>
<tr>
<td>__CMS_WRITE</td>
<td>Sets __error to result of FSWRITE.</td>
</tr>
<tr>
<td>__CMS_STATE</td>
<td>Sets __error to result of FSSTATE.</td>
</tr>
<tr>
<td>__CMS_ERASE</td>
<td>Sets __error to result of FSERASE.</td>
</tr>
<tr>
<td>__CMS_RENAME</td>
<td>Sets __error to result of CMS RENAME command.</td>
</tr>
<tr>
<td>__CMS_EXTRACT</td>
<td>Sets __error to result of DMS EXTRACT call.</td>
</tr>
<tr>
<td>__CMS_LINERD</td>
<td>Sets __error to result of LINERD macro.</td>
</tr>
</tbody>
</table>
Table 67. __last_op values and diagnosis information (AMODE 64) (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>__CMS_LINEWRT</td>
<td>Sets __error to result of LINEWRT macro.</td>
</tr>
<tr>
<td>__CMS_QUERY</td>
<td>__error is not set.</td>
</tr>
<tr>
<td>__HSP_CREATE</td>
<td>Indicates last op was a DSPSERV CREATE to create a hiperspace for a hiperspace memory file. If CREATE fails, stores abend code in __amrc_code__abend__syscode, reason code in __amrc_code__abend__rc.</td>
</tr>
<tr>
<td>__HSP_DELETE</td>
<td>Indicates last op was a DSPSERV DELETE to delete a hiperspace for a hiperspace memory file during termination. If DELETE fails, stores abend code in __amrc_code__abend__syscode, reason code in __amrc_code__abend__rc.</td>
</tr>
<tr>
<td>__HSP_READ</td>
<td>Indicates last op was a HSPSERV READ from a hiperspace. If READ fails, stores abend code in __amrc_code__abend__syscode, reason code in __amrc_code__abend__rc.</td>
</tr>
<tr>
<td>__HSP_WRITE</td>
<td>Indicates last op was a HSPSERV WRITE to a hiperspace. If WRITE fails, stores abend code in __amrc_code__abend__syscode, reason code in __amrc_code__abend__rc.</td>
</tr>
<tr>
<td>__HSP_EXTEND</td>
<td>Indicates last op was a HSPSERV EXTEND during a write to a hiperspace. If EXTEND fails, stores abend code in __amrc_code__abend__syscode, reason code in __amrc_code__abend__rc.</td>
</tr>
<tr>
<td>__LFS_OPEN</td>
<td>Sets __error with reason code from HFS services. Reason code from HFS services must be broken up. The low order 2 bytes can be looked up in z/OS UNIX System Services Programming: Assembler Callable Services Reference.</td>
</tr>
<tr>
<td>__LFS_CLOSE</td>
<td>Sets __error with reason code from HFS services. Reason code from HFS services must be broken up. The low order 2 bytes can be looked up in z/OS UNIX System Services Programming: Assembler Callable Services Reference.</td>
</tr>
<tr>
<td>__LFS_READ</td>
<td>Sets __error with reason code from HFS services. Reason code from HFS services must be broken up. The low order 2 bytes can be looked up in z/OS UNIX System Services Programming: Assembler Callable Services Reference.</td>
</tr>
<tr>
<td>__LFS_WRITE</td>
<td>Sets __error with reason code from HFS services. Reason code from HFS services must be broken up. The low order 2 bytes can be looked up in z/OS UNIX System Services Programming: Assembler Callable Services Reference.</td>
</tr>
<tr>
<td>__LFS_LSEEK</td>
<td>Sets __error with reason code from HFS services. Reason code from HFS services must be broken up. The low order 2 bytes can be looked up in z/OS UNIX System Services Programming: Assembler Callable Services Reference.</td>
</tr>
<tr>
<td>__LFS_FSTAT</td>
<td>Sets __error with reason code from HFS services. Reason code from HFS services must be broken up. The low order 2 bytes can be looked up in z/OS UNIX System Services Programming: Assembler Callable Services Reference.</td>
</tr>
</tbody>
</table>

Using file I/O tracing to debug C/C++ file I/O problems

You can use file I/O tracing to debug C/C++ file I/O problems. For more information, see Debugging I/O programs in z/OS XL C/C++ Programming Guide.
Displaying an error message with the perror() function

To find a failing routine, check the return code of all function calls. After you have found the failing routine, use the perror() function after the routine to display the error message. perror() displays the string that you pass to it and an error message corresponding to the value of errno. perror() writes to the standard error stream (stderr). By default, the errno2 value will be appended to the end of the perror() string.

If you do not want the errno2 value appended to the perror() string, set the _EDC_ADD_ERRNO2 environment variable to 0.

Figure 226 is an example of a routine using perror().

```c
#include <stdio.h>
int main(void)
{
    FILE *fp;
    fp = fopen("myfile.dat", "w");
    if (fp == NULL)
        perror("fopen error");
}
```

Figure 226. Example of a routine using perror() (AMODE 64)

Using __errno2() to diagnose application problems

Use the __errno2() function when diagnosing problems in an application program. This function enables z/OS XL C/C++ application programs to access additional diagnostic information, errno2 (errnojr), associated with errno. The __errno2 may be set by the z/OS XL C/C++ runtime library, z/OS UNIX callable services, or other callable services. The errno2 is intended for diagnostic display purposes only and is not a programming interface.

Note: Not all functions set errno2 when errno is set. In the cases where errno2 is not set, the __errno2() function may return a residual value. You may use the __err2ad() function to clear errno2 to reduce the possibility of a residual value being returned.

Figure 227 is an example of a routine using __errno2() and Figure 228 on page 456 shows the sample output from that routine.

```c
#pragma runopts(posix(on))
#define _EXT
#include <stdio.h>
#include <errno.h>
int main(void) {
    FILE *f;
    f = fopen("testfile.dat", "r");
    if (f == NULL) {
        perror("fopen() failed");
        printf("__errno2 = %08x\n", __errno2());
    }
    return 0;
}
```

Figure 227. Example of a routine using __errno2() (AMODE 64)
Figure 229 is an example of a routine using the environment variable _EDC_ADD_ERRNO2. Figure 230 shows the sample output from that routine. For more information about _EDC_ADD_ERRNO2, see z/OS XL C/C++ Programming Guide.

```c
#pragma runopts(posix(on))
#define _EXT
#include <stdio.h>
#include <errno.h>
#include <stdlib.h>

int main(void) {
  FILE *fp;
  /* do NOT add errno2 to perror message */
  setenv("_EDC_ADD_ERRNO2", "0", 1);
  fp = fopen("testfile.dat", "r");
  if (fp == NULL)
    perror("fopen() failed");
  return 0;
}
```

Figure 229. Example of a routine using _EDC_ADD_ERRNO2 (AMODE 64)

fopen() failed: EDC5129I No such file or directory. (errno2=0x05620062)
__errno2 = 05620062

Figure 228. Sample output of routine using __errno2() (AMODE 64)

fopen() failed: EDC5129I No such file or directory.

Figure 230. Sample output of routine using _EDC_ADD_ERRNO2 (AMODE 64)

Figure 231 on page 457 is an example of a routine using __err2ad() in combination with __errno2(). Figure 232 on page 457 shows the sample output from that routine. For more information about __errno2() and __err2ad(), see z/OS XL C/C++ Runtime Library Reference.
Using C/C++ listings

For a detailed description of available listings, see z/OS XL C/C++ User’s Guide.

Finding variables

You can determine the value of a variable in the routine at the point of interrupt by using the compiled code listing as a guide to its address, then finding this address in the Language Environment dump or system dump. The method you use depends on the storage class of variable.

It is possible for the routine to be interrupted before the value of the variable is placed in the location provided for it. This can explain unexpected values in the dump.

Steps for finding automatic variables

Perform the following steps to find automatic variables in the Language Environment dump or system dump:

1. Determine the name of the automatic variable and the function it is defined in. As an example, we will find the variable `aa` in the function `main` from the program `cdivzero` shown in Figure 69 on page 208.
2. From the compiler listing, locate the variable in the storage offset listing:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Class</th>
<th>Location</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>aa</td>
<td>automatic</td>
<td>2248(r4)</td>
<td>4</td>
</tr>
</tbody>
</table>

The location is specified as decimal offset (base register). So variable aa is located at register $4 + 2248$ (X'8C8').

3. From the Traceback (in the Language Environment dump or in the formatted output from the IPCS VERBEXIT LEDATA CEEDUMP subcommand for a system dump) locate the function:

If the base register is R4, the register 4 value is always the DSA address for the function.

If the base register is not R4, the register value must be located from saved registers.

If the Status field indicates Exception, use the saved registers from when the condition occurred. In the Language Environment dump, the saved registers can be found in the Condition information associated with the DSA address in the Condition Information for Active Routines section. In the formatted output from the IPCS VERBEXIT LEDATA CM subcommand for a system dump, the saved registers can be found in the CIBH that has the DSA address as the value for the SV1 field.

If the Status field indicates Call, use the saved registers from the DSA address that appears on the line above the function in the Traceback. In the Language Environment dump, the DSAs can be found in the "Control Blocks for Active Routines" section. In the formatted output from the IPCS VERBEXIT LEDATA 'STACK' subcommand for a system dump, the DSAs can be found in the "DSA backchain" section.

Note: Some functions do not save all registers.

4. Add the register value to the offset of the variable to obtain the address of the variable. In the Language Environment dump, the contents of the variable can be read in the DSA Frame section corresponding to the function the variable is contained in. For a system dump, use the IPCS LIST subcommand to display the storage where the variable is located.

The address for variable aa is X'1082FF080' + X'980' = X'1082FFA00'.

Restriction: The parameter value might never be stored, since the first few parameters might be passed in registers and there might be no need to save them.

Steps for finding C/C++ parameters
The C/C++ parameter list is always located in the caller's DSA at offset 2176 (X'880'). Parameters that are passed in registers are not always stored in the parameter list. The compiler option XPLINK(STOREARGS) can be used to ensure that all parameters are stored in the parameter list.
Perform the following steps to find parameters in the Language Environment dump or system dump:

1. Determine the name of the parameter and the function it is for. As an example, we will find the parameter `pp` for the function `funcb` from the program `cdizero` shown in Figure 53. C routine with a divide-by-zero error.

2. From the compiler listing, locate the parameter in the storage offset listing:

| pp | 5828-0:15 | Class = parameter, | Location = 2432(r4), | Length = 8 |

3. From the Traceback (in the Language Environment dump or in the formatted output from the IPCS VERBEXIT LEDATA 'CEEDUMP' subcommand for a system dump) locate the function:

<table>
<thead>
<tr>
<th>DSA Addr</th>
<th>E Addr</th>
<th>PU Addr</th>
<th>PU Offset</th>
<th>Comp Date Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000003</td>
<td>00000000</td>
<td>00000000</td>
<td>00000000</td>
<td>******** 20040408 XPLINK EBCDIC IEEE</td>
</tr>
</tbody>
</table>

If the base register is R4, the register 4 value is always the DSA address for the function.

If the base register is not R4, the register value must be located from saved registers.

If the Status field indicates Exception, use the saved registers from when the condition occurred. In the Language Environment dump, the saved registers can be found in the Condition information associated with the DSA address in the "Condition Information for Active Routines" section. In the formatted output from the IPCS VERBEXIT LEDATA 'CM' subcommand for a system dump, the saved registers can be found in the CIBH that has the DSA address as the value for the SV1 field.

If the Status field indicates Call, use the saved registers from the DSA address that appears on the line above the function in the Traceback. In the Language Environment dump, the DSAs can be found in the "Control Blocks for Active Routines" section. In the formatted output from the IPCS VERBEXIT LEDATA 'STACK' subcommand for a system dump, the DSAs can be found in the "DSA backchain" section.

**Note:** Some functions do not save all registers.

4. Add the register value to the offset of the parameter to obtain the address of the parameter. In the Language Environment dump, the contents of the parameter can be read in the DSA Frame section corresponding to the function that passed the parameter. For a system dump, use the IPCS LIST subcommand to display the storage where the parameter is located.

The address for parameter `pp` is X'1082FF080' + X'980' = X'1082FFA00'.

**Steps for finding members of aggregates**

You can define aggregates in any of the storage classes or pass them as parameters to a called function. The first step is to find the start of the aggregate. You can compute the start of the aggregate as described in previous sections, depending on the type of aggregate used.
The aggregate map provided for each declaration in a routine can further assist in finding the offset of a specific variable within an aggregate. Structure maps are generated using the AGGREGATE compiler option. Figure 233 shows an example of an aggregate.

typedef struct {
  int asid;
  void *addr;
  asfAmodeType amode;
} asfTargetRef;
asfTargetRef tempTargetRef;

Figure 233. Example code for structure variables (AMODE 64)

Figure 234 shows an example of aggregate map.

---

To find the value of variable tempTargetRef.addr:

1. Locate the automatic variable tempTargetRef in the storage offset listing:

```c
typedef struct {
  int asid;
  void *addr;
  asfAmodeType amode;
} asfTargetRef;
asfTargetRef tempTargetRef;
```

```
Figure 233. Example code for structure variables (AMODE 64)
```

---

<table>
<thead>
<tr>
<th>Aggregate map for: struct with no tag #68 Total size: 24 bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>asfTargetRef</td>
</tr>
<tr>
<td>Offset Bytes(Bits)</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>16</td>
</tr>
<tr>
<td>17</td>
</tr>
</tbody>
</table>

---

Figure 234. Example of aggregate map (AMODE 64)

To find the value of variable tempTargetRef.addr:

1. Locate the automatic variable tempTargetRef in the storage offset listing:

```
typedef struct {
  int asid;
  void *addr;
  asfAmodeType amode;
} asfTargetRef;
asfTargetRef tempTargetRef;
```

```
Figure 233. Example code for structure variables (AMODE 64)
```

---

The variable tempTargetRef is located at register 4 + 2264 (X'8D8'). For this example, assume that the register 4 value is X'1082FD3E0'. The result is X'1082FDCC8'(X'1082FD3E0' + X'8D8'). This is the address of the value of the automatic variable tempTargetRef in the dump

2. Find the offset of addr in the Aggregate Map, shown in Figure Figure 234. The offset is 8. Add the offset from the Aggregate Map to the address of the tempTargetRef variable.

The result is X'1082FDCC0' (X'1082FDCC8' + X'8'). This is the address of the value of tempTargetRef.addr in the dump

---

Generating a Language Environment dump of a C/C++ routine

You can use the cdump(), csnap(), and ctrace() C/C++ functions to generate a Language Environment dump of C/C++ routines.
cdump()

If your routine is running under z/OS, you can generate useful diagnostic information by using the cdump() function. cdump() produces a main storage dump with the activation stack. When cdump() is invoked from a user routine, the C/C++ library issues an OS IEATDUMP macro to obtain a dump of virtual storage. You can use the Interactive Problem Control System (IPCS) to format and analyze IEATDUMP dumps.

The DD definition for CEESNAP must include the desired data set name and DCB information:

LRECL=4160, BLKSIZE=4160, and RECFM=FBS

If the data set is not defined, or is not usable for any reason, cdump() returns a failure code of 1. This occurs even if the call to CEE3DMP is successful.

Because cdump() returns a code of 0 only if the IEATDUMP was successful or 1 if it was unsuccessful, you cannot distinguish whether a failure of cdump() occurred in the call to CEE3DMP or IEATDUMP. A return code of 0 is issued only if both IEATDUMP and CEE3DMP are successful.

Support for IEATDUMP dumps using the _cdump function is provided only under z/OS. In addition to a IEATDUMP dump, a Language Environment formatted dump is also taken.

csnap()

The csnap() function produces a condensed storage dump. To use these functions, you must add #include <ctest.h> to your C/C++ code. The dump is directed to output dumpname, which is specified in a //CEEDUMP DD statement in JCL.

See the z/OS XL C/C++ Runtime Library Reference for more details about the syntax of these functions.

ctrace()

The ctrace() function produces a traceback and includes the offset addresses from which the calls were made.

Sample C routine that calls cdump()  
Figure 235 on page 462 shows a sample C routine that uses the cdump function to generate a dump. Figure 241 on page 465 shows the dump output.
```c
#include <stdio.h>
#include <signal.h>
#include <stdlib.h>

void hsigfpe(int);
void hsigterm(int);
void atf1(void);

typedef int (*FuncPtr_T)(void);

int st1 = 99;
int st2 = 255;
int xcount = 0;

int main(void) {
    /*
     * 1) Open multiple files
     * 2) Register 2 signals
     * 3) Register 1 atexit function
     * 4) Fetch and execute a module
     */
    FuncPtr_T fetchPtr;
    FILE* fp1;
    FILE* fp2;
    int rc;
    fp1 = fopen("myfile.data", "w");
    if (!fp1) {
        perror("Could not open myfile.data for write");
        exit(101);
    }
    fprintf(fp1, "record 1\n");
    fprintf(fp1, "record 2\n");
    fprintf(fp1, "record 3\n");
    fp2 = fopen("memory.data", "wb,type=memory");
    if (!fp2) {
        perror("Could not open memory.data for write");
        exit(102);
    }
    fprintf(fp2, "some data\n");
    fprintf(fp2, "some more data\n");
    fprintf(fp2, "even more data\n");
    signal(SIGFPE, hsigfpe);
    signal(SIGTERM, hsigterm);
    rc = atexit(atf1);
    if (rc) {
        fprintf(stderr, "Failed on registration of atexit function atf1\n");
        exit(103);
    }
    fetchPtr = (FuncPtr_T) fetch("MODULE1");
    if (!fetchPtr) {
        fprintf(stderr, "Failed to fetch MODULE1\n");
        exit(104);
    }
    fetchPtr();
    return(0);
}
```

Figure 235. Example C routine using cdump() to generate a dump (AMODE 64) (Part 1 of 2)
void hsigfpe(int sig) {
  ++st1;
  return;
}

void hsigterm(int sig) {
  ++st2;
  return;
}

void atf1() {
  ++xcount;
}

Figure 236. Example C routine using cdump() to generate a dump (AMODE 64) (Part 2 of 2)

#include <ctest.h>
#pragma linkage(func1, fetchable)
int func1(void) {
  __cdump("This is a sample dump");
  return(0);
}

Figure 237. Fetched module for C routine (AMODE 64)

Sample C++ routine that generates a Language Environment dump

#include <iostream.h>
#include <ctest.h>
#include "stack.h"

int main() {
  cout << "Program starting:\n";
  cerr << "Error report:\n";
  Stack<int> x;
  x.push(1);
  cout << "Top value on stack : " << x.pop() << '\n';
  cout << "Next value on stack: " << x.pop() << '\n';
  return(0);
}

Figure 238. Example C++ routine with protection exception generating a dump (AMODE 64)

Figure 239 on page 464 shows the template file stack.c
Figure 240 shows the header file stack.h.

```
#ifndef __STACK__
#include "stack.h"
#endif

template <class T> T Stack<T>::pop() { 
  T value = head->value;
  head = head->next;
  return(value);
}
template <class T> void Stack<T>::push(T value) { 
  Node* newNode = new Node;
  newNode->value = value;
  newNode->next = head;
  head = newNode;
}
```

Figure 239. Template file STACK.C (AMODE 64)

#pragma once

```
#ifndef __STACK__
#define __STACK__
template <class T> class Stack {
  public:
    Stack() { 
      char* badPtr = 0; badPtr -= (0x01010101); 
      head = (Node*) badPtr; /* head initialized to 0xFEFEFEFF */ 
    }
    T pop();
    void push(T);
  private:
    struct Node { 
      T value;
      struct Node* next;
    }* head;
};
#endif
```

Figure 240. Header file STACK.H (AMODE 64)

Sample Language Environment dump with C/C++-specific information

This sample dump was produced by compiling the routines shown in Figure 235 on page 462 and Figure 237 on page 463. They were both compiled using options LP64 and GONUM to produce statement numbers in the CEEDUMP. Notice the sequence of calls in the traceback section - CELQINIT is the Language Environment module that invokes the main entry. main calls fetchPtr() at statement number 60, which in turn, through @@FECBMODU1 fetches the user-defined function func1 shown in Figure 237 on page 463. func1 calls the library routine __cdump() in statement number 5. The complete program unit names for main and func1 are shown in the Fully Qualified Names section along with its load module name.
Information for enclave main

Information for thread 25AC528000000000

Traceback:

<table>
<thead>
<tr>
<th>DSA</th>
<th>E Offsets</th>
<th>Statement</th>
<th>Load Mod</th>
<th>Program Unit</th>
<th>Service Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000001</td>
<td>__cdump +00000000</td>
<td>CELQLIB</td>
<td>HLE7730</td>
<td>Call</td>
<td></td>
</tr>
<tr>
<td>00000002</td>
<td>Func1 +00000000</td>
<td>CELQLIB</td>
<td>func1.c</td>
<td>Call</td>
<td></td>
</tr>
<tr>
<td>00000003</td>
<td>@FECMODU1</td>
<td></td>
<td></td>
<td>Call</td>
<td></td>
</tr>
<tr>
<td>00000004</td>
<td>main +00000000</td>
<td>FIG142</td>
<td>Call</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00000005</td>
<td>CELQINIT +00000000</td>
<td>CELQLIB</td>
<td>CELQINIT</td>
<td>Call</td>
<td></td>
</tr>
</tbody>
</table>

DSA DSA Addr E Addr PU Addr PU Offset Comp Date Attributes

<table>
<thead>
<tr>
<th>DSA</th>
<th>DSA Addr</th>
<th>E Addr</th>
<th>PU Addr</th>
<th>PU Offset</th>
<th>Comp Date Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000001</td>
<td>00000000025007E0</td>
<td>0000000025C1FFE0</td>
<td>0000000000000000</td>
<td>********</td>
<td>20060111 XPLINK EBCDIC POSIX IEEE</td>
</tr>
<tr>
<td>00000002</td>
<td>0000000002500B00</td>
<td>0000000025D8A0D0</td>
<td>0000000000000000</td>
<td>********</td>
<td>20060222 XPLINK EBCDIC POSIX IEEE</td>
</tr>
<tr>
<td>00000003</td>
<td>0000000002500080</td>
<td>0000000025D8D058</td>
<td>0000000025D8D048</td>
<td>XPLINK EBCDIC POSIX Floating Point</td>
<td></td>
</tr>
<tr>
<td>00000004</td>
<td>0000000002500080</td>
<td>00000000257000D0</td>
<td>0000000000000000</td>
<td>********</td>
<td>20060222 XPLINK EBCDIC POSIX IEEE</td>
</tr>
<tr>
<td>00000005</td>
<td>0000000002500080</td>
<td>0000000025703010</td>
<td>000000010000134C</td>
<td>20060111 XPLINK EBCDIC POSIX Floating Point</td>
<td></td>
</tr>
</tbody>
</table>

 fuller Qualified Names

<table>
<thead>
<tr>
<th>DSA</th>
<th>Entry</th>
<th>Program Unit</th>
<th>Load Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000002</td>
<td>func1</td>
<td>AQMVSOE:/u/alfcar/tools/func1.c</td>
<td>MODULE1</td>
</tr>
<tr>
<td>00000004</td>
<td>main</td>
<td>PLPSC://POSIX.CRTL.C(FIG142)</td>
<td>CSAMPLE</td>
</tr>
</tbody>
</table>

Control Blocks for Active Routines:

DSA for __cdump: 00000001082FEDC0

<table>
<thead>
<tr>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>R7</th>
<th>R8</th>
<th>R9</th>
<th>R10</th>
<th>R11</th>
<th>R12</th>
<th>R13</th>
<th>R14</th>
<th>R15</th>
<th>Reserved</th>
<th>Reserved</th>
<th>HPTRAN...</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000001082FEDC0</td>
<td>00000001082FEF00</td>
<td>0000000025D77E10</td>
<td>R4...</td>
<td>R5...</td>
<td>R6...</td>
<td>R7...</td>
<td>R8...</td>
<td>R9...</td>
<td>R10...</td>
<td>R11...</td>
<td>R12...</td>
<td>Reserved</td>
<td>Reserved</td>
<td>HPTRAN...</td>
</tr>
</tbody>
</table>

DSA for Func1: 00000001082FF700

<table>
<thead>
<tr>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>R7</th>
<th>R8</th>
<th>R9</th>
<th>R10</th>
<th>R11</th>
<th>R12</th>
<th>R13</th>
<th>R14</th>
<th>R15</th>
<th>Reserved</th>
<th>Reserved</th>
<th>HPTRAN...</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000001082FEDC0</td>
<td>00000001082FEF00</td>
<td>0000000025D77E10</td>
<td>R4...</td>
<td>R5...</td>
<td>R6...</td>
<td>R7...</td>
<td>R8...</td>
<td>R9...</td>
<td>R10...</td>
<td>R11...</td>
<td>R12...</td>
<td>Reserved</td>
<td>Reserved</td>
<td>HPTRAN...</td>
</tr>
</tbody>
</table>

DSA for CELQINIT: 00000001082FFA80

<table>
<thead>
<tr>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>R7</th>
<th>R8</th>
<th>R9</th>
<th>R10</th>
<th>R11</th>
<th>R12</th>
<th>R13</th>
<th>R14</th>
<th>R15</th>
<th>Reserved</th>
<th>Reserved</th>
<th>HPTRAN...</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000001082FEDC0</td>
<td>00000001082FEF00</td>
<td>0000000025D77E10</td>
<td>R4...</td>
<td>R5...</td>
<td>R6...</td>
<td>R7...</td>
<td>R8...</td>
<td>R9...</td>
<td>R10...</td>
<td>R11...</td>
<td>R12...</td>
<td>Reserved</td>
<td>Reserved</td>
<td>HPTRAN...</td>
</tr>
</tbody>
</table>

Storage for Active Routines:

DSA frame(00000001082FEDC0)

<table>
<thead>
<tr>
<th>800</th>
<th>801</th>
<th>802</th>
<th>803</th>
<th>804</th>
<th>805</th>
<th>806</th>
<th>807</th>
<th>808</th>
<th>809</th>
<th>810</th>
<th>811</th>
<th>812</th>
<th>813</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000001082FEDC0</td>
<td>00000001082FF00</td>
<td>0000000025D7E10</td>
<td>R4...</td>
<td>R5...</td>
<td>R6...</td>
<td>R7...</td>
<td>R8...</td>
<td>R9...</td>
<td>R10...</td>
<td>R11...</td>
<td>R12...</td>
<td>Reserved</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

Figure 241. Example dump from sample C routine (AMODE 64) (Part 1 of 4)
This is a sample dump.

Figure 242. Example dump from sample C routine (AMODE 64) (Part 2 of 4)
Figure 243. Example dump from sample C routine (AMODE 64) (Part 3 of 4)

Control Blocks Associated with the Thread:

<table>
<thead>
<tr>
<th>Address</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
</tbody>
</table>

MATH PARAMETERS: (0000000258282AD0)

<table>
<thead>
<tr>
<th>Address</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
</tbody>
</table>

Thread Synchronization Queue Element (SQEL)(0000000258282B0E)

<table>
<thead>
<tr>
<th>Address</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
</tbody>
</table>

DUMMY DSA: 00000001082FF68

<table>
<thead>
<tr>
<th>Address</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
<tr>
<td>0080000000000000</td>
<td>...</td>
</tr>
</tbody>
</table>

Registers on Entry to CEE3DMP:

<table>
<thead>
<tr>
<th>Register</th>
<th>Address</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR0.....</td>
<td>0000000000000000</td>
<td>...</td>
</tr>
<tr>
<td>PR1.....</td>
<td>0000000000000000</td>
<td>...</td>
</tr>
<tr>
<td>PR2.....</td>
<td>0000000000000000</td>
<td>...</td>
</tr>
<tr>
<td>PR3.....</td>
<td>0000000000000000</td>
<td>...</td>
</tr>
<tr>
<td>PR4.....</td>
<td>0000000000000000</td>
<td>...</td>
</tr>
<tr>
<td>PR5.....</td>
<td>0000000000000000</td>
<td>...</td>
</tr>
<tr>
<td>PR6.....</td>
<td>0000000000000000</td>
<td>...</td>
</tr>
<tr>
<td>PR7.....</td>
<td>0000000000000000</td>
<td>...</td>
</tr>
<tr>
<td>PR8.....</td>
<td>0000000000000000</td>
<td>...</td>
</tr>
<tr>
<td>PR9.....</td>
<td>0000000000000000</td>
<td>...</td>
</tr>
</tbody>
</table>

Chapter 13. Debugging AMODE 64 C/C++ routines
Figure 244. Example dump from sample C routine (AMODE 64) (Part 4 of 4)
C/C++ contents of the Language Environment trace tables

Language Environment provides C/C++ trace table entry types 5 and 6, which contain character data.

Trace entry 5 occurs when a C library function is called. The format for trace table entry 5 is:

```
NameOfCallingFunction
--> (xxx) NameOfCalledFunction<(input_parameters)>
```

or, for called functions calloc, free, malloc, and realloc:

```
NameOfCallingFunction
--> (xxx) NameOfCalledFunction<(input_parameters)>
```

In addition, when the call is due to one of these C++ operators:

- `new`,
- `new[]`,
- `delete`,
- `delete[]`

then the C++ operator will appear and the format becomes:

```
NameOfCallingFunction
--> (xxx) NameOfCalledFunction<(input_parameters)>

NameOfC++Operator
```

The `input_parameters` and `NameOfC++Operator` only appear for the appropriate functions. The angle brackets (<>) indicate that this information does not always appear.

Trace entry 6 occurs when a C library function returns. The format for trace table entry 6 is:

```
<-- (xxx)
R1=xxxxxxxxxxxxxxxx R2=xxxxxxxxxxxxxxxx R3=xxxxxxxxxxxxxxxx
ERRNO=xxxxxxxxx ERRNO2=xxxxxxxx
```

In the entry types, (xxx) and (xxxx) are numbers associated with the called library function and are used to associate a specific entry record with its corresponding return record.

For entry types 5 and 6, the number will be the same as the number of the function as seen in the C runtime library definition side-deck, SCEELIB dataset member CELQS003, on the IMPORT statement for that function.

Figure 245 on page 470 shows an XPLINK trace that contains examples of the trace entries 5 and 6. For more information about the Language Environment trace table format, see “Understanding the trace table entry (TTE)” on page 439.
Language Environment Trace Table:

Most recent trace entry is at displacement: 000680

<table>
<thead>
<tr>
<th>Displacement</th>
<th>Trace Entry in Hexadecimal</th>
<th>Trace Entry in EBCDIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>+000000</td>
<td>Time 21.58.20.255216</td>
<td>filebuf::overflow(int)</td>
</tr>
<tr>
<td>+00010</td>
<td>Member ID: 03 Flags: 000000 Entry Type: 80000005</td>
<td></td>
</tr>
<tr>
<td>+0001B</td>
<td>86893835 824A867A 79A6585 99B69396 A640B999 A35D4040 40404040 40404040</td>
<td></td>
</tr>
<tr>
<td>+0003B</td>
<td>06060640 F0F1F5F6 5D406D60 85999995 96404040 40404040 40404040 40404040</td>
<td></td>
</tr>
<tr>
<td>+0005B</td>
<td>40404040 40404040 40404040 40404040 40404040 40404040 40404040 40404040</td>
<td></td>
</tr>
<tr>
<td>+0007B</td>
<td>40404040 40404040 40404040 40404040 40404040 40404040 40404040 40404040</td>
<td></td>
</tr>
<tr>
<td>+00080</td>
<td>Time 21.58.20.255216</td>
<td>filebuf::overflow(int)</td>
</tr>
<tr>
<td>+00090</td>
<td>Member ID: 03 Flags: 000000 Entry Type: 80000006</td>
<td></td>
</tr>
<tr>
<td>+000B8</td>
<td>7EF0F0F0 F0F0F0F0 F0F2F5F5 F2CF28C2 F840F9F3 7EF0F0F0 F0F0F0F0 F0F0F0F0</td>
<td></td>
</tr>
<tr>
<td>+000B8</td>
<td>86893835 7F4D5D40 40404040 40404040 40404040 40404040 40404040 40404040</td>
<td></td>
</tr>
<tr>
<td>+000F8</td>
<td>40404040 00000000 00000000 00000000 00000000 00000000 00000000 00000000</td>
<td></td>
</tr>
</tbody>
</table>

Figure 245. Trace table with XPLINK trace table entries 5 and 6 (AMODE 64)
Debugging examples of C/C++ routines

This section contains examples that demonstrate the debugging process for C/C++ routines. Important areas of the output are highlighted. Data unnecessary to the debugging examples has been replaced by ellipses.

Divide-by-zero error

The code was compiled with RENT so static and external variables need to be calculated from the WSA field. The code was compiled with LP64, GONUM (to produce statement numbers) and XREF, LIST and OFFSET to generate a listing, which is used to calculate addresses of functions and data. The code was processed by the binder with MAP to generate a binder map, which is used to calculate the addresses of static and external variables. The program was created with the option TERMTHDACT(UADUMP) which produced both a Language environment dump and a system dump.

Figure 246. Trace table with XPLINK trace table entries 5 and 6 (AMODE 64)
To debug this routine, use the following steps:

1. Locate the Original Condition message in the Condition Information for Active Routines section of the dump. In this example, the message is CEE3209S. The system detected a fixed-point divide exception. This message indicates the error was caused by an attempt to divide by zero. For additional information about CEE3209S, see z/OS Language Environment Runtime Messages.

The traceback section of the dump indicates that the exception occurred at offset X’52’ within function funcb. This information is used along with the compiler-generated Pseudo Assembly Listing to determine where the problem occurred.

If the GONUMBER compiler option is specified, statement number information is in the dump. Figure 248 on page 473 shows the generated traceback from the dump.

```c
/* C Routine with a Divide-by-Zero Error */
#pragma options(noinline)
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
int statint = 73;
int fa;
int funcb(int *pp);
int main(void) {
    int aa, bb=1;
    aa = bb;
    aa = funcb(&aa);
    return(aa);}
int funcb(int *pp) {
    int result;
    fa = *pp;
    result = fa/(statint-73);
    printf("Result = %d\n",result);
    return result;}
```

Figure 247. C routine with a divide-by-zero error (AMODE 64)
Figure 248. Sections of the dump from example C/C++ routine (AMODE 64) (Part 1 of 2)
2. In the traceback, statement number 12, corresponding to DSA 7, refers to line:
   \[ aa = \text{funcb}(\&aa); \]
in the listing. This is where entry funcb is called. Similarly, statement number 18, corresponding to DSA 6, points to line:
   \[ \text{result} = \frac{fa}{(\text{statint}-73)}; \]
in the listing. This line is where the divide by zero exception takes place.

3. Locate the instruction with the divide-by-zero error in the Pseudo Assembly Listing in Figure 250 on page 475.

The offset (within funcb) of the exception from the traceback (X'52') reveals the divide instruction: DR R6,R0 at that location. Instructions at offsets X'32' through X'58' refer to the result = \( \frac{fa}{(\text{statint}-73)} \); line of the C/C++ routine.
OFFSET OBJECT CODE  |  FILE#  |  PSEUDO ASSEMBLY LISTING
--- | --- | ---
000010  F2F0  F0F6  |  =C'2006'  |  Compiled Year
000014  F0F2  F2F1  |  =C'0221'  |  Compiled Date MMDD
000018  F1F5  F3F3  F3F5  |  =C'153315'  |  Compiled Time HMMSS
00001E  F0F1  F0F8  F0F0  |  =C'010800'  |  Compiler Version

Timestamp and Version End

15694A01 V1.8 z/OS XL C  |  'POSIX.CRTL.C(ODIVZERO)': funcb  |  02/21/06 15:33:15  |  Page 148

OFFSET OBJECT CODE  |  FILE#  |  PSEUDO ASSEMBLY LISTING
--- | --- | ---
000028  |  02L8  |  DS 00
00002B  00C3DC05  |  =f'12779717'  |  XPLink entrypoint marker
00002C  00C500F1  |  =f'12910833'  |  
000030  0000010B  |  =f'264'  |  
000034  00000100  |  =f'256'  |  
000000  000015  |  funcb  |  DS 00
000000  E859  4708  0024  000015  |  STMF r5,r9,1800(r4)
000006  A748  F000  000015  |  AGHI r4,H'-256'
00000A  |  Start of Prolog
00000A  C090  0000  006F  000000  |  LARL r3,F'111'
000010  E310  49B0  0024  000015  |  STG r1,pp,(r4,2432)
000016  000017  |  int result;
000016  000017  |  fa = *pp;
000016  E360  4980  0004  000017  |  LG r6,pp,(r4,2432)
00001C  E380  6800  0014  000017  |  LG r0,(r)int,(r6,0)
000022  E360  4808  0004  000017  |  LG r6,#Save_ADA_Ptr_2,(r4,2056)
000028  E380  6800  0004  000017  |  LG r6,-A(fa),(r6,0)
00002E  5000  6000  000017  |  ST r0,fa,(r6,0)
000032  E360  6000  0014  000018  |  result = fa/(statint-73);
000038  E370  4808  0004  000018  |  LG r7,#Save_ADA_Ptr_2,(r4,2056)
00003E  E370  7008  0004  000018  |  LG r7,-A(statint),(r7,8)
000044  E300  7000  0014  000018  |  LGF r0,statint,(r7,0)
00004A  A708  FFB7  000018  |  AGHI r0,H'-73'
00004E  B6E0  0020  000018  |  SIGA r6,32
000052  B6E0  0008  000018  |  DR r6,r0
000054  B904  0087  000018  |  LGR r0,r7
000058  5000  48C0  000018  |  ST r0,result,(r4,2240)
00005C  E320  48C0  0014  000019  |  printf("Result = %d\n",result);
000062  E360  4808  0004  000019  |  LG r6,#Save_ADA_Ptr_2,(r4,2056)
000068  EB56  6010  0004  000019  |  LMG r5,r6,-A(printf),(r6,16)
00006E  9004  0019  000019  |  LGR r1,r9
000072  0076  000019  |  BASR r7,r6
000074  0700  000019  |  NOPR 0
000076  E330  48C0  0014  000020  |  return result;
000077  000021  |  
00007C  000021  02L8  DS 00

Start of Epilog

00007C  E370  4818  0004  000021  |  LG r7,2072,(r4)
000082  E889  4820  0004  000021  |  LMG r5,r7,20800,(r4)
000088  4140  4100  000021  |  LA r4,236,(r4)
00008C  47F0  7002  000021  |  B 2,(r7)

Figure 250. Pseudo assembly listing (AMODE 64) (Part 1 of 3)
```
/* C Routine with a Divide-by-Zero Error from LE Debugging Guide */
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
int statint = 73;
int fa;
int funcb(int *pp);

int main(void)
{
  int aa, bb = 1;

  STMG r5, r7, 1800(r4)
  AGHI r4, H'12779717'
  =F'12910833'

  A748 FF00
  LA r1, aa(, r4, 2240)
  LG r5, #Save_ADA_Ptr_1(, r4, 2056)
  BRAS r7, funcb
  NOPR 1
  LGR r0, r3

  ST r0, aa(, r4, 2240)

  return(aa);
}
```

Figure 251. Pseudo assembly listing (AMODE 64) (Part 2 of 3)
4. Verify the value of the divisor statint. The procedure specified below is to be used for determining the value of static variables only. If the divisor is an automatic variable, there is a different procedure for finding the value of the variable.

   Because this routine was compiled with the RENT option, find the WSA address in the Enclave Control Blocks section of the dump. In this example, this address is X'108300050'. Figure 253 shows the WSA address.

   Figure 253. C/C++ CAA information in dump (AMODE 64)

5. Routines compiled with the RENT option must also be processed by the binder. The binder produces the Writable Static Map. Find the offset of statint in the Writable Static Map in Figure 254 on page 478. In this example, the offset is X'30'.
6. Add the WSA address of X'108300050' to the offset of statint. The result is X'108300080'. This is the address of the variable statint, which is in the writable static area.

7. Use IPCS to display the writeable static area in the system dump. The value at location X'108300080' is X'49' (that is, statint is 73), and hence the fixed-point divide exception.

---

**Figure 254. Writable static map (AMODE 64)**

---

**Figure 255. IPCS storage display of the writeable static area (AMODE 64)**

### Calling a nonexistent function

[Figure 256 on page 479](#) demonstrates the error of calling a nonexistent function. This routine was compiled with the compiler options LP64, GONUM, LIST, OFFSET, and RENT and was run with the option TERMTHDACT(UADUMP).
To debug this routine, use the following steps:

1. Locate the Original Condition message in the Condition Information for Active Routines section of the dump, shown in Figure 257 on page 480. In this example, the message is CEE3201S The system detected an operation exception (System Completion Code=0C1). This message suggests that the error was caused by an attempt to branch to an unknown address. For additional information about CEE3201S, see z/OS Language Environment Runtime Messages.

The Location section of the dump indicates that the exception occurred at offset X'-209000D0'' within function funca and that there may have been a bad branch from statement 17 offset X'+00000036'' within function funca. The negative offset indicates that the offset cannot be used to locate the instruction that caused the error. Another indication of bad data is the value of X'00000002' in the instruction address of the PSW shown in the Condition Information section. This address indicates that an instruction in the routine branched outside the bounds of the routine.

In the traceback, the statement number displayed for entry 'main' points to line 12 in the source code shown in Figure 256. This line contains the statement "funca(&aa);" in which entry 'funca' is called. As message CEE3841I explains, for entry 'funca' no statement number could be displayed. In this example, this problem is caused because 'funca' has an invalid offset. For further information about this message see z/OS Language Environment Runtime Messages.

/* C/C++ Example of Calling a Nonexistent Subroutine */
/* from LE Debugging Guide */
#pragma options(noinline)
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
#include <signal.h>
void funca(int* aa);
int (*func_ptr)(void)=0;

int main(void) {
  int aa;
  funca(&aa);
  printf("result of funca = %d\n",aa);
  return;
}

void funca(int* aa) {
  *aa = func_ptr();
  return;
}

Figure 256. C/C++ example of calling a nonexistent subroutine (AMODE 64)
Figure 257. Sections of the dump from example C routine (AMODE 64) (Part 1 of 3)
Figure 258. Sections of the dump from example C routine (AMODE 64) (Part 2 of 3)
2. Find the branch instructions for \texttt{funca} in the listing in Figure 260. Notice the \texttt{BASR r7,r6} instruction at offset X'000036'. This branch is part of the instruction \texttt{aa=func_ptr();} in statement 17 in Figure 256 on page 479.
3. Find the offset of `func_ptr` in the Writable Static Map, shown in Figure 262.

4. Add the offset of `func_ptr` (X'40') to the address of WSA (X'108300050') (the WSA address was obtained from the dump report in Figure 260 on page 482). The result (X'108300090') is the address of the function pointer `func_ptr` in the writable static storage area. This value is 0, indicating the variable is uninitialized. Figure 263 on page 484 shows the sections of the dump.
Handling dumps written to the z/OS UNIX file system

When a z/OS UNIX C/C++ application program is running in an address space created as a result of a call to spawn(), vfork(), or one of the exec family of functions, the SYSMDUMP DD allocation information is not inherited. Even though the SYSMDUMP allocation is not inherited, a SYSMDUMP allocation must exist in the parent in order to obtain a HFS storage dump. If the program terminates abnormally while running in this new address space, the kernel causes an unformatted storage dump to be written to an HFS file in the user's working directory. The file is placed in the current working directory or into /tmp if the current working directory is not defined. The file name has the following format:

```plaintext
/directory/coredump.pid
```

where directory is the current working directory or tmp, and pid is the hexadecimal process ID (PID) for the process that terminated. For details on how to generate the system dump, see “Steps for generating a system dump in a z/OS UNIX shell” on page 379.

To debug the dump, use the Interactive Problem Control System (IPCS). If the dump was written to an HFS file, you must allocate a data set that is large enough and has the correct attributes for receiving a copy of the HFS file. For example, from the ISPF DATA SET UTILITY panel you can specify a volume serial and data set name to allocate. Doing so brings up the DATA SET INFORMATION panel for specifying characteristics of the data set to be allocated.

Figure 264 on page 485 is a sample filled-in panel that shows the characteristics defined for the URCOMPJRUSL.COREDUMP dump data set. Fill in the information for your data set as shown, and estimate the number of cylinders required for the dump file you are going to copy.
Use the TSO/E OGET or OCOPY command with the BINARY keyword to copy the file into the data set. For example, to copy the HFS memory dump file coredump.00060007 into the data set URCOMP.JRUSL.COREDUMP just allocated, a user with the user ID URCOMP enters the following command:

```
OGET '/u/urcomp/coredump.00060007' 'urcomp.jrusl.coredump' BINARY
```

For more information on using the copy commands, see z/OS UNIX System Services User's Guide.

After you have copied the memory dump file to the data set, you can use IPCS to analyze the dump. See “Formatting and analyzing system dumps” on page 380 for information about formatting Language Environment control blocks.

**Multithreading consideration**

Certain control blocks are locked while a dump is in progress. For example, a csnap() of the file control block would prevent another thread from using or dumping the same information. An attempt to do so causes the second thread to wait until the first one completes before it can continue.

**Understanding C/C++ heap information in storage reports**

Storage reports that contain specific C/C++ heap information can be generated in two ways; details on how to request and interpret the reports are provided in the following sections.

- By setting the Language Environment RPTSTG(ON) runtime option for Language Environment created heaps
- By issuing a stand-alone call to the C function __uheapreport() for user-created heaps.

**Language Environment storage report with heap pools statistics**

To request a Language Environment storage report set RPTSTG(ON). If the C/C++ application specified the HEAPPOLLS(ON) or HEAPPOLLS64(ON) runtime option, the storage report displays heap pools statistics. For a sample storage
HEAPPOOLS64 storage statistics
The HEAPPOOLS64 runtime option controls usage of the heap pools storage algorithm at the enclave level. The heap pools algorithm allows for the definition of one to twelve heap pools, each consisting of a number of storage cells of a specified length.

Note: The use of an alternative vendor heap manager (VHM) overrides the use of the HEAPPOOLS64 runtime option.

HEAPPOOLS64 statistics:
- Pool p size: ssss Get requests: gggg
  - p number of the pool. When there are multiple pools for a cell size, the pools are numbered using the format aa.bbb
  - aa number for the cell size
  - bbb number for the pool within the cell size
- ssss cell size specified for the pool
- gggg number of storage requests that were satisfied from this pool
- Successful Get Heap requests: xxxxyyyyy n
  - xxxx low side of the 8 byte range
  - yyyy high side of the 8 byte range
  - n number of requests in the 8 byte range
- Requests greater than the largest cell size — the number of storage requests that are not satisfied by heap pools.

Note: Values displayed in the HEAPPOOLS64 statistics report are not serialized when collected; therefore, the values are not necessarily exact.

HEAPPOOLS64 summary: The HEAPPOOLS64 summary displays a report of the HEAPPOOLS64 statistics and provides suggested cell sizes.

Specified Cell Size
- the size of the cell specified in the HEAPPOOLS64 runtime option

Element Size
- the size of the cell plus any additional storage needed for control information or to maintain alignment

Cells Per Extent
- the cell pool count specified by the HEAPPOOLS64 runtime option. When there is more than one pool for a cell size, the count is divided by the number of pools.

Extents Allocated
- the number of times that each pool allocated an extent in order to optimize storage usage. The extents allocated needs to be either one or two. If the number of extents allocated is too high, increase the cell count for the pool.

Maximum Cells Used
- the maximum number of cells used for each pool.
Cells In Use
the number of cells that were never freed. A large number in this field could indicate a storage leak.

Suggested Cell Sizes
sizes that are calculated to optimally use storage (assuming that the application will __malloc/__free with the same frequency). The suggested cell sizes are given with no cell counts because the usage of each new cell pool size is not known. If there are less than 12 cell sizes calculated, then the last pool size is set at 65536.

For more information about stack and heap storage for AMODE64 applications, see z/OS Language Environment Programming Guide for 64-bit Virtual Addressing Mode.

HEAPPOOLS storage statistics
The HEAPPOOLS runtime option controls usage of the heap pools storage algorithm at the enclave level. The heap pools algorithm allows for the definition of one to twelve heap pools, each consisting of a number of storage cells of a specified length. HEAPPOOLS runtime option can be used by AMODE 64 applications to manage user heap storage above the 16MB line and below the 2GB bar.

Note: The use of an alternative Vendor Heap Manager (VHM) overrides the use of the HEAPPOOLS runtime option.

HEAPPOOLS statistics:
• Pool p size: ssss Get requests: gggg
  p number of the pool. When there are multiple pools for a cell size, the pools are numbered using the format aa.bbb
  aa number for the cell size
  bbb number for the pool within the cell size
  ssss cell size specified for the pool
  gggg number of storage requests that were satisfied from this pool
• Successful Get Heap requests: xxxx-yyyy n
  xxxx low side of the 8 byte range
  yyyy high side of the 8 byte range
  n number of requests in the 8 byte range
• Requests greater than the largest cell size — the number of storage requests that are not satisfied by heap pools.

Note: Values displayed in the HEAPPOOLS statistics report are not serialized when collected, therefore the values are not necessarily exact.

HEAPPOOLS summary: The HEAPPOOLS summary displays a report of the HEAPPOOLS statistics and provides suggested percentages for current cell sizes as well as suggested cell sizes.
• Specified Cell Size — the size of the cell specified in the HEAPPOOLS runtime option
• Element Size — the size of the cell plus any additional storage needed for control information or to maintain alignment
• Extent Percent — the cell pool percent specified by the HEAPPOOLS runtime option
• Cells Per Extent — the number of cells per extent. This number is calculated using the following formula, with a minimum of four cells:

\[
\text{Initial Heap Size} \times \frac{\text{Extent Percent}}{100} \div \text{Element Size}
\]

**Note:** Having a small number of cells per extent is not suggested because the pool can allocate many extents, which causes the HEAPPOOLS algorithm to perform inefficiently.

• Extents Allocated — the number of times that each pool allocated an extent.

To optimize storage usage, the extents allocated need to be either one or two. If the number of extents allocated is too high, increase the percentage for the pool.

• Maximum Cells Used — the maximum number of cells used for each pool.

• Cells In Use — the number of cells that were never freed.

A large number in this field can indicate a storage leak.

• Suggested Percentages for current Cell Sizes — percentages calculated to find the optimal size of the cell pool extent. The calculation is based on the following formula:

\[
\frac{\text{Maximum Cells Used} \times \text{Element Size} \times 100}{\text{Initial Heap Size}}
\]

With a minimum of 1% and a maximum of 90%

Make sure that your cell pool extents are neither too large nor too small. If your percentages are too large then additional, unreferenced virtual storage will be allocated, thereby causing the program to exhaust the region size. If the percentages are too small then the HEAPPOOLS algorithm will run inefficiently.

• Suggested Cell Sizes — sizes that are calculated to optimally use storage (assuming that the application will `malloc`/`free` with the same frequency).

**Note:** The suggested cell sizes are given with no percentages because the usage of each new cell pool size is not known. If there are less than 12 cell sizes calculated and the last calculated cell size is smaller than the largest cell size currently in effect, the largest cell size currently in effect is used for the last suggested cell size.


**C function __uheapreport() storage report**

To generate a user-created heap storage report use the C function, `__uheapreport()`. Use the information in the report to assist with tuning your application's use of the user-created heap.

User-created HeapPools statistics

- Pool _p_ size: _ssss_
  - _p_ — the number of the pool
  - _ssss_ — the cell size specified for the pool.

- Successful Get Heap requests: _xxxx-yyyy n_
  - _xxxx_ — the low side of the range
  - _yyyy_ — the high side of the range
  - _n_ — the number of requests in the range.

- Requests greater than the largest cell size — the number of storage requests that are not satisfied by heap pools.

Note: Values displayed in the HeapPools statistics report are not serialized when collected, therefore the values are not necessarily exact.

HeapPools summary

The HeapPools summary displays a report of the HeapPool statistics and provides suggested percentages for current cell sizes as well as suggested cell sizes. Figure 265 shows a sample storage report generated by __uheapreport().

- Cell Size — the size of the cell specified on the __ucreate() call
- Cells Per Extent — the cell pool count specified on the __ucreate() call
- Extents Allocated — the number of times that each pool allocated an extent in order to optimize storage usage.
- Maximum Cells Used — the maximum number of cells used for each pool.
- Cells In Use — the number of cells that were never freed.
  A large number in this field could indicate a storage leak.
- Suggested Cell Sizes — sizes that are calculated to optimally use storage (assuming that the application will __umalloc/__ufree with the same frequency).
The suggested cell sizes are given with no cell counts because the usage of each new cell pool size is not known. If there are less than 12 cell sizes calculated, then the last pool size is set at 65536.
Part 4. Appendixes
Appendix A. Diagnosing problems with Language Environment

This section provides information for diagnosing problems in the Language Environment product. It helps you determine if a correction for a product failure similar to yours has been previously documented. If the problem has not been previously reported, it tells you how to open a problem management record (PMR) to report the problem to IBM, and if the problem is with an IBM product, what documentation you need for an Authorized Program Analysis Report (APAR).

Diagnosis checklist

Step through each of the items in the diagnosis checklist below to see if they apply to your problem. The checklist is designed to either solve your problem or help you gather the diagnostic information required for determining the source of the error. It can also help you confirm that the suspected failure is not a user error; that is, it was not caused by incorrect usage of the Language Environment product or by an error in the logic of the routine.

1. If your failing application contains programs that were changed since they last ran successfully, review the output of the compile or assembly (listings) for any unresolved errors.

2. If there have not been any changes in your applications, check the output (job or console logs, CICS transient (CESE) queues) for any messages from the failing run.

3. Check the message prefix to identify the system or subsystem that issued the message. This can help you determine the cause of the problem. Following are some of the prefixes and their respective origins.

   EDC  The prefix for C/C++ messages. The following series of messages are from the C/C++ runtime component of Language Environment: 5000 (except for 5500, which are from the DSECT utility), 6000, and 7000.

   IGZ  The prefix for messages from the COBOL runtime component of Language Environment.

   FOR  The prefix for messages from the Fortran runtime component of Language Environment.

   IBM  The prefix for messages from the PL/I runtime component of Language Environment.

   CEE  The prefix for messages from the common runtime component of Language Environment.

4. For any messages received, check for recommendations in the “Programmer Response” sections of the messages in this information.

5. Verify that abends are caused by product failures and not by program errors. See the appropriate chapters in this manual for a list of Language Environment-related abend codes.

6. Your installation may have received an IBM Program Temporary Fix (PTF) for the problem. Verify that you have received all issued PTFs and have installed them, so that your installation is at the most current maintenance level.

7. The preventive service planning (PSP) bucket, an online database available to IBM customers through IBM service channels, gives information about
product installation problems and other problems. Check to see whether it contains information related to your problem.

8. Narrow the source of the error.
   - If a Language Environment dump is available, locate the traceback in the Language Environment dump for the source of the problem.
   - For AMODE 64 applications, IBM recommends that you use the IPCS Verbexit IEDATA with the CEEDUMP option to format the traceback. Check the traceback for the source of the problem. For information on how to generate and use a Language Environment or system dump to isolate the cause of the error, see Chapter 3, “Using Language Environment debugging facilities,” on page 37 or Chapter 12, “Using Language Environment AMODE 64 debugging facilities,” on page 361.
   - Alternatively, in a non-XPLINK environment, you can follow the save area chain to find out the name of the failing module and whether IBM owns it. For information on finding the routine name, see "Locating the name of the failing routine for a non-XPLINK application."

9. After you identify the failure, consider writing a small test case that re-creates the problem. The test case could help you determine whether the error is in a user routine or in the Language Environment product. Do not make the test case larger than 75 lines of code. The test case is not required, but it could expedite the process of finding the problem.
   If the error is not a Language Environment failure, see the diagnosis procedures for the product that failed.

10. Record the conditions and options in effect at the time the problem occurred. Compile your program with the appropriate options to obtain an assembler listing and data map. If possible, obtain the binder or linkage editor output listing. Note any changes from the previous successful compilation or run. For an explanation of compiler options, see the compiler-specific programming guide.

11. If you are experiencing a no-response problem, try to force a dump. For example, CANCEL the program with the dump option.

12. Record the sequence of events that led to the error condition and any related programs or files. It is also helpful to record the service level of the compiler associated with the failing program.

**Locating the name of the failing routine for a non-XPLINK application**

If a system dump is taken, follow the save area chain to find out the name of the failing routine and whether IBM owns it. Following are the procedures for locating the name of the failing routine, which is the primary entry point name.

1. Find the entry point associated with the current save area. The entry point address (EPA), located in the previous save area at displacement X'10', decimal 16, points to it.
2. Determine the entry point type, of which there are four:

<table>
<thead>
<tr>
<th>Entry point type is...</th>
<th>If...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Environment conforming</td>
<td>The entry point plus 4 is X'00C3C5C5'.</td>
</tr>
<tr>
<td>Language Environment conforming OPLINK</td>
<td>The entry point plus 4 is X'01C3C5C5'. OPLINK linkage conventions are used.</td>
</tr>
<tr>
<td>C/C++</td>
<td>The entry point plus 5 is X'CE'.</td>
</tr>
</tbody>
</table>
For routines with Language Environment-conforming and C/C++ entry points, Language Environment provides program prolog areas (PPAs). PPA1 contains the entry point name and the address of the PPA2; PPA2 contains pointers to the timestamp, where release level keyword information is found, and to the PPA1 associated with the primary entry point of the routine.

- If the entry point type of the failing routine is Language Environment-conforming, go to step 3.
- If the entry point type is C/C++, go to step 5.
- If the entry point type is nonconforming, go to step 6 on page 496.

3. If the entry point type is Language Environment-conforming, find the entry point name for the Language Environment or COBOL program.
   
   a. Use an offset of X'C' from the entry point to locate the address of the PPA1.
   b. In the PPA1, locate the offset to the length of the name. If OPLINK, then multiply the offset by 2 to locate the actual offset to the length of the name.
   
   **Note:** Enterprise COBOL V5.1 and later releases use OPLINK.
   c. Add this offset to the PPA1 address to find the halfword containing the length of the name, followed by the entry point name.
      
      The entry point name appears in EBCDIC, with the translated version in the right-hand margin of the system dump.

4. Find the Language Environment or COBOL program name.
   a. Find the address of PPA2 at X'04' from the start of PPA1. For Enterprise COBOL V5.1 or later releases, find a signed offset at X'04' from the start of PPA1, then add this offset to the entry point address to obtain the address of PPA2.
   b. Find the address of the compilation unit’s primary entry point at X'10' in the PPA2. For Enterprise COBOL V5.1 and later releases, find a signed offset at X'10' in the PPA2, then add this offset to the address of PPA2 to obtain the compilation unit’s primary entry point.
   c. Find the entry point name associated with the primary entry point as described above. The primary entry point name is the routine name.

   See [z/OS Language Environment Vendor Interfaces](#) for details of:
   - the non-XPLINK Language Environment-conforming PPA1 and PPA2.
   - the XPLINK Language Environment-conforming PPA1, and the XPLINK PPA1 optional area fields.
   - the non-XPLINK Language Environment PPA2.
   - the Language Environment PPA2: Compile Unit Block for XPLINK.
   - the PPA2 timestamp and version information.

5. If the entry point type is C/C++, find the C/C++ routine name.
   a. Use the entry point plus 4 to locate the offset to the entry point name in the PPA1 (see Figure 266 on page 496).
   b. Use this offset to find the length-of-name byte followed by the routine name.
6. If the entry point type is nonconforming, find the PL/I routine name.
   a. Find the one byte length immediately preceding the entry point. This is the
      length of the routine name.
   b. Go back the number of bytes specified in the name length. This is the
      beginning of the routine name.

7. If the entry point type is nonconforming, find the name of the routine other
   than PL/I.
   a. Use the entry point plus 4 as the location of the entry point name.
   b. Use the next byte as the length of the name. The name directly follows the
      length of name byte. The entry point name appears in EBCDIC with the
      translated version in the right-hand margin.

Figure 267 shows a nonconforming entry point type. Nonconforming entry
points that can appear do not necessarily follow this linking convention. The
location of data in these save areas can be unpredictable.

```
Figure 266. C PPA1

Figure 267. Nonconforming entry point type with sample dump
```
Searching the IBM Software Support Database

Failures in the Language Environment product can be described through the use of keywords. A keyword is a descriptive word or abbreviation assigned to describe one aspect of a product failure. A set of keywords, called a keyword string, describes the failure in detail. You can use a keyword or keyword string as a search argument against an IBM software support database, such as the Service Information Search (SIS). The database contains keyword and text information describing all current problems reported through APARs and associated PTFs. IBM Support Center personnel have access to the software support database and are responsible for storing and retrieving the information. Using keywords or a keyword string, they will search the database to retrieve records that describe similar known problems.

If you have IBMLink or some other connection to the IBM databases, you can do your own search for previously recorded product failures before calling the IBM Support Center.

If your keyword or keyword string matches an entry in the software support database, the search may yield a more complete description of the problem and possibly identify a correction or circumvention. Such a search may yield several matches to previously reported problems. Review each error description carefully to determine if the problem description in the database matches the failure.

If a match is not found, go to “Preparing documentation for an authorized program analysis report (APAR).”

Preparing documentation for an authorized program analysis report (APAR)

This section provides an overview of how to prepare documentation if a problem arises. For detailed information, see the following URL:


Prepare documentation for an APAR only after you have done the following:

• Eliminated user errors as a possible cause of the problem.
• Followed the diagnostic procedures.
• You or your local IBM Support Center has been unsuccessful with the keyword search.

Having met these criteria, follow the instructions below.

1. Report the problem to IBM.
   If you have not already done so, report the problem to IBM by opening a problem management record (PMR).
   If you have IBMLink or some other connection to IBM databases, you can open a PMR yourself. Or, the IBM Software Support Center can open the PMR after consulting with you on the phone. The PMR is used to document your problem and to record the work that the Support Center does on the problem. Be prepared to supply the following information:
   • Customer number
   • PMR number
   • Operating system
   • Operating system release level
• Your current Language Environment maintenance level (PTF list and list of APAR fixes applied)
• Keyword strings you used to search the IBM software support database
• Processor number (model and serial)
• A description of how reproducible the error is. Can it be reproduced each time? Can it be reproduced only sometimes? Have you been unable to reproduce it? Supply source files, test cases, macros, subroutines, and input files required to re-create the problem. Test cases are not required, but can often speed the response time for your problem.

If the IBM Support Center concludes that the problem described in the PMR is a problem with the Language Environment product, they will work with you to open an APAR, so the problem can be fixed.

2. Provide APAR documentation. When you submit an APAR, you will need to supply information that describes the failure. Table 68 describes how to produce documentation required for submission with the APAR.

<table>
<thead>
<tr>
<th>Item</th>
<th>Materials Required</th>
<th>How to Obtain Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Machine-readable source program, including macros, subroutines, input files, and any other data that might help to reproduce the problem.</td>
<td>IBM-supplied system utility program</td>
</tr>
<tr>
<td>2</td>
<td>Compiler listings: Source listing, Object listing, Storage map, Traceback, Cross-reference listing, JCL listing and linkage editor listing, Assembler-language expansion</td>
<td>Use appropriate compiler options</td>
</tr>
<tr>
<td>3</td>
<td>Dumps Language Environment dump, System dump</td>
<td>See instructions in Chapter 3, “Using Language Environment debugging facilities,” on page 37 (as directed by IBM support personnel).</td>
</tr>
<tr>
<td>4</td>
<td>Partition/region size/virtual storage size</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>List of applied PTFs</td>
<td>System programmer</td>
</tr>
<tr>
<td>6</td>
<td>Operating instructions or console log</td>
<td>Application programmer</td>
</tr>
<tr>
<td>7</td>
<td>JCL statements used to invoke and run the routine, including all runtime options, in machine-readable form</td>
<td>Application programmer</td>
</tr>
<tr>
<td>8</td>
<td>System output associated with the MSGFILE runtime option.</td>
<td>Specify MSGFILE(SYSOUT)</td>
</tr>
<tr>
<td>9</td>
<td>Contents of the applicable catalog</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>A hardcopy log of the events leading up to the failure.</td>
<td>Print out each display.</td>
</tr>
</tbody>
</table>

3. Submit the APAR documentation.
   When submitting material for an APAR to IBM, carefully pack and clearly identify any media containing source programs, job stream data, interactive environment information, data sets, or libraries.
All magnetic media submitted must have the following information attached and visible:

- The APAR number assigned by IBM.
- A list of data sets on the tape (such as source program, JCL, data).
- A description of how the tape was made, including:
  - The exact JCL listing or the list of commands used to produce the machine-readable source. Include the block size, LRECL, and format of each file. If the file was unloaded from a partitioned data set, include the block size, LRECL, and number of directory blocks in the original data set.
  - Labeling information used for the volume and its data sets.
  - The recording mode and density.
  - The name of the utility program that created each data set.
  - The record format and block size used for each data set.

Any printed materials must show the corresponding APAR number.

The IBM service personnel will inform you of the mailing address of the service center nearest you.

If an electronic link with IBM Service is available, use this link to send diagnostic information to IBM Service.

After the APAR is opened and the fix is produced, the description of the problem and the fix will be in the software support database in SIS, accessible through ServiceLink.
Appendix B. Accessibility

Accessible publications for this product are offered through IBM Knowledge Center (http://www.ibm.com/support/knowledgecenter/SSLTBW/welcome).

If you experience difficulty with the accessibility of any z/OS information, send a detailed message to the http://www.ibm.com/systems/z/os/zos/webqs.html or use the following mailing address.
IBM Corporation
Attention: MHVRCFS Reader Comments
Department H6MA, Building 707
2455 South Road
Poughkeepsie, NY 12601-5400
United States

Accessibility features

Accessibility features help users who have physical disabilities such as restricted mobility or limited vision use software products successfully. The accessibility features in z/OS can help users do the following tasks:

- Run assistive technology such as screen readers and screen magnifier software.
- Operate specific or equivalent features by using the keyboard.
- Customize display attributes such as color, contrast, and font size.

Consult assistive technologies

Assistive technology products such as screen readers function with the user interfaces found in z/OS. Consult the product information for the specific assistive technology product that is used to access z/OS interfaces.

Keyboard navigation of the user interface

You can access z/OS user interfaces with TSO/E or ISPF. The following information describes how to use TSO/E and ISPF, including the use of keyboard shortcuts and function keys (PF keys). Each guide includes the default settings for the PF keys.

- z/OS TSO/E Primer
- z/OS TSO/E User’s Guide
- z/OS ISPF User’s Guide Vol I

Dotted decimal syntax diagrams

Syntax diagrams are provided in dotted decimal format for users who access IBM Knowledge Center with a screen reader. In dotted decimal format, each syntax element is written on a separate line. If two or more syntax elements are always present together (or always absent together), they can appear on the same line because they are considered a single compound syntax element.

Each line starts with a dotted decimal number; for example, 3 or 3.1 or 3.1.1. To hear these numbers correctly, make sure that the screen reader is set to read out
punctuation. All the syntax elements that have the same dotted decimal number
(for example, all the syntax elements that have the number 3.1) are mutually
exclusive alternatives. If you hear the lines 3.1 USERID and 3.1 SYSTEMID, your
syntax can include either USERID or SYSTEMID, but not both.

The dotted decimal numbering level denotes the level of nesting. For example, if a
syntax element with dotted decimal number 3 is followed by a series of syntax
elements with dotted decimal number 3.1, all the syntax elements numbered 3.1
are subordinate to the syntax element numbered 3.

Certain words and symbols are used next to the dotted decimal numbers to add
information about the syntax elements. Occasionally, these words and symbols
might occur at the beginning of the element itself. For ease of identification, if the
word or symbol is a part of the syntax element, it is preceded by the backslash (\)
character. The * symbol is placed next to a dotted decimal number to indicate that
the syntax element repeats. For example, syntax element *FILE with dotted decimal
number 3 is given the format 3 \* FILE. Format 3* FILE indicates that syntax
element FILE repeats. Format 3* \* FILE indicates that syntax element * FILE
repeats.

Characters such as commas, which are used to separate a string of syntax
elements, are shown in the syntax just before the items they separate. These
characters can appear on the same line as each item, or on a separate line with the
same dotted decimal number as the relevant items. The line can also show another
symbol to provide information about the syntax elements. For example, the lines
5.1*, 5.1 LASTRUN, and 5.1 DELETE mean that if you use more than one of the
LASTRUN and DELETE syntax elements, the elements must be separated by a comma.
If no separator is given, assume that you use a blank to separate each syntax
element.

If a syntax element is preceded by the % symbol, it indicates a reference that is
defined elsewhere. The string that follows the % symbol is the name of a syntax
fragment rather than a literal. For example, the line 2.1 %OP1 means that you must
refer to separate syntax fragment OP1.

The following symbols are used next to the dotted decimal numbers.

? indicates an optional syntax element
The question mark (?) symbol indicates an optional syntax element. A dotted
decimal number followed by the question mark symbol (?) indicates that all
the syntax elements with a corresponding dotted decimal number, and any
subordinate syntax elements, are optional. If there is only one syntax element
with a dotted decimal number, the ? symbol is displayed on the same line as
the syntax element, (for example 5? NOTIFY). If there is more than one syntax
element with a dotted decimal number, the ? symbol is displayed on a line by
itself, followed by the syntax elements that are optional. For example, if you
hear the lines 5 ?, 5 NOTIFY, and 5 UPDATE, you know that the syntax elements
NOTIFY and UPDATE are optional. That is, you can choose one or none of them.
The ? symbol is equivalent to a bypass line in a railroad diagram.

! indicates a default syntax element
The exclamation mark (!) symbol indicates a default syntax element. A dotted
decimal number followed by the ! symbol and a syntax element indicate that
the syntax element is the default option for all syntax elements that share the
same dotted decimal number. Only one of the syntax elements that share the
dotted decimal number can specify the ! symbol. For example, if you hear the
lines 2? FILE, 2.1! (KEEP), and 2.1 (DELETE), you know that (KEEP) is the
default option for the FILE keyword. In the example, if you include the FILE keyword, but do not specify an option, the default option KEEP is applied. A default option also applies to the next higher dotted decimal number. In this example, if the FILE keyword is omitted, the default FILE(KEEP) is used. However, if you hear the lines 2? FILE, 2.1, 2.1.1! (KEEP), and 2.1.1 (DELETE), the default option KEEP applies only to the next higher dotted decimal number, 2.1 (which does not have an associated keyword), and does not apply to 2? FILE. Nothing is used if the keyword FILE is omitted.

* indicates an optional syntax element that is repeatable

The asterisk or glyph (*) symbol indicates a syntax element that can be repeated zero or more times. A dotted decimal number followed by the * symbol indicates that this syntax element can be used zero or more times; that is, it is optional and can be repeated. For example, if you hear the line 5.1* data area, you know that you can include one data area, more than one data area, or no data area. If you hear the lines 3* , 3 HOST, 3 STATE, you know that you can include HOST, STATE, both together, or nothing.

Notes:

1. If a dotted decimal number has an asterisk (*) next to it and there is only one item with that dotted decimal number, you can repeat that same item more than once.

2. If a dotted decimal number has an asterisk next to it and several items have that dotted decimal number, you can use more than one item from the list, but you cannot use the items more than once each. In the previous example, you can write HOST STATE, but you cannot write HOST HOST.

3. The * symbol is equivalent to a loopback line in a railroad syntax diagram.

+ indicates a syntax element that must be included

The plus (+) symbol indicates a syntax element that must be included at least once. A dotted decimal number followed by the + symbol indicates that the syntax element must be included one or more times. That is, it must be included at least once and can be repeated. For example, if you hear the line 6.1+ data area, you must include at least one data area. If you hear the lines 2+, 2 HOST, and 2 STATE, you know that you must include HOST, STATE, or both. Similar to the * symbol, the + symbol can repeat a particular item if it is the only item with that dotted decimal number. The + symbol, like the * symbol, is equivalent to a loopback line in a railroad syntax diagram.
Notices

This information was developed for products and services offered in the U.S.A. or elsewhere.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

IBM Director of Licensing
IBM Corporation
North Castle Drive
Armonk, NY 10504-1785
U.S.A.

For license inquiries regarding double-byte character set (DBCS) information, contact the IBM Intellectual Property Department in your country or send inquiries, in writing, to:

Intellectual Property Licensing
Legal and Intellectual Property Law
IBM Japan, Ltd.
19-21, Nihonbashi-Hakozakicho, Chuo-ku
Tokyo 103-8510, Japan

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION “AS IS” WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this IBM product and use of those Web sites is at your own risk.
IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Licensees of this program who wish to have information about it for the purpose of enabling: (i) the exchange of information between independently created programs and other programs (including this one) and (ii) the mutual use of the information which has been exchanged, should contact:

Site Counsel
IBM Corporation
2455 South Road
Poughkeepsie, NY 12601-5400
USA

Such information may be available, subject to appropriate terms and conditions, including in some cases, payment of a fee.

The licensed program described in this information and all licensed material available for it are provided by IBM under terms of the IBM Customer Agreement, IBM International Program License Agreement, or any equivalent agreement between us.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

All statements regarding IBM’s future direction or intent are subject to change or withdrawal without notice, and represent goals and objectives only.

If you are viewing this information softcopy, the photographs and color illustrations may not appear.

COPYRIGHT LICENSE:

This information might contain sample application programs in source language, which illustrate programming techniques on various operating platforms. You may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs. The sample programs are provided "AS IS", without warranty of any kind. IBM shall not be liable for any damages arising out of your use of the sample programs.

Policy for unsupported hardware

Various z/OS elements, such as DFSMS, HCD, JES2, JES3, and MVS, contain code that supports specific hardware servers or devices. In some cases, this device-related element support remains in the product even after the hardware devices pass their announced End of Service date. z/OS may continue to service element code; however, it will not provide service related to unsupported hardware devices. Software problems related to these devices will not be accepted.
for service, and current service activity will cease if a problem is determined to be associated with out-of-support devices. In such cases, fixes will not be issued.

Minimum supported hardware

The minimum supported hardware for z/OS releases identified in z/OS announcements can subsequently change when service for particular servers or devices is withdrawn. Likewise, the levels of other software products supported on a particular release of z/OS are subject to the service support lifecycle of those products. Therefore, z/OS and its product publications (for example, panels, samples, messages, and product documentation) can include references to hardware and software that is no longer supported.

- For information about software support lifecycle, see: IBM Lifecycle Support for z/OS (http://www.ibm.com/software/support/systemsz/lifecycle/)
- For information about currently-supported IBM hardware, contact your IBM representative.

Programming interface information

This publication documents information NOT intended to be used as a Programming Interface of Language Environment in z/OS.

Trademarks

IBM, the IBM logo, and ibm.com are trademarks or registered trademarks of International Business Machines Corp., registered in many jurisdictions worldwide. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the Web at “Copyright and trademark information” at http://www.ibm.com/legal/copytrade.shtml

Adobe, Acrobat, and PostScript are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States, other countries, or both.

Java and all Java-based trademarks and logos are trademarks or registered trademarks of Oracle and/or its affiliates.

UNIX is a registered trademark of The Open Group in the United States and other countries.

Other company, product, and service names might be trademarks or service marks of others.
Index

Special characters

__abend 166, 448
__alloc 166, 448
__amrc 166, 448
__cabend() function 352, 360, 378
__code 166, 448
__error 166, 448
__feedback 166, 448
__last_op 166, 448
__le_cib_get() function 352
__le_message_get_and_and_write() function 344, 354
__le_message_get() function 354
__le_msg_write() function 344, 354
__msg 167, 450
__reset_exception_handler() function 352
__set_exception_handler() function 352, 353
_BPXK_MDUMP 85, 379
_EDC_ADD_ERRNO2 172, 456

Numerics

64-bit applications 343, 357, 361, 447

A

abend codes
>= 4000 32, 358
< 4000 32, 358
4093 357

abends internal, table of output 337
Language Environment 34, 333, 359
requested by assembler user exit 26
system 35, 360
under CICS 333
user 34, 360

ABPERC runtime option
function 9
generating a system dump and
modifying condition handling
behavior and 23

ABTERMENC runtime option 9, 26
using 26

accessibility 501
contact IBM 501
features 501

AGGREGATE compiler option 4, 7
AMODE 64 applications
classifying errors 357
debugging C/C++ 447
preparing for debugging 343
using debugging 361

anywhere heap
statistics 20

APAR (Authorized Program Analysis Report) 497
documentation 498

application program interfaces
(API) 352, 354
application programs
debugging
handling a storage dump written
to a BFS file 218, 484
handling a storage dump written
to an HFS file 218, 484
argument in dump 63
arguments, registers, and variables for
active routines 61, 377
assembler language
user exit 25, 26
for CICS 337
generating a system dump
with 82, 378
modifying condition handling
behavior and 26
using 25, 26
assistive technologies 501
atexit
information in dump 192
automatic variables
locating in dump 282, 314

B

base locator
for working storage 237
in dump 237
below heap
statistics 20
BLOCKS option of CEE3DMP callable service 39

C

C library function
trace table entries for 469
C return codes to CICS 334
C/C++
__amrc
example of structure 166, 448
information in dump 193
__msg 167, 450
atexit
information in dump 192
C-specific common anchor area
(C-CAA) 191
cdump() function 183, 461
compiler options 3
debugging examples 207, 215, 471
dump information in 192

C/C++ (continued)
dump (continued)
parameter in 179
signal information in 191
structure variables, locating
in 180
system, structures in 180

file
control block information 193
status and attributes in dump 193
functions
calling dump, example 182, 460
cdump() 44, 182, 363, 460
csnap() 44, 182, 184, 363, 461
ctrace() 44, 182, 184, 363, 460, 461
fetch() 165, 447
fopen() 167, 450
ferror() 165, 172, 447, 455
printf() 166, 448
to produce dump output 44, 363
memory file control block 193
stdio.h 166, 448
timestamp 182

CAA (common anchor area) 65, 377,
382, 384, 397, 429
call chain 63

CALL statement
CDUMP/CPDUMP 255
dump, dump with 37
DUMP/PDUMP 254
SDUMP 255
callable services 22
case 1 condition token 29, 354
case 2 condition token 29, 354
cdump() function 182, 358, 460
CEE prefix 31, 33, 357, 359
CEE3ABD—terminate enclave with an
abend 23, 34, 83
generating a dump and 83
handling user abends and 23, 34
modifying condition handling
behavior and 23
CEE3DMP—generate dump 37, 63
generating a Language Environment
dump with 37
options 38
relationship to PLIDUMP 274, 308
syntax 38
CEE3GRO—returns location offset 23
CEE3SRP—set resume point 23
CEEBXITA assembler user exit 25, 26
CEECXITA assembler user exit 337
CEEDCOD—decompose a condition
token 29
CEEDUMP—Language Environment
Dump Service 37
control blocks 108, 396
locating 153
CEEHDLR—register user condition
handler 25
CEEHDLR—register user exception
handler 353
fetch
fetch information in dump 192
fetch() function 165, 447
fetchable module 165, 447
file
for COBOL, in dump 237
status key 230
file control block (FCB) 193
FILES option of CEE3DMP callable service 39
FLAG compiler option 4
floating point registers
in dump 58
fopen() function 167, 450
FOR prefix 31, 33
Fortran
compiler options 6
debugging examples 260, 265
dump services 253
errors, determining the source of 251
listings 253
HANDLE ABEND EXEC CICS command 331
header files, C
test.h 182, 460
errno.h 207, 471
stdio.h 166, 448
stdlib.h 207, 471
heap pool 409
trace report 382
heap pools 116
trace report 120, 415
heap storage
created by CEECRHP callable service 22
in LEDATA Output 111, 399
reports 115, 407
storage in dump 62
user 19
HEAP64 runtime option 346
HEAPCHK runtime option function 9, 116, 344, 409
Heap Pool
storage statistics 489
HEAPPOOLS 409
storage statistics 220, 222, 487
user-created, _uheapreport() 488
user-created, _uheapreport 221
trace report 88, 120
HEAPPOOLS runtime option 346
HEAPPOOLS64 415
storage statistics 486
HEAPPOOLS64 runtime option 346
HEAPZONE runtime option function 9
HEAPZONES runtime option 344
I
I/O conventions 165, 447
IBM prefix 31, 33
IGZ prefix 31, 33
INFOMSGFILTER runtime option function 9, 344
INITIALIZE statement 230
instance specific information (ISI) 354
instruction length counter (ILC) in dump 61, 376
Inter-procedural Analysis (IPA) 343
interactive problem control system (IPCS)
analyzing a storage dump 218, 484
cbf command 436
VERBEXIT 380, 381, 385, 419
INTERRUPT compiler option function 7
INTERRUPT runtime option 9
interruption code in dump 61, 376
IOHEAP64 runtime option 346
ITBLK in dump 240
Language Environment dump output
for C routines 187
for COBOL program 232
for Fortran routines 258
for PL/I routines 274, 308
information for multiple enclaves 44, 363
PL/I information in 277, 311
TERMTHDACT suboptions 42, 362
title 57, 374
traceback with condition information
C routine 187, 464
COBOL program 234
Fortran routine 251, 259
Language Environment routine 56, 374
PL/I routine 274, 308
using C functions 44, 363
using CDUMP/CPDUMP subroutine 253
using CEE3DMP callable service 37, 56, 374
using DUMP/PDUMP subroutine 253
using PLIDUMP subroutine 44, 274, 308
using SDUMP subroutine 253
using TERMTHDACT runtime option 40, 361
LCA (library communication area) 437
LEDATA
IPCS VERBEXIT
C/C++ Output 123
COBOL Output 142
Parameters 87
Understanding Output 90
IPCS VERBEXIT 380
C/C++ Output 419
Parameters 381
Understanding Output 385
LIBHEAP64 runtime option 346
linkage section
for COBOL programs in dump 237
LIST compiler option 4, 5, 7
listings generated by compiler
COBOL 232
Fortran 253
PL/I 268, 302
LMESSAGE compiler option 7
local
variables 61
LP64 compiler option 343, 447
machine state information
in dump 61, 376
MAP compiler option 5, 8
MEMLIMIT storage parameter 357
memory file control block (MFCB) 191, 193
message
classifying errors and 32, 358
runtime, CICS 331
Index 511
message (continued)
user-created 27
using in your routine 27
module
fetchable 165, 447
module name prefixes, Language Environment 31, 357
MSG suboption
of TERMTHDACT 40, 361
MSGFILE runtime option
function 9
runtime messages and 33, 358
MSGQ runtime option 10

N
navigation
keyboard 501
nested condition 30, 355
no response (wait/loop) 32, 358
NOBLOCKS option of CEE3DMP callable service 39
NOCONDITION option of CEE3DMP callable service 40
NOENTRY option of CEE3DMP callable service 40
NOFILES option of CEE3DMP callable service 39
NOSTORAGE option of CEE3DMP callable service 39
NOTRACEBACK option of CEE3DMP callable service 39
NOVARIABLES option of CEE3DMP callable service 39

O
OFFSET compiler option 4, 5, 8
optimizing
C 4, 63
COBOL 5
Fortran 256
PL/I 7
options
C compiler 3
COBOL compiler 5
defaults for dump 41, 362
determining runtime in effect 10, 12, 344
Fortran compiler 6
Language Environment runtime 9, 343
PL/I compiler 7, 8
out-of-storage condition
virtual storage 357
OUTDD compiler option 6
output
incorrect 32, 358
missing 32, 358

P
page number
in dump 57, 374
PAGESIZE(n) option of CEE3DMP callable service 40
parameter
checking value of 26
perror() function 172
perror() function 455
PL/I
address of interrupt, finding in dump 279, 313
CAA address, finding in dump 285, 317
common anchor area (CAA) 285, 317
compiler listings
object code listing 272
static storage map 271
variable storage map 272
compiler options
generating listings with 268, 302
list of 7
CSECT 271
debugging examples 286, 291, 318, 326
dump
error type, finding in dump 279, 312
parameter list, finding contents in 283, 315
PL/I information, finding in 277, 283, 311, 315
PLIDUMP subroutine and 274, 308
statement number, finding in dump 279, 313
timestamp, finding in dump 283
variables, finding in 282, 314
ERROR ON-unit 266, 279, 300, 312
errors 265, 266, 299, 302
floating-point register 266, 300
object code listing 272
ON statement control block 272
static storage listing 271
SUBSCRIPTRANGE condition 266, 267, 286, 288, 289, 300, 301, 318, 322
PLIDUMP subroutine 275, 308
PMR (problem management record) 497
pointer
variable 165, 447
PPA 495
preventive service planning (PSP)
bucket 493
printf() function 27, 166, 448
problem management record (PMR) 497
procedure division listings 232
process
control block 62, 378
member list 57, 378
process control block (PCB) 57, 378
PROFILE runtime option
function 10, 344
program
class storage 237
program prolog area 495
program status word (PSW) 61, 376
PSP (preventive service planning)
bucket 493
QUIET suboption of TERMTHDACT runtime option 40, 361
reason code
nonzero returned to CICS 337
under CICS 333
registers 0–15
in dump 58
release number
in dump 57, 374
request parameter list (RPL) 193
return code
bad or nonzero 32, 358
RPTOPTS runtime option 10
RPTSTG runtime option 13, 346
run unit
COBOL 238
level control block 238
storage in dump 62, 238
time
messages
under CICS 331
runtime options 23, 352
determining those in effect 10, 12, 344
sample options report 10
specifying 26
S
scope
terminator 229
SDUMP routine
description 255
formal specifications 256
output 255
usage considerations 256
sending comments to IBM xx
service routines
CDUMP/CPDUMP 255
DUMP/PDUMP 254
SDUMP 255
SET statement 230
shortcut keys 501
signal information in dump 191
sorted cross-reference listing 232
SOURCE compiler option 5, 6, 8
stack
frame 63
frame format 63, 64
STACK64 runtime option 346
STACKFRAME option of CEE3DMP callable service 40
statement numbers
in dump 57, 374
static
variables in dump 282, 314
writable map 176, 180, 181
status
of routines in dump 375
stderr 27, 358, 361, 362
stdio.h 166, 448
stdout 27
storage  
evaluating use of  13, 346  
for active routines  62, 377  
leak detecting  62, 116, 377, 409  
report  13, 346  
statistics  19, 20  
STORAGE compiler option  8  
storage dump  
written to an HFS file  218, 484  
STORAGE option of CEE3DMP callable service  39  
STORAGE runtime option  10, 344  
structure  
  map  180  
    variable example code  180  
summary of changes  xxiii  
Summary of changes  xxiii  
symbolic  
feedback code  28, 353  
symbolic dumps  255  
how to call under Fortran  255  
syntax diagrams  
how to read xvii  
system abend  
  with TRAP(OFF)  32, 358  
  with TRAP(ON)  32, 358  
system dump  
  generating  82, 378  
    in z/OS UNIX shell  85  

T  
task global table (TGT)  236  
TERMINAL compiler option  5, 8  
TERMTHDACT runtime option  
  function  9, 40, 289, 322, 343, 361  
    generating a dump and  24, 352  
    modifying condition handling behavior and  10, 344  
suboptions  40, 361  
TEST compiler option  4, 5, 6, 7  
TEST runtime option  10, 344  
text file name prefixes, Language Environment  31, 357  
THDCOM in dump  240  
THREAD option of CEE3DMP callable service  39  
THREADSTACK64 runtime option  346  
time  
in dump  57, 374  
TRACE runtime option  
  function  10, 344  
    trace table  154, 439  
TRACE suboption of TERMTHDACT runtime option  40, 361  
TRACEBACK option of CEE3DMP callable service  39, 63  
transaction  
    dump  333  
    rollback  337  
    rollback effects of assembler user exit on  337  
    work area  333  
TRAP runtime option  
  function  10, 344  
Language Environment condition handling and  24, 82, 378  

TRAP runtime option (continued)  
Language Environment exception handling and  352  

U  
UADUMP suboption of TERMTHDACT runtime option  24, 41, 352, 362  
UAIMM suboption of TERMTHDACT runtime option  24, 41, 352, 362  
UAONLY suboption of TERMTHDACT runtime option  24, 41, 352, 362  
UATRACE suboption of TERMTHDACT runtime option  24, 41, 352, 362  
unhandled conditions  26, 29, 354  
establishing enclave termination behavior for  26  
USE EXCEPTION/ERROR declaratives  230  
USE FOR DEBUGGING declarative  230, 231  
user  
    abend  34, 359, 360  
    code  32, 358  
    exit  25, 26  
    heap  
    statistics  20  
    stack  
    statistics  19  
user interface  
  ISPF  501  
  TSO/E  501  
user-specified abends  34, 359  
USRHDLR runtime option  9, 25, 343  
utility and service subroutines  
  CDUMP/CPDUMP  255  
  DUMP/PDUMP  254  
  SDUMP  255  

V  
variables  
in Language Environment dump  63  
structure example code  180  
VARIABLES option of CEE3DMP callable service  39, 63  
VBREF compiler option  6  
verb cross-reference  232  
VERBEXIT  
  LEDATA  87, 380  
  version number  
in dump  57, 374  

W  
working storage  
in dump  62, 237, 377  
Writable Static Area  175  

X  
XPLINK  
    (continued)  
stack frame format  63, 64  
storage statistics  19  
trace table entries for  202  
XREF compiler option  6, 8  
XUFLOW runtime option  
  function  10  
    modifying condition handling behavior and  25  

Z  
z/OS UNIX System Services  
C application program and  218, 484  
generating a system dump  85