FUJITSU

FUJITSU Software NetCOBOL V11.0

Debugging Guide

Windows(64)

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Preface

NetCOBOL allows you to create, execute, and debug COBOL programs. This manual describes the debugging functions available.

Audience

This manual is for people who develop COBOL programs using NetCOBOL. It assumes users possess basic knowledge of COBOL and are familiar with the appropriate Windows platform.

How this Manual is Organized

This manual consists of the following chapters and appendices:

Chapter	Contents
Chapter 1 Introduction to Debugging with NetCOBOL	An overview of the various debugging functions.
Chapter 2 NetCOBOL Debugging Functions	Details of using COBOL debugging functions.

How to Use This Manual

Check the features listed in the introduction and determine which debugging features you wish to use. Select the chapter that details those features.

Conventions Used in this Manual

This manual uses the following typographic conventions.

Example of Convention	Description
setup	Characters you enter appear in bold.
Program-name	Underlined text indicates a placeholder for information you supply.
ENTER	Small capital letters are used for the name of keys and key sequences such as ENTER and CTRL+R. A plus sign (+) indicates a combination of keys.
...	Ellipsis indicates the item immediately proceeding can be specified repeatedly.
Edit, Literal	Names of pull-down menus and options appear with the initial letter capitalized.
[def]	Indicates that the enclosed item may be omitted.
{ABC|DEF}	Indicates that one of the enclosed items delimited by | is to be selected.
CHECK WITH PASCAL LINKAGE ALL PARAGRAPH-ID COBOL ALL	Commands, statements, clauses, and options you enter or select appear in uppercase. Program section names, and some proper names also appear in uppercase. Defaults are underlined.

`PROCEDURE DIVISION:`
`  ADD 1 TO POW-FONTSIZE OF LABEL1.`
`  IF POW-FONTSIZE OF LABEL1 > 70 THEN`
	This font is used for examples of program code.

Example of Convention	Description
`MOVE 1 TOW POW-FONTSIZE OF LABEL1.` `END-IF.`	
The *sheet* acts as an application creation form.	Italics are occasionally used for emphasis.
Refer to "Setting Environment Variables" in the "NetCOBOL User's Guide".	References to other publications or sections within publications are in quotation marks.

Product Names

Product Name	Abbreviation
Microsoft® Windows Server® 2012 R2 Datacenter Microsoft® Windows Server® 2012 R2 Standard Microsoft® Windows Server® 2012 R2 Essentials Microsoft® Windows Server® 2012 R2 Foundation	Windows Server 2012 R2
Microsoft® Windows Server® 2012 Datacenter Microsoft® Windows Server® 2012 Standard Microsoft® Windows Server® 2012 Essentials Microsoft® Windows Server® 2012 Foundation	Windows Server 2012
Microsoft® Windows Server® 2008 R2 Foundation Microsoft® Windows Server® 2008 R2 Standard Microsoft® Windows Server® 2008 R2 Enterprise Microsoft® Windows Server® 2008 R2 Datacenter	Windows Server 2008 R2
Windows® 8.1 Windows® 8.1 Pro Windows® 8.1 Enterprise	Windows 8.1(x64)
Windows® 8 Windows® 8 Pro Windows® 8 Enterprise	Windows 8(x64)
Windows® 7 Home Premium Windows® 7 Professional Windows® 7 Enterprise Windows® 7 Ultimate	Windows 7(x64)
Microsoft(R) Visual C++(R) development system	Visual C++
Microsoft(R)Visual Basic(R) programming system	Visual Basic
Oracle Solaris	Solaris

- In this manual, when all the following products are indicates, it is written as "Windows" or "Windows(x64)".
  - Windows Server 2012 R2
  - Windows Server 2012
  - Windows Server 2008 R2
  - Windows 8.1(x64)

- Windows 8(x64)
- Windows 7(x64)

Product Differences

The following products are not supported in the US English language version, or other English language versions, of this product, but may be mentioned in this manual:

- BS*NET
- IDCM
- MeFt/NET
- MeFt/NET-SV
- PowerAIM
- RDB/7000 Server for Windows NT
- SequeLink
- MeFt/Web
- Print Walker/OVL option
- System Walker/List Works

Trademarks

Acknowledgments

The language specifications of COBOL are based on the original specifications developed by the work of the Conference on Data Systems Languages (CODASYL). The specifications described in this manual are also derived from the original. The following passages are quoted at the request of CODASYL.

"COBOL is an industry language and is not the property of any company or group of companies, or of any organization or group of organizations. No warranty, expressed or implied, is made by the COBOL Committee as to the accuracy and functioning of the programming system and language. Moreover, no responsibility is assumed by the committee, in connection therewith.

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- FACT, DSI 27A5260-2760, copyrighted 1960 by Minneapolis-Honeywell."

The object-oriented language specification for COBOL is based on the Forth COBOL International Standards resulting from the efforts of the ISO/IEC JTC1/SC22/WG4 and NCITS J4 Technology Committees. We would like to express our special thanks to those committees for their efforts and dedication.

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Exportation/release of this document may require necessary procedures in accordance with the regulations of the Foreign Exchange and Foreign Trade Control Law of Japan and/or US export control laws.

March 2014

Contents

Chapter 1 Introduction to Debugging with NetCOBOL

The introduction gives you an overview of the debugging options available with NetCOBOL.

1.1 Debugging with NetCOBOL

NetCOBOL provides debugging aids:

- NetCOBOL Studio debugging functions
- COBOL Debug Functions

The debugging function of NetCOBOL Studio is a full featured, interactive debugger that provides a rich set of functions to help you locate bugs and analyze the behavior of your programs. It works on the executable code, in EXE or DLL format, so you are seeing the same code execute that will be run when the applications are used in production. Working with the executable code also means that mixed language debugging is straightforward. For more information on using the NetCOBOL Studio debugging function , refer to "NetCOBOL Studio User's Guide".

The COBOL debug functions include tracing of executed statements and checking for subscripts and modifiers going out of range, as well as the ability to count executed statements. With these functions, you can determine the exact points at which abnormal termination occurs and prevent programs from writing to memory outside their allotted range.

1.2 Features of the COBOL Debugging Functions

There are COBOL debugging functions as follows:

- TRACE
- CHECK
- COUNT
- Memory Check
- COBOL Error Report
- Compiler Listings and Debugging tool

These functions can be very useful in trapping problems that are difficult to reproduce in production situations.

1.2.1 TRACE

TRACE records the following information at program execution time:

- Results of executed statements
- Line number and position within line, of the statement causing abnormal termination.
- Program name being executed.
- Messages output during execution.

TRACE lets you check where abnormal termination is happening and the path taken to reach that point.

TRACE is enabled by specifying an option at compile time and providing specific details in environment variables at run time.

1.2.2 CHECK

CHECK is also a compile time option. When set, the COBOL runtime system checks the following items:

- The subscript and the index boundaries, and reference modification
- Numeric data exceptions and divide-by-zero errors
- Parameters for calling a method

- Program calling conventions

A message is output when one of these items goes out of range.

A count can be specified so that the message is only displayed after a certain number of occurrences.

1.2.3 COUNT

COUNT records the following information at program execution time:

- The execution count for each statement written in a source program sequentially, along with the percentage of this execution count to the total execution count for all the statements.
- The execution count by verb, along with the percentage of this execution count vs. the total execution count for all the statements.

COUNT lets you check all the routes the program has followed during execution.

1.2.4 Memory Check

When Memory Check is enabled by specifying environment variables, the COBOL runtime system checks the specified area. If the area has been destroyed, the following information is output:

- Name of the program or method for which area destruction was detected
- Location where destruction was detected (procedure division start or end)
- Addresses of the destroyed area

Memory Check lets you check the program that destroyed the runtime system area.

1.2.5 COBOL Error Report

The COBOL Error Report outputs diagnostic information for the following problems:

- Application errors
- Runtime messages of U-level

COBOL Error Report check lets you check which error has occurred and in which statement.

1.2.6 Compiler Listings and Debugging tool

Programs are debugged using the translation list and debugging tool.

- Retrieves the statement that the application terminated abnormally.
- Identifies the data that was referenced when the application terminated abnormally.

Chapter 2 NetCOBOL Debugging Functions

This chapter provides instructions on using the NetCOBOL debugging functions.

Outline of the debugging functions:

- Using the CHECK Function
- Using the TRACE Function
- Using the COUNT Function
- Using the Memory Check Function
- Using the COBOL Error Report
- Debugging Using Compiler Listings and Debugging Tool

2.1 Outline of the Debugging Functions

Six types of debugging functions are available for COBOL:

- Tracing executed COBOL statements (TRACE function)
- Checking the referencing of an incorrect area, data exceptions, and parameters (CHECK function)
- Reporting the execution count for each statement sequentially, as well as by verb, along with percentage of these counts (COUNT function).
- Checking the runtime system area (Memory Check function)
- Generating diagnostic reports and dump on application errors and runtime messages (COBOL Error Report).
- Specific of the statement that terminated abnormally and data reference(debugging using an compilation listing and debugging tool)

To use the debugging function, specify the compiler option for each desired debugging function at the compilation of the COBOL program, and specify the environment to operate the debugging function at the execution of the program.

Table 2.1 Outline of the debugging functions and compiler options

Function Name	Outline	Compiler Option
CHECK function	The following items are checked. - Whether the subscript or the index addresses an area outside of the range of a table when that table is referenced - Whether the reference modified exceeds the data length at reference modification - Whether the contents of the object word are correct when the data containing the OCCURS DEPENDING ON clause is referenced - Whether the numeric item contains a value of the type that is specified by the attribute. - Whether the divisor in division is not zero. - Whether, in an invoked method, the number of parameters and attributes for a calling method match those for a called method. - Whether, in an invoked program, the calling conventions of a calling program match those of a called program. - Whether, the number of parameters and length of the CALL statements match those of a called program.	CHECK

Function Name	Outline	Compiler Option
	Purpose - To prevent an operation error of the program due to a memory reference error - To prevent erroneous numbers from causing a program to behave unexpectedly - To prevent invalid parameters from causing a program to behave unexpectedly	
TRACE function	The following types of information are output: - Tracing result of executed statements - Line number and verb number of the statement that was executed at abnormal termination - Program name that contains the statements that were executed and program attribute information - Message output during execution **Purpose** - To ascertain at which statement abnormal termination occurred - To ascertain the path of the statements that were executed up to abnormal termination - To check the message output during execution	TRACE
COUNT function	This function reports: - The execution count for each statement in your program, sequentially, along with the percentage of this execution count vs. the total execution count for all the statements. - The execution count by verb that appears in your program, along with the percentage of this count vs. the total execution count for all the statements. **Purpose** - To identify all the routes the program have followed during execution - To improve the efficiency of your program	COUNT

Memory check function	The following items are checked.
	- The runtime system area is checked when the program and method procedure divisions start and end. If the area has been destroyed, the following information is output.
	  - Name of the program or method for which area destruction was detected
	  - Location where destruction was detected (procedure division start or end)
	  - Addresses of the destroyed area
	Purpose
	- To identify the program that destroyed the runtime system area.
		-

COBOL Error Report	This function reports the following information : - Error type (Exception code or runtime message) - Problem location (Module name, program name, source file name, line number) - Calling path - System information	TEST

Function Name	Outline	Compiler Option
	- Environment variable - Runtime environment information - Process list - Module list - Thread information Moreover, the dump is output. **Purpose** - To identify which error has occurred and in which statement - To identify the calling path for the programs run until errors occurred - To identify the status of applications or the computer in effect when errors occurred	
Debugging Using Compiler Listings and Debugging Tool	The following compiler listings are output: - Object program listing - Data map listing - Source program listing **Purpose** - To determine at which statement the abnormal termination occurred - To identify the data that was referenced when the program terminated abnormally	LIST -P SOURCE COPY MAP

Note

You cannot use the TRACE and COUNT functions at the same time.

2.1.1 Statement Number

A statement number described in the subsequent explanation indicates the following expression:

```
line-number
```

Refer to "SOURCE(Whether a source program listing should be output)" in the "NetCOBOL User's Guide".

line-number

When compiler option NUMBER is selected, the format is "[COPY-qualification-value-]user-line-number" and when NONUMBER is selected, the format is "[COPY-qualification-value-]sequence-number-in-file."

The sequence number in the file is the value assigned in ascending order by the compiler, starting from "1" as the first line in the file and incrementing by 1 for each line.

2.2 Using the CHECK Function

The CHECK function checks the following items. If the function detects an abnormality, it writes a message and terminates abnormally. Therefore, program operation errors can be prevented.

- Subscripts, indexes and reference modification outside their range
- Numeric data exceptions and zero divisor check

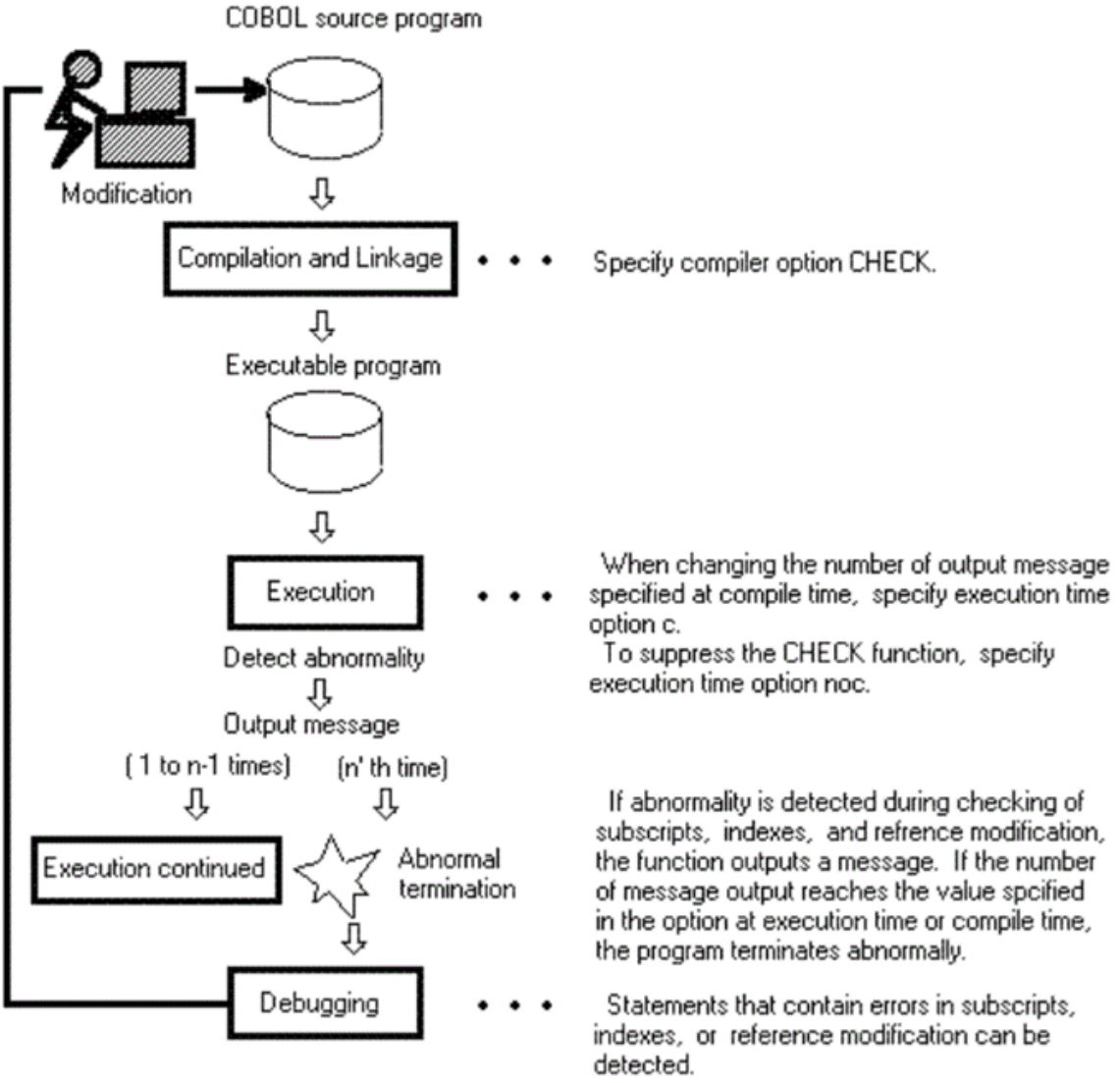
- Parameters for calling a method
- Internal program call parameters
- External program call parameters

This section describes how to use the CHECK function.

2.2.1 Flow of Debugging

The following section shows the flow of debugging operation when using the CHECK function.

Figure 2.1 Flow of debugging with CHECK function



2.2.2 Output Message

If the CHECK function checks and detects an abnormality, it will generate a message. This message is usually output to the message box.

While the messages that are generated by the CHECK function normally have the severity code E, the severity code changes to U when the message output count equals a predetermined value. (For more information about severity codes, refer to "NetCOBOL Messages".)

The CHECK(PRM) internal program call parameter produces a diagnostic message at compilation if it determines an error in the calling structure parameters, but it does not check the number of times specified (n,PRM) for runtime message output.

Message Output Count

Specify a message count in compiler option CHECK at compile time. If one run unit contains two or more COBOL programs which had the CHECK option specified, the number of messages specified with the compile option for the program that is activated first will be used. The message count can be changed at execution time by using execution time option c.

The following CHECK functions can be suppressed by specifying an execution time option. Plurals can be specified.

- noc : Suppress all of the CHECK functions
- nocb : Suppress CHECK(BOUND)
- noci : Suppress CHECK(ICONF)
- nocn : Suppress CHECK(NUMERIC)
- nocp : Suppress CHECK(PRM)

Program execution continues until the message count reaches the specified count. Refer to "Format of Runtime Options" in the "NetCOBOL User's Guide" for more information.

2.2.3 Examples of Using the CHECK Function

Checking Reference Modification

Program A

```
000000 @OPTIONS CHECK(BOUND)
          :
000500 77 data-1                   PIC X(12).
000600 77 data-2                   PIC X(12).
000700 77 length-to-be-referenced  PIC 9(4) BINARY.
          :
001100    MOVE 10   TO  length-to-be-referenced.
001200    MOVE data-1 (1:length-to-be-referenced) TO data-2 (4:length-to-be-referenced).
          :
```

The following message is written for data-2 when the MOVE statement on line 1200 is executed:

```
JMP0821I-E/U  [PID:xxxxxxxx TID:xxxxxxxx] REFERENCE MODIFIER IS OUT OF RANGE.  PGM=A. LINE=1200.1.
OPD=data-2.
```

Checking Subscripts and Indexes

Program A

```
000000 @OPTIONS CHECK(BOUND)
           :
000500 77  subscript  PIC S9(4).
000600 01  dtable.
000700   02 table-1 OCCURS 10 TIMES INDEXED BY index-1.
000800      03  element-1  PIC X(5).
           :
001100     MOVE  15  TO  subscript.
001200     ADD    1  TO  element-1(subscript).
001300     SET   index-1  TO  0.
001400     SUBTRACT  1  FROM  element-1(index-1).
           :
```

When the ADD/SUBTRACT statement is executed, the following message is written:

```
JMP0820I-E/U  [PID:xxxxxxxx TID:xxxxxxxx] SUBSCRIPT/INDEX IS OUT OF RANGE.  PGM=A. LINE=1200.
OPD=element-1
JMP0820I-E/U  [PID:xxxxxxxx TID:xxxxxxxx] SUBSCRIPT/INDEX IS OUT OF RANGE.  PGM=A. LINE=1400.
OPD=element-1
```

Checking Target Words of the OCCURS DEPENDING ON Clause

Program A

```
000000 @OPTIONS CHECK(BOUND)
      :
000050 77  subscript  PIC S9(4).
000060 77  cnt        PIC S9(4).
000070 01  dtable.
000080  02 table-1 OCCURS 1 TO 10 TIMES DEPENDING ON cnt.
000090      03  element-1  PIC X(5).
      :
000110     MOVE   5  TO  subscript.
000120     MOVE  25  TO  cnt.
000130     MOVE  "ABCDE"  TO  element-1(subscript).
      :
```

The following message is written for the count:

```
JMP0822I-E/U  [PID:xxxxxxxx TID:xxxxxxxx] ODO OBJECT VALUE IS OUT OF RANGE.  PGM=A. LINE=120.
OPD=element-1. ODO=cnt.
```

Checking Numeric Data Exceptions

Program A

```
000000 @OPTIONS CHECK(NUMERIC)
         :
000050 01 CHAR PIC X(4) VALUE "ABCD".
000060 01 EXTERNAL-DECIMAL REDEFINES CHAR PIC S9(4).
000070 01 NUM PIC S9(4).
         :
000150       MOVE EXTERNAL-DECIMAL TO NUM.
         :
```

For EXTERNAL-DECIMAL, the following message will appear.

```
JMP08281-E/U  [PID:xxxxxxxx TID:xxxxxxxx] INVALID VALUE SPECIFIED.  PGM=A. LINE=150. OPD= EXTERNAL-
DECIMAL
```

Checking a zero divisor

Program A

```
000000 @OPTIONS CHECK(NUMERIC)
         :
000060 01    DIVIDEND PIC S9(8) BINARY VALUE 1234.
000070 01    DIVISOR PIC S9(4) BINARY VALUE 0.
000080 01    RESULT PIC S9(4) BINARY VALUE 0.
         :
000150       COMPUTE RESULT = DIVIDEND / DIVISOR.
         :
```

For the DIVISOR, the following message will appear.

```
JMP08291-E/U  [PID:xxxxxxxx TID:xxxxxxxx] DIVIDED BY ZERO.  PGM=A. LINE=150. OPD= DIVISOR
```

Checking parameters for calling a method

Program A

```
000000 @OPTIONS CHECK(ICONF)
000010 PROGRAM-ID. A.
             :
```

```
000030 01 PRM-01 PIC X(9).
000040 01 0BJ-U USAGE IS OBJECT REFERENCE.
            :
000060    SET    OBJ-U TO B.
000070    INVOKE OBJ-U "C" USING BY REFERENCE PRM-01.

           Class B/Method C
000010 CLASS-ID. B.
            :
000030 FACTORY.
000040 PROCEDURE DIVISION.
            :
000060 METHOD-ID.C.
            :
000080 LINKAGE SECTION.
000090 01 PRM-01 PIC 9(9) PACKED-DECIMAL.
000100 PROCEDURE DIVISION USING PRM-01.
            :
```

The following message is written when the INVOKE statement of program A is executed:

```
JMP08101-E/U  [PID:xxxxxxxx TID:xxxxxxxx] FAILURE IN USING PARAMETER OF THE 'C' METHOD.  PARAMETER=1.
PGM=A  LINE=70.
```

Internal program call parameter investigation

Program A

```
000001 @OPTIONS CHECK(PRM)
000002 PROGRAM-ID. A.
000003 ENVIRONMENT DIVISION.
000004 CONFIGURATION SECTION.
000005 REPOSITORY.
000006     CLASS CLASS1.
000007 DATA DIVISION.
000008 WORKING-STORAGE SECTION.
000009 01 P1 PIC X(20).
000010 01 P2 PIC X(10).
000011 01 P3 USAGE OBJECT REFERENCE CLASS1.
000012 PROCEDURE DIVISION.
000013     CALL "SUB1" USING P1 P2            *> JMN3333I-S
000014     CALL "SUB2"                        *> JMN3414I-S
000015     CALL "SUB1" USING P1 RETURNING P2  *> JMN3508I-S
000016     CALL "SUB1" USING P2               *> JMN3335I-S
000017     CALL "SUB3" USING P3               *> JMN3334I-S
000018     EXIT PROGRAM.
000019*
000020 PROGRAM-ID. SUB1.
000021 DATA DIVISION.
000022 LINKAGE SECTION.
000023 01 L1 PIC X(20).
000024 PROCEDURE DIVISION USING L1.
000025 END PROGRAM SUB1.
000026*
000027 PROGRAM-ID. SUB2.
000028 DATA DIVISION.
000029 LINKAGE SECTION.
000030 01 RET PIC X(10).
000031 PROCEDURE DIVISION RETURNING RET.
000032 END PROGRAM SUB2.
000033*
000034 PROGRAM-ID. SUB3.
000035 DATA DIVISION.
```

```
000036 LINKAGE SECTION.
000037 01 L-OR1 USAGE OBJECT REFERENCE.
000038 PROCEDURE DIVISION USING L-OR1.
000039 END PROGRAM SUB3.
000040 END PROGRAM A.
```

When you compile program A, the following diagnostic message is output at the time of compilation.

```
** DIAGNOSTIC MESSAGE ** (A)
13: JMN3333I-S  THE NUMBER OF PARAMETERSPECIFIED IN USING PHRASE OF CALL STATEMENT MUST BE THE SAME
NUMBER OF PARAMETER SPECIFIED IN USING PHRASE OF PROCEDURE DIVISION.
14: JMN3414I-S  RETURNING ITEM MUST BE SPECIFIED FOR CALL STATEMENT WHICH CALLS 'SUB2'. THERE IS
RETURNING SPECIFICATION IN PROCEDURE DIVISION OF PROGRAM 'SUB2'.
15: JMN3508I-S  RETURNING ITEM MUST NOT BE SPECIFIED FOR CALL STATEMENT WHICH CALLS 'SUB1'. THERE IS
NOT RETURNING SPECIFICATION IN PROCEDURE DIVISION OF PROGRAM 'SUB1'.
16: JMN3335I-S  THE LENGTH OF PARAMETER 'P2' SPECIFIED IN USING PHRASE OR RETURNING PHRASE OF CALL
STATEMENT MUST BE THE SAME LENGTH OF PARAMETER 'L1' SPECIFIED IN PROCEDURE DIVISION USING PHRASE OR
RETURNING PHRASE OF PROGRAM 'SUB1'.
17: JMN3334I-S  THE TYPE OF PARAMETER 'P3' SPECIFIED IN USING PHRASE OR RETURNING PHRASE OF CALL
STATEMENT MUST BE THE SAME TYPE OF PARAMETER 'L-OR1' SPECIFIED IN PROCEDURE DIVISION USING PHRASE OR
RETURNING PHRASE OF PROGRAM 'SUB3'.
STATISTICS: HIGHEST SEVERITY CODE=S, PROGRAM UNIT=1
```

External program call parameter investigation

In a program invocation, an error in passing parameters causes a program malfunction because the program refers to or updates an unexpected data item or area.

When a COBOL program compiled by specifying a CHECK(PRM) compile option calls another COBOL program compiled in the same way, a message is output if the lengths of each of the parameters do not match.

```
000010 @OPTIONS CHECK(PRM)
000020 IDENTIFICATION DIVISION.
000030 PROGRAM-ID. A.
000040 DATA DIVISION.
000050 WORKING-STORAGE SECTION.
000060 01  USE-PRM01   PIC 9(04).
000070 01  USE-PRM02   PIC 9(04).
000080 01  RET-PRM01   PIC 9(04).
000090 PROCEDURE DIVISION.
000100     CALL 'B' USING USE-PRM01 USE-PRM02
000110              RETURNING RET-PRM01.
000120 END PROGRAM A.
```

```
000000 @OPTIONS CHECK(PRM)
000010 IDENTIFICATION DIVISION.
000020 PROGRAM-ID. B.
000030 DATA DIVISION.
000070 LINKAGE SECTION.
000080 01  USE-PRM01   PIC 9(08).
000090 01  USE-PRM02   PIC 9(04).
000100 01  RET-PRM01   PIC 9(04).
000120 PROCEDURE DIVISION USING USE-PRM01 USE-PRM02
000130                          RETURNING RET-PRM01.
000140 END PROGRAM B.
```

When the CALL statement in program A is executed, the following message is output:

```
JMP0812I-E/U  [PID:xxxxxxxx TID:xxxxxxxx] FAILURE IN 'USING 1ST PARAMETER' OF CALL STATEMENT.  PGM=A.
LINE=10.
```

2.2.4 Notes

You should consider the following things when using the CHECK function.

- Always use the CHECK function and correct abnormalities based on the detected information. If a detected abnormality is not corrected, serious trouble that can be difficult to detect, such as memory destruction, can occur at execution. The results of executing applications for which detected abnormalities have not been corrected will be unpredictable.
  Execution can be continued after an abnormality is detected by specifying a message output count, however, operation after detection of an abnormality cannot be guaranteed.
- The CHECK function performs processing other than the processing described in the COBOL program such as checking data. Therefore, the program size increases and execution speed deteriorates when the CHECK function is used.
- Use the CHECK function during debugging only. When debugging is completed, recompile the program with compiler option NOCHECK specified.
- In arithmetic statements with an ON SIZE ERROR or NOT ON SIZE ERROR phrase, CHECK(NUMERIC) does not check for a zero divisor as the COBOL code already handles that situation.
- If zero-divisor checking is performed, the program terminates abnormally, regardless of the specification of the message output count.
- CHECK(PRM) does not investigate CALL statements that specify identifiers as program names.
- CHECK(PRM) does not perform an investigation when an internal program is called by a CALL statement in which the program name is specified in an identifier.
- Both of the calling and called programs must be compiled with the CHECK(PRM) option in order to check parameters for calling external programs. A parameter check is not exercised if a program calls a program written in another language or is called by a program written in another language.
- In a CHECK(PRM) investigation for calling an external program an error is not always found if the difference in the number of calling and called parameters is more than 3.
- In the checks performed when CHECK(PRM) is specified, the parameter length of a variable-length item is the maximum length, not the length at the time of execution. Therefore, for a variable-length item, a message may be output even if the parameter lengths actually match.
- If a calling or called program does not specify a RETURNING phrase, the PROGRAM-STATUS is passed implicitly. Therefore the CHECK(PRM) checks will find a 8-byte RETURNING parameter in these situations where the RETURNING phrase is omitted.
- The CHECK function is effective only in programs that specify the CHECK option. When two or more programs are linked, only specify the CHECK option in the programs that you want to target.

2.3 Using the TRACE Function

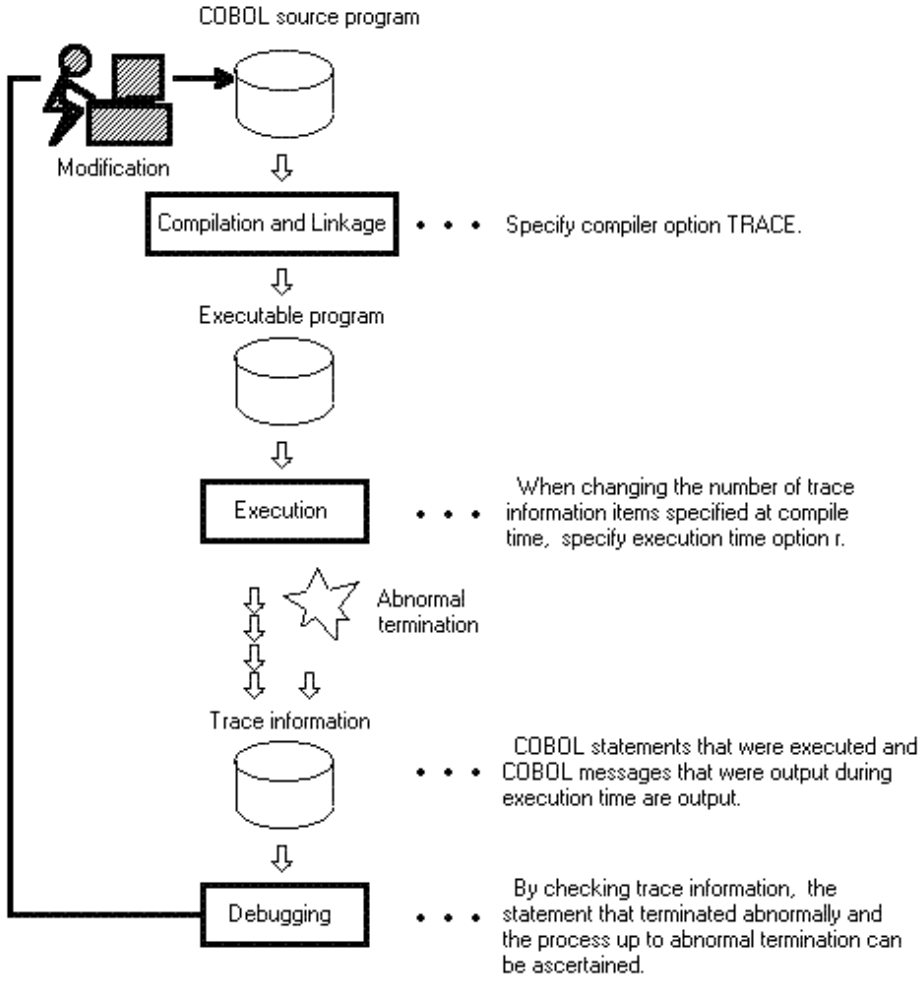
The TRACE function outputs trace information for the COBOL statements that have been executed up to program abnormal termination.

This section describes how to use the TRACE function.

2.3.1 Flow of Debugging

The following section shows the flow of debugging operation when using the TRACE function:

Figure 2.2 Flow of debugging with TRACE function



2.3.2 Trace Information

The TRACE function writes the statement numbers of COBOL statements that were executed, up to abnormal termination, as trace information.

Number of Trace Information Items

When compiler option TRACE is specified without specifying the number of information items at compile time, up to 200 trace information items are produced.

If one run unit contains two or more COBOL programs which had the TRACE option specified, the number specified with the TRACE option for the program that is activated first will be used.

To change the number of trace items to be generated, use the execution-time option r. The TRACE function can be suppressed by specifying execution time option nor. Refer to "Format of Runtime Options" in the "NetCOBOL User's Guide" for more information.

Note

Zero cannot be specified for the number of trace information items.

Trace Information Storage Destination

Trace information is stored in files specified in the environment variable information @CBR_TRACE_FILE. Refer to "@CBR_TRACE_FILE (Specify the trace information output file)" in the "NetCOBOL User's Guide".

If the environment variable information @CBR_TRACE_FILE is not specified, trace information is stored in files named after the executable file with the extensions TRC and TRO.

The trace information is always stored in a file with the extension TRC. When the number of stored information items reaches the specified count at compilation or execution, the contents of the file with the extension TRC are converted to a file with the extension TRO.

Examples of trace information storage file names that are assumed when the environment variable information @CBR_TRACE_FILE is specified and when it is not specified are provided below.

Example

If C:\PROG1.TRC is specified in the environment variable information @CBR_TRACE_FILE

- Trace information storage destination (current information): C:\PROG1.TRC
- Trace information storage destination (information on the previous generation): C:\PROG1.TRO

If the environment variable information @CBR_TRACE_FILE is not specified

- Executable program storage destination: C:\PROG2.EXE
- Trace information storage destination (current information): C:\PROG2.TRC
- Trace information storage destination (information on the previous generation): C:\PROG2.TRO

Output Format of Trace Information

The output format of trace information is shown below.

```
NetCOBOL DEBUG INFORMATION   DATE 2007-07-04 TIME 11:39:22
                                                        PID=00000123 (1)
TRACE INFORMATION
(2)        (3)                  (4)                  (5)             (6)
1 External-program-name [Internal-program-name] Compilation-date   TID=00000099
2            (7) 1100.1 TID=00000099
3              1200.1 TID=00000099
4              1300.1 TID=00000099
5    (8)       1300.2  (9)          (5)
6 Class-name [Method-name] Compilation-date TID=00000099
7              2100.1 TID=00000099
8              2200.1 TID=00000099
9     JMPnnnnI-x xxxxxxxxx xx xxxxxxxxx.                (10)
10       THE INTERRUPTION WAS OCCURRED.PID=00000123,... (11)
11       EXIT-THREAD TID=00000099                       (12)
:
```

- [1] Process ID (hexadecimal notation): The process identification number assigned by the operating system when the program was run.
- [2] Trace information sequence number (decimal notation): The value is incremented whenever trace information output is displayed. Since trace information is overwritten to two files alternately, this value indicates the sequence number of the information from the start of the program.
- [3] External program name: An external program name is output.
- [4] Internal program name: The name is the output when an internal program executes. This information is not displayed for external programs.
- [5] Compilation date: When an external program executes, the compilation date and time of the program are output.

- [6] Thread ID (hexadecimal notation): The thread identification number assigned by the operating system when the program was run.
- [7] Statement or procedure-name/paragraph-name that was executed: The statement number of the statement, procedure name, or paragraph name that was executed is the output.
- [8] Class-name: A class-name is listed here. If an inheriting method is executed, the class-name of the parent that has defined the procedures for the method will be listed.
- [9] Method-name: method-name is listed.
- [10] Execution-time message: If messages are generated by the runtime system during execution of the program, those messages will be shown here.
- [11] Exception report message: This message is generated when an exception (such as a reference to an illegal address) has been reported by the operating system. The message is not generated when the program has ended normally or when a U-level error has occurred.
- [12] Thread end report message: This message is generated when the program terminates normally and the thread has ended.

Trace Information File

The trace information file of each process is output. In order to prevent overwriting the results of each run with trace, change the name of the trace output file each time you execute the same program.

When the trace information file name of each process is changed, the environment variable information @CBR_TRACE_PROCESS_MODE is specified.

Refer to "@CBR_TRACE_PROCESS_MODE (Unique file name foe each Trace file output)" in the "NetCOBOL User's Guide" for the detail.

An example of the file name when @CBR_TRACE_PROCESS_MODE is specified is shown below.

Example

When the environment variable information @CBR_TRACE_PROCESS_MODE is specified

```
Executable file name:SAMPLE.EXE
Process-ID:00000EC4
Execution date:12/1/2010
Execution time:10:48:50
```

The newest trace information file name is :

```
SAMPLE-00000EC4_20100112_104850.TRC
```

The older trace information file name is :

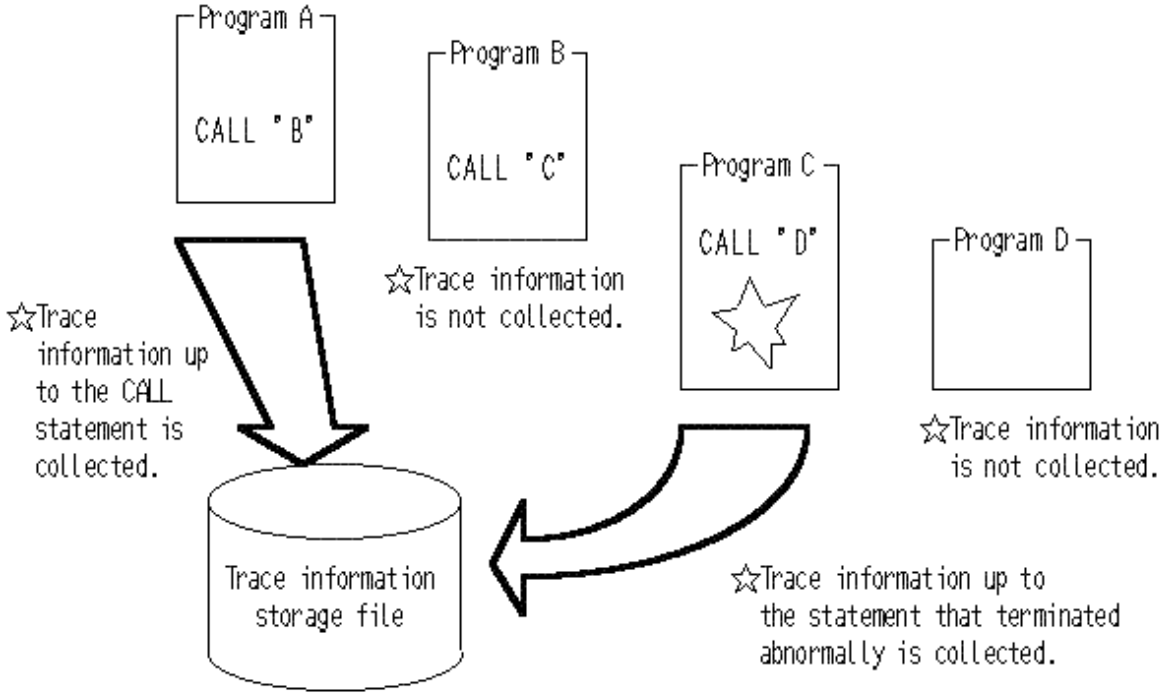
```
SAMPLE-00000EC4_20100112_104850.TRO
```

2.3.3 Notes

This section provides you with some notes/suggestions you should take into account when you use the TRACE function.

Trace information can be collected only for COBOL programs compiled with compiler option TRACE specified.

Figure 2.3 Collecting TRACE information



Program A : COBOL program that was compiled with compiler option TRACE specified
Program B : COBOL program that was compiled with compiler option NOTRACE specified
Program C : COBOL program that was compiled with compiler option TRACE specified
Program D : Program coded in a different language

- The TRACE function performs processing other than the processing described in the COBOL program, such as collection of trace information. Therefore, the program size increases and the execution speed deteriorates when the TRACE function is used.
- Use the TRACE function during debugging only. When debugging is completed, recompile the program with compiler option NOTRACE specified.
- The number of trace information items cannot be set to 0.
- When the TRACE function is selected, trace information is generated regardless of whether the program terminated normally or abnormally.
- When a program is executed again while a trace information file exists, the contents of the original trace information file will be lost.
- When a trace information file is no longer needed, delete the file.
- No exception report message may be generated when the TRACE function is used in conjunction with the debugging function of NetCOBOL Studio.
- No information is included in a trace information file that identifies a prototype-declared method.
- In referencing the statement number of a method, reference the class name and the method name to determine whether the method has been separated by a prototype declaration. With a separated method, the statement number is expressed by the line number of the source file of the separated method, not by the line number of the class definition source file.
- A trace information file is output for each executable file processed.
  Information cannot be output from two or more processes to the same file at the same time- this will produce an output error at execution time.
  In order to prevent overwriting the results of each run with trace, change the name of the trace output file each time you execute the same program.

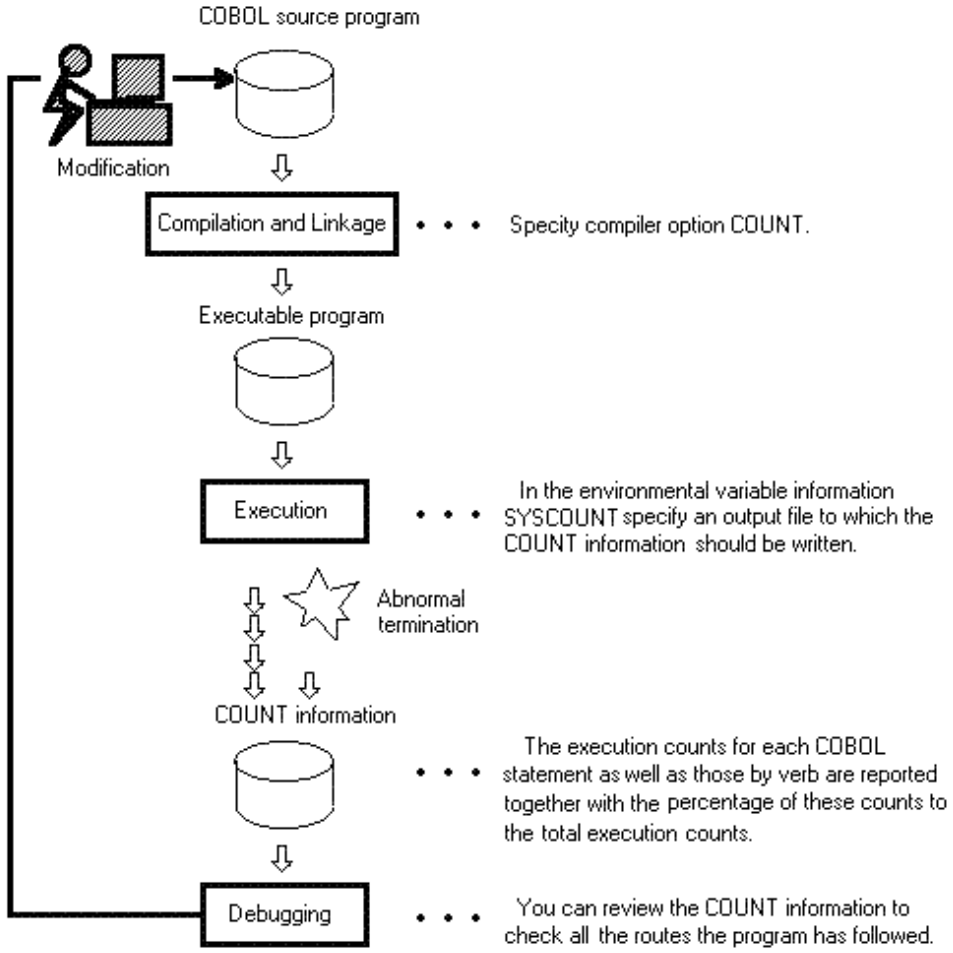
2.4 Using the COUNT function

The COUNT function provides the ability to report the execution count for each statement written in a source program sequentially, along with the percentage of one count vs. another for all the statements. In addition, it shows the count by verb along with its percentage. The COUNT function enables the user to know exactly how many times each statement is executed and helps to optimize programs.

2.4.1 Flow of Debugging

The following section shows the flow of debugging operation when using the COUNT function.

Figure 2.4 Flow of debugging with COUNT function



2.4.2 Count Information

When the compile option COUNT is enabled, the data will be written to a file specified in the environment variable name SYSCOUNT.

Output Format of Count Information

The output format of count information is shown below:

```
[1]
NetCOBOL COUNT INFORMATION(END OF RUN UNIT)   DATE 2007-07-04 TIME 20:45:21
                                               PID:00000123 TID:00000099
[2]
STATEMENT EXECUTION COUNT  PROGRAM-NAME : COUNT-PROGRAM
```

```
    [3]                                          [5]          [6]
    STATEMENT     [4]                            EXECUTION    PERCENTAGE
      NUMBER      PROCEDURE-NAME/VERB-ID            COUNT           (%)
-------------  -------------------------- ---------------- -----------
           15  PROCEDURE DIVISION   COUNT-PROGRAM
           17      DISPLAY                              1     14.2857
           19      CALL                                 1     14.2857
           21      DISPLAY                              1     14.2857
           23      STOP RUN                             1     14.2857
           31 PROCEDURE DIVISION   INTERNAL-PROGRAM
           33      DISPLAY                              1     14.2857
           35      INVOKE                               1     14.2857
           37      EXIT PROGRAM                         1     14.2857
-------------  -------------------------- ---------------- -----------
                                                        7
[7]
VERB EXECUTION COUNT    PROGRAM-NAME : COUNT-PROGRAM
                                  [11]                        [13]
[8]       [9]         [10]        PERCENTAGE  [12]            PERCENTAGE
VERB-ID   ACTIVE VERB TOTAL VERB        (%)  EXECUTION COUNT       (%)
------------ -------- ---------- -------- ------------------ --------
CALL              1           1 100.0000                  1  25.0000
DISPLAY           2           2 100.0000                  2  50.0000
STOP RUN          1           1 100.0000                  1  25.0000
------------ -------- ---------- -------- ------------------ --------
                  4           4 100.0000                  4
[7]
VERB EXECUTION COUNT    PROGRAM-NAME : COUNT-PROGRAM
                                       (INTERNAL-PROGRAM)
                                  [11]                        [13]
[8]       [9]         [10]        PERCENTAGE  [12]            PERCENTAGE
VERB-ID   ACTIVE VERB TOTAL VERB        (%)  EXECUTION COUNT       (%)
------------ -------- ---------- -------- ------------------ --------
DISPLAY           1           1 100.0000                  1  33.3333
EXIT PROGRAM      1           1 100.0000                  1  33.3333
INVOKE            1           1 100.0000                  1  33.3333
------------ -------- ---------- -------- ------------------ --------
                  3           3 100.0000                  3
[14]
PROGRAM EXECUTION COUNT    PROGRAM-NAME : COUNT-PROGRAM
                                    [18]                      [20]
[15]       [16]         [17]      PERCENTAGE [19]            PERCENTAGE
PROGRAM NAME ACTIVE VERB TOTAL VERB        (%) EXECUTION COUNT       (%)
------------ ---------- ----------- --------- --------------- ----------
COUNT-PROGRAM      4           4 100.0000                  4  57.1429
INTERNAL           3           3 100.0000                  3  42.8571
------------ ---------- ----------- --------- --------------- ----------
                   7           7 100.0000                  7
[1]
NetCOBOL COUNT INFORMATION(END OF RUN UNIT)   DATE 2007-07-04 TIME 20:45:21
                                               PID=00000123 TID=00000099
[2]
STATEMENT EXECUTION COUNT  CLASS-NAME : COUNT-CLASS
    [3]                                          [5]          [6]
    STATEMENT     [4]                            EXECUTION    PERCENTAGE
      NUMBER      PROCEDURE-NAME/VERB-ID            COUNT           (%)
-------------  -------------------------- ---------------- -----------
           15  PROCEDURE DIVISION   COUNT-METHOD
           16      DISPLAY                              1     50.0000
           37      EXIT PROGRAM                         1     50.0000
-------------  -------------------------- ---------------- -----------
                                                        2
[7]
```

```
VERB EXECUTION COUNT    CLASS-NAME  : COUNT-CLASS
                        METHOD-NAME : COUNT-METHOD
                                  [11]                        [13]
[8]       [9]         [10]       PERCENTAGE  [12]            PERCENTAGE
VERB-ID   ACTIVE VERB TOTAL VERB        (%)  EXECUTION COUNT       (%)
------------ -------- ---------- -------- ------------------ --------
DISPLAY            1           1 100.0000                  1  50.0000
END METHOD         1           1 100.0000                  1  50.0000
------------ -------- ---------- -------- ------------------ --------
                   2           2 100.0000                  2
[14]
VERB EXECUTION COUNT    CLASS-NAME  : COUNT-CLASS
                                  [18]                        [20]
[15]      [16]        [17]       PERCENTAGE  [19]            PERCENTAGE
VERB-ID   ACTIVE VERB TOTAL VERB        (%)  EXECUTION COUNT       (%)
------------ -------- ---------- -------- ------------------ --------
COUNT METHOD       2           2 100.0000                  2 100.0000
------------ -------- ---------- -------- ------------------ --------
                   2           2 100.0000                  2
[21]
PROGRAM/CLASS/PROTOTYPE METHOD EXECUTION COUNT
[22]                                  [25]                        [27]
PROGRAM/CLASS [23]        [24]       PERCENTAGE  [26]            PERCENTAGE
/METHOD-NAME  ACTIVE VERB TOTAL VERB        (%)  EXECUTION COUNT       (%)
------------  ----------- ---------- ---------- ---------------- ---------
COUNT PROGRAM           7          7 100.0000                  7 100.0000
COUNT CLASS             2          2 100.0000                  2 100.0000
------------  ----------- ---------- ---------- ---------------- ---------
                        9          9 100.000                   9
```

- [1] Indicates that this is an output file for the COUNT function. In the parentheses, the stage when this report is generated will be denoted. There are four stages when this report could be generated:
  - END OF RUN UNIT

    Upon completion of a COBOL run unit (i.e., at the time a STOP RUN statement or an EXIT PROGRAM statement of a main program is executed), a report is produced.
  - ABNORMAL END

    When the program ends abnormally, a report is produced.
  - END OF INITIAL PROGRAM

    Upon completion of a program that has the INITIAL attribute, a report is produced. Upon completion of the internal program, however, no report will be produced.
  - CANCEL PROGRAM

    When a program that has the compile option COUNT enabled is canceled by a CANCEL statement, a report is produced. Upon completion of an internal program, however, no report will be produced.
- [2] The execution counts of source program images are listed here. Execution counts are shown by compilation unit of a source program. If a compilation unit is a program, PROGRAM-NAME shows an external program-name. In case of a class, CLASS-NAME shows a class-name. In case of a method, CLASS-NAME shows a class-name and METHOD-NAME shows a method-name.
- [3] Statement-numbers appear in the following format:

```
[COPY qualifying value-] line number
```

  If one line contains two or more statements, the same line number will be assigned to the second and succeeding statements.
- [4] Procedure names and statements are shown here. At the top of the procedure division, "PROCEDURE DIVISION" is followed by a program-name or method-name.
- [5] Statement execution counts are shown here. At the end, the total of those execution counts is calculated.

- [6] Percentage of the execution count for one specific statement vs. all executed statements.
- [7] Execution counts by verb are listed here. Verb execution counts are shown by program unit or method unit. For programs having internal programs or for classes having two or more methods, therefore, two or more listings of execution counts by verb will appear. PROGRAM-NAME denotes a program-name in the following format:

```
PROGRAM-NAME: program-name
           [(called internal program)]
```

- [8] Lists verbs in alphabetical order. Verbs to be listed here are those coded in the corresponding programs.
- [9] The number of imperatives actually executed among those written in the source program.
- [10] The total number of the verbs of that type found in the source program.
- [11] Percentage of those verbs actually executed vs. the total, using the following formula: [9] / [10] * 100.
- [12] Execution counts for each verb. At the bottom, the total of those execution counts is indicated.
- [13] Percentage of the execution count for a specific verb vs. that for all, using the following formula: each verb's execution count/ total execution count * 100.
- [14] Execution counts by program or by method are listed here. This list is generated when a class or program has an internal program.
- [15] Program- or method-names in the order listed in the source program.
- [16] The number of verbs actually executed among those found in the source program.
- [17] The total number of verbs of that type found in the source program.
- [18] Percentage of actually executed verbs vs. the total number of verbs of that type, using the following formula: [16] / [17] * 100.
- [19] Verb execution counts by program or method. At the bottom, the total of those execution counts is indicated.
- [20] For each program or method, the percentage of actually executed verbs vs. the total number of the verbs of that type, using the following formula: verb execution count for each program (or method)/total verb execution counts for all programs (or methods) * 100.
- [21] Verb execution counts by source program (compilation unit) are listed here. If one run unit has two or more source programs (or compilation units), the above-mentioned data repeatedly appear for each of such programs.
- [22] Names of external programs, classes, and prototype methods.
- [23] Refer to [16].
- [24] Refer to [17].
- [25] Refer to [18].
- [26] Verb execution counts for each compilation unit. At the end, the total of those counts is indicated.
- [27] Percentage of the verb execution counts for each compilation unit vs. that for all the compilation units. This is obtained by calculating the following: verb execution count for each compilation unit / verb execution count for all the compilation units * 100.

2.4.3 Debugging Programs with the COUNT Function

You can utilize the COUNT function to debug your program for the following purposes:

- To check all the routes the program follows:

  The listings generated by the COUNT function shows how many times statements were actually executed. This information allows you to check all the possible routes your program would follow.

- To improve the efficiency of your program

  The listings generated by the COUNT function shows the percentage of execution counts for each statement and the percentage of verb execution counts by program unit. This enables you to identify frequently used portions of your program. Optimizing these portions will allow you to improve the efficiency of your program.

2.4.4 Notes

This section provides you with some notes/suggestions you should take into account when you use the COUNT function.

- The COUNT function performs tasks not described by COBOL statements, such as gathering COUNT information. When this function is used, it will increase your program in size and slow down its executing speed. Therefore, it is recommended to use this only for debugging activities. Debugged programs should be recompiled with the compile option NOCOUNT specified.
- If a file is produced due to the abnormal termination of a program, the statement that has caused it will be included in the report.
- If a CANCEL statement is executed, COUNT information for the program to be canceled will be written. If the canceled program calls another program, COUNT information for the latter program will be shown under the calling program.
- You should specify the SYSCOUNT environment variable to define an output file name.
- When an application called from a different language program terminates abnormally , the COUNT information might not be output.
- COUNT information is output to the output file specified for environment variable SYSCOUNT. It cannot be output from two or more processes to the same file at the same time - this will produce an output error at execution time. Change the output file name of each process when you execute two or more processes at the same time.

2.5 Using the Memory Check Function

The memory check function is used to diagnose memory area destruction when a COBOL application is executed. The memory check function checks the runtime system area at the start and end of the procedure division of a COBOL application. If the following runtime messages are output or event occurs, the area may have been destroyed. Therefore, use the memory check function to check for the cause of memory destruction.

- JMP0009I-U INSUFFICIENT STORAGE AVAILABLE. (*1)
- JMP0010I-U LIBRARY WORK AREA IS BROKEN.
- An application error occurred (access violation).

  *1 : This message can also be output even when virtual memory is not insufficient. Refer to "Virtual memory shortages" in the "NetCOBOL User's Guide".

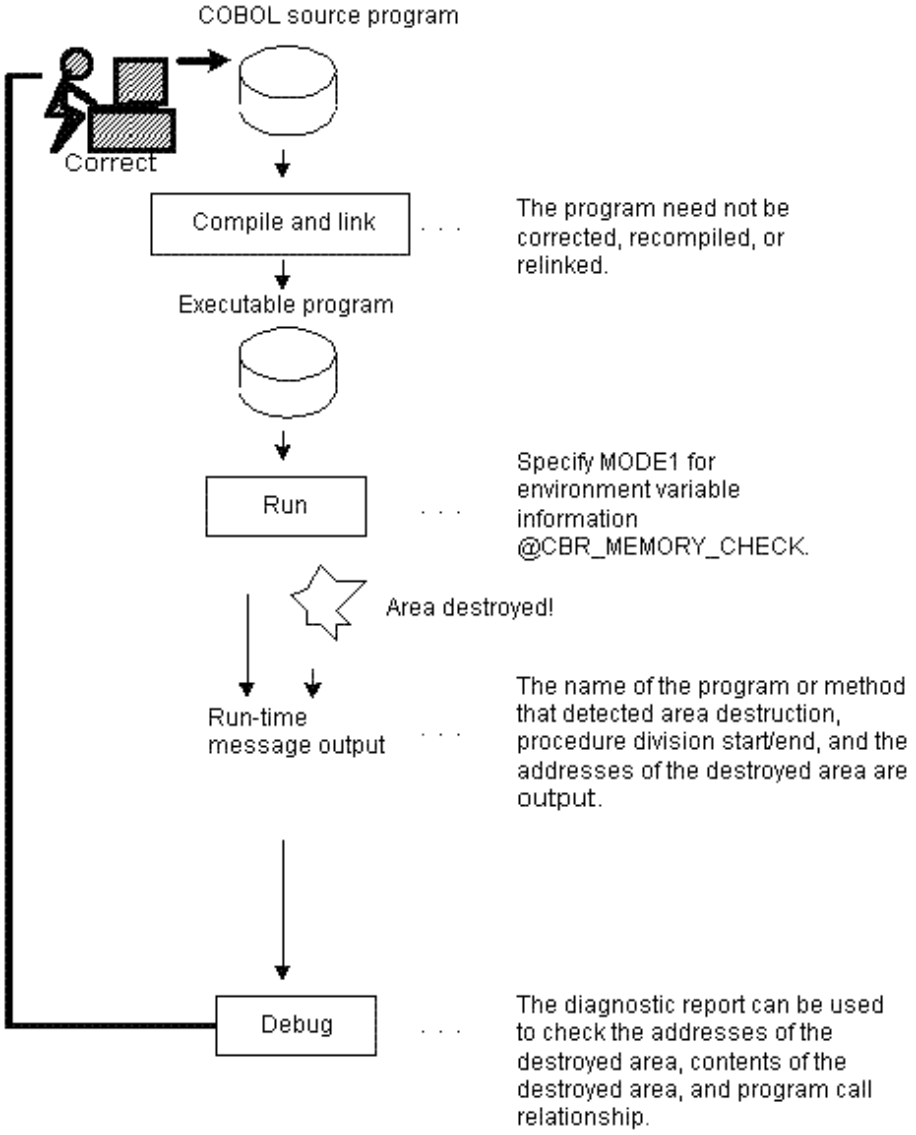
When using the memory check function, specify environment variable information @CBR_MEMORY_CHECK=MODE1.

Refer to "@CBR_MEMORY_CHECK (Specify the inspection using the memory check function)" in the "NetCOBOL User's Guide".

2.5.1 Flow of Debugging

The following section shows the flow of debugging operation when using the memory check function.

Figure 2.5 Flow of debugging with memory check function



2.5.2 Output Message

The memory check function outputs the following messages when area destruction is detected. The messages are usually output to the message box.

The following describes the messages of the memory check function:

When area destruction is detected at the start of a procedure division of a program or method

JMP0071I-U

[PID:xxxxxxxx TID:xxxxxxxx] LIBRARY WORK AREA DESTRUCTION WAS DETECTED. START PGM=program-name BRKADR=leading-address-of-destroyed-area

If area destruction is detected for a method, PGM=program-name will be replaced by CLASS=class-name METHOD=method-name.

When area destruction is detected at the end of a procedure division of a program or method

JMP0071I-U

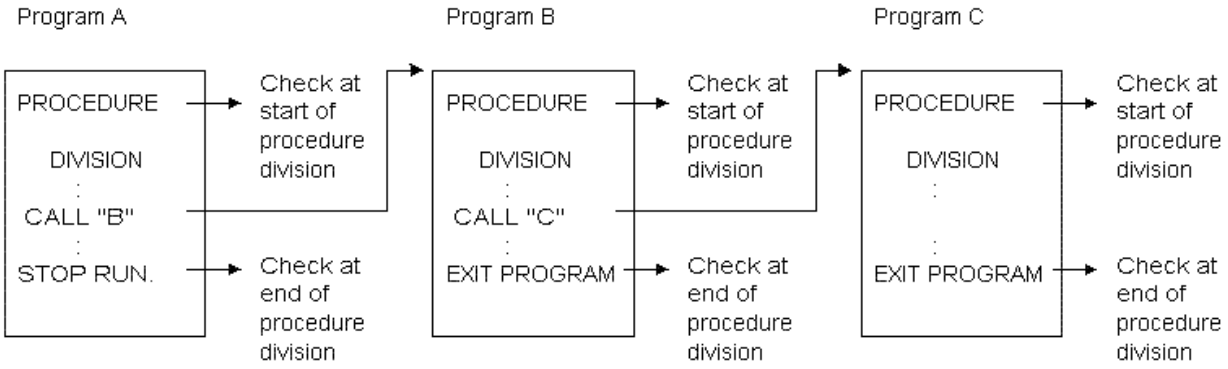
[PID:xxxxxxxx TID:xxxxxxxx] LIBRARY WORK AREA DESTRUCTION WAS DETECTED . END PGM=program-name BRKADR=leading-address-of-destroyed-area

If area destruction is detected for a method, PGM=program-name will be replaced by CLASS=class-name METHOD=method-name.

2.5.3 Identifying programs

The following shows how to identify programs that caused area destruction.

Assume that an area destruction message is output for the following call relationship:




```
JMP0071I-U [PID:00000010 TID:0000000E] LIBRARY WORK AREA DESTRUCTION WAS DETECTED.
        START PGM=C BRKADR=0x00000000 00202000
```

The memory check function checks the runtime system area at the start and end of the procedure division of a program. In this example, area destruction is not detected by the check at the start of the procedure division of COBOL program A or by the check at the start of the procedure division of COBOL program B. Area destruction is detected by the check at the start of the procedure division of COBOL program C. Accordingly, area destruction occurred before invoking COBOL program C after the check at the start of the procedure division of COBOL program B.

2.5.4 Notes

The memory check function checks the runtime system area at the start and end of the procedure division of a program. As a result, the execution speed will be slower. When debugging ends, disable the memory check function (environment variable information @CBR_MEMORY_CHECK).

2.6 Using the COBOL Error Report

This section explains the outline and the usage of COBOL Error Report.

2.6.1 COBOL Error Report overview

The COBOL Error Report outputs diagnostic information for the following problems:

- Application errors
- Runtime messages of U-level

The COBOL Error Report outputs error information such as the location where the error occurred, program calling relationship, and application state. The COBOL Error Report uses COBOL language-level information such as the program name and line number to output the error information.

The COBOL Error Report outputs Dump for the following problems:

- Application errors except a stack overflow exception (0xC00000FD)

- Runtime messages of U-level
  - JMP0009I-U
  - JMP0010I-U
  - JMP0370I-U

The COBOL Error Report can also be used for troubleshooting when the application error or runtime messages occurred when operating.

The COBOL Error Report has the following features:

- The COBOL Error Report works directly on operational modules without having to reconfigure the application to use it.
- COBOL Language level information can be output by using the debugging information file and program database file.

2.6.2 Resources used by the COBOL Error Report

This section focuses on the programs and resources the COBOL Error Report uses to generate diagnostic reports.

2.6.2.1 Programs

For application errors and runtime messages of U-level errors, the COBOL Error Report is enabled while the COBOL runtime environment is open. Hence, the COBOL Error Report works on the following kinds of programs:

- COBOL programs
- Non-COBOL programs linked with a COBOL program

2.6.2.2 Relationships between compiler and linkage options and output information

There are no special constraints on creating programs to be the object of the COBOL Error Report. The COBOL Error Report will generate a diagnostic report on any program as long as it is a COBOL program. The coverage of information in the diagnostic report, however, varies with each combination of compiler and linkage options specified. A summary of the correspondence between the possible combinations of compiler and linkage options and output information in the diagnostic report is given in "Table 2.2 Relationships between COBOL programs and output information".

Table 2.2 Relationships between COBOL programs and output information

Step	Details		[1]	[2]	[3]	[4]	[5]	[6]
Compiling	Specification of the TEST option		No	No	Yes	Yes	Yes	Yes
Linkage	Specification of the /DEBUG options		No	Yes	No	No	Yes	Yes
Execution	Availability of a debugging information file		No	No	Yes	No	No	Yes
	Availability of a program database file		No	Yes	No	No	Yes	Yes
Diagnostics	Information level	Export name + Offset	Yes	Yes	Yes	Yes	Yes	Yes
		Symbol name + Offset	No	Yes	No	No	Yes	Yes
		Program name + Line number	No	No	No	No	No	Yes

For details about export and symbol names, refer to "Export relative position" and "Symbol relative position" of "2.6.4.2 Diagnostic report output information".

The level of information output to the diagnostic report is determined by the compilation, linkage, and run conditions.

For example, if no option is specified at compilation and linkage (conditions of column [1]), information of the "Export name + Offset" level will be output to the diagnostic report.

If COBOL language-level information such as the program name and line number is output to the diagnostic report, statements that cause problems can be easily identified. Therefore, it is recommended that options be specified at compilation and linkage and that

applications be executed where the COBOL Error Report can access the debugging information file and the program database file(conditions of column [6]).

When the COBOL Error Report can output information to the language-level, items of information are generated in the form of the following examples.

Example

Output example: In case of [6] in "Table 2.2 Relationships between COBOL programs and output information"

```
Module File : D:\APL\SAMPDLL2.dll
Section Relative Position : .text+0000025D
Export Relative Position : SAMPDLL2+00000229
Symbol Relative Position : SAMPDLL2+0000025D
Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
External Program/Class : SAMPDLL2
Source File : SAMPDLL2.cob
Source Line : 35
```

The COBOL Error Report will not generate language-level information when it examines the following kinds of programs but will still generate the export and symbol names and their offsets from the beginning:

- A program in which neither a compiler option nor a linkage option is specified
- When the COBOL Error Report cannot read the debugging information file and the program database file at execution time even if you specify both the compiler option and the linkage option

The export name, the symbol name, and the offset from each head are generated in the form of the following examples.

Example

Output example: Only the export name and the offset (In case of [1][3][4] in "Table 2.2 Relationships between COBOL programs and output information")

```
Module File : D:\APL\SAMPDLL2.dll
Section Relative Position : .text+0000025D
Export Relative Position : SAMPDLL2+00000229
```

Output example: Symbol name and offset (In case of [2][5] in "Table 2.2 Relationships between COBOL programs and output information")

```
Module File : D:\APL\SAMPDLL2.dll
Section Relative Position : .text+0000025D
Export Relative Position : SAMPDLL2+00000229
Symbol Relative Position : SAMPDLL2+0000025D
```

Since export and symbol names each represent a compilation unit, they can easily be identified without needing language-level information output at execution time.

At this level, an object program listing is required to locate problems. The object program listing is created when the compiler options LIST and PRINT are specified at compilation. Refer to "LIST (Determines whether to output the object program listings)" and "-P (Compiler listing file name)" in the "NetCOBOL User's Guide".

An example of an object program listing is shown below. A summary method of locating problems from export and symbol name relative offsets is described below.

```
       ADDR       OBJECT CODE  LABEL   INSTRUCTION

       BEGINNING OF SAMPDLL2
       BEGINNING OF SAMPDLL2
       BEGINNING OF ENTRY POINT CODE
[1] -> 000000000000  3100
```

```
       000000000002  0800
       000000000004  53414D50444C4C32
                     "SAMPDLL2"
       00000000000C  08
       00000000000D  4E6574434F424F4C
                     "NetCOBOL"
       000000000015  07
       000000000016  5631302E322E30
                     "V10.2.0"
       00000000001D  3230313030323231
                     "20100221"
       000000000025  3133303631343030
                     "13061400"
       00000000002D  2B30303030
       000000000032  30313031
       000000000036  CCCC
                              GLB.1
                              SAMPDLL2:
[2] -> 000000000038  48894C2408              mov       qword ptr [rsp+0x08],rcx
       00000000003D  4889542410              mov       qword ptr [rsp+0x10],rdx
       000000000042  4C89442418              mov       qword ptr [rsp+0x18],r8
       000000000047  4C894C2420              mov       qword ptr [rsp+0x20],r9
       00000000004C  55                      push      rbp
       00000000004D  4889E5                  mov       rbp,rsp
Omitted
```

A symbol name + offset 0 are located at [1] in the list above. Symbol name relative offsets, therefore, match the output offsets in the object program listing. Given a symbol name relative offset and an object program listing, problems can be easily located.

An export name + offset 0 are located at [2] in the list. Knowledge of the differences between [1] and [2] is essential to locating problems from an object program listing on the basis of export name relative offsets. In this example, an export name relative offset plus 38 (hexadecimal) matches the offset in the object program listing.

2.6.2.3 Compiling and linking programs

To allow the COBOL Error Report to generate language-level information, it is necessary to specify an option when compiling and linking programs.

The compiler options that are specified at program compile time are described below.

(Use of the compiler Visual C++ is assumed for this example, for non-COBOL programs.)

```
COBOL programs: TEST
C/C++ programs: There is no compiler option to specify for the COBOL Error Report
```

Specify the compiler option TEST to compile COBOL source programs. If TEST is specified, the compiler generates information in the object file for use by the COBOL Error Report and creates a debugging information file at the same time. The debugging information file is named after the COBOL source file name with its extension changed to SVD.

The compiler option OPTIMIZE may be specified together with the compiler option TEST to direct optimization. The debugging information file created when both TEST and OPTIMIZE are specified is smaller than that created when only TEST is specified, because the amount of information written to the debugging information file is limited by both compiler options TEST and OPTIMIZE.

Note

The debugging information file created by having the compiler option OPTIMIZE specified cannot be used with the debugger of NetCOBOL Studio.

The linkage options specified at program linkage time are shown below.

```
/DEBUG
```

Specify the linkage options /DEBUG to link object files of COBOL and non-COBOL programs. When this option is specified, the linker directs the information generated by the compiler in the object file to a Program database file.

2.6.2.4 Location of the Debugging Information File and the Program Database File

To allow the COBOL Error Report to generate the language-level information, it is necessary to store the debugging information file and the Program database file in the same folder as an executable file and the dynamic link library.

Store the debugging information file and the Program database file in the operation machine together with an executable file and the dynamic link library when you use the COBOL Error Report by operating environment. When the debugging information file and the Program database file do not exist, the COBOL Error Report outputs the assembler-level information composed of export name, symbol name and offset. Refer to "2.6.2.2 Relationships between compiler and linkage options and output information" for output information on the COBOL Error Report.

2.6.3 Starting the COBOL Error Report

2.6.3.1 How to start the COBOL Error Report

When an application error or U-level runtime message occurs, the COBOL Error Report detects the error and starts automatically.

Environment variable @CBR_JUSTINTIME_DEBUG can be used to control starting of the COBOL Error Report. When @CBR_JUSTINTIME_DEBUG has not been set, the COBOL Error Report will be started as the default. Refer to "@CBR_JUSTINTIME_DEBUG (Specify inspection using the COBOL Error Report at abnormal termination)" in the "NetCOBOL User's Guide".

2.6.3.2 Start parameter

The format of the start parameters is shown below. In the example below, the COBOL Error Report is directed to change the output folder of the report file and report event occurrence to an event log file.

Example

```
@CBR_JUSTINTIME_DEBUG=ALLERR, SNAP -r c:\log -l
```

Table 2.3 Start parameters

Specification format	Description
-d { YES | NO }	Specifies whether to output the dump. - YES : Output the dump. - NO : Do not output the dump. If this parameter is omitted, the defaults is YES.
-i {0 | 1 | 2}	Specifies the output contents. - 2 : Output the environment variable information, initial file name and the contents of various information files. - 1 : Output the environment variable information and initial file name. - 0 : Do not output the environment variable information or initial file name. Omitting this start parameter defaults to 2.
-o folder-name	Specifies the output destination folder for the dump file as either an absolute path or a relative path. Specify an existing folder. (*) A relative path specifies a folder relative to where the executable file exists. If the specified folder does not exist and output is not possible, the dump file is output to the standard output destination folder.

Specification format	Description
	If this start parameter is omitted, the dump file is output to the standard output destination folder. Refer to "2.6.5.2 Dump output destination" for information concerning the standard output destination folder.
-r folder-name	Specifies the output destination folder for the diagnostic report file as either an absolute path or a relative path. Specify an existing folder. (*) A relative path locates the diagnostic report file output destination folder relative to the folder in which the executable file exists. If the specified output destination folder does not exist and output is not possible, the diagnostic report file is output to the standard output destination folder. Similarly, if this start parameter is omitted, the diagnostic report file is output to the standard output destination folder. Refer to "2.6.4.1 Diagnostic report output destination" for information concerning the standard output destination folder.
-l [computer-name]	Specifies that the occurrence of each application error or runtime message be written to an event log. If a computer name is specified, the occurrence is written to the event log of the specified computer. If a computer name is not specified, the occurrence is written to the event log of the computer where the problem occurred.
-s output-unit-count	Specifies the size for outputting to the stack dump as the output unit count (1 unit: 1024 bytes). Specify a value greater than 0 for the output unit count. - 0: Output all stack contents. - 1 or greater: Output stack contents having a size of the specified value ´ 1024 bytes. Omitting this start parameter defaults to 2.

* : The following access authority to Everyone group is necessary for the folder.

- Modify
- Read & execute
- List folder contents
- Read
- Write

Note

- Start parameters are handled the same way whether they are preceded with a hyphen (-) or slash (/).
- The parameter name that follows the first character of an initial name is case-insensitive.
- Spaces may or may not intervene between a parameter name and the operand.
- When two or more start parameters are specified, they must be separated from one another by at least one blank.
- When a folder name appearing in a parameter contains a blank, the folder name must be enclosed with quotation marks ("). When a folder name begins with a hyphen (-), it must also be enclosed with quotation marks (").

Information

If the start parameters -l is omitted, the occurrence of an application error or a runtime message will be reported to the computer on which the problem occurred via the message box.

2.6.4 Diagnostic Report

2.6.4.1 Diagnostic report output destination

The COBOL Error Report writes diagnostic information to a report file.

The report file name is "Applicaton-name_ProcessID_Error-occurrence-time" with the extension LOG.

Example

```
Application name            :  TESTPGM.EXE
Process ID                  :  2D8
Error occurrence time       :  2009.07.10 15:04:26
Diagnostic report file name :  TESTPGM_2D8_20090710-150426.LOG
```

The standard output destination for diagnostic reports is \Fujitsu\NetCOBOL\COBSNAP under the user common application data folder (the folder on each computer where application-specific data is stored).

Generally the diagnostic reports output destination is created using the following names:

C:\ProgramData\Fujitsu\NetCOBOL\COBSNAP

To change the output destination folder, specify the "-r" start parameter. Refer to "2.6.3.2 Start parameter" for details of start parameters.

Note

The user common application data folder is usually a read-only folder. The following access authority to the Everyone group is necessary for the folder that outputs the diagnostic report.

- Modify
- Read & execute
- List folder contents
- Read
- Write

The COBOL Error Report writes the occurrence of each event to the message box and to the application event log file.

In the message box, a message indicating the event occurrence and a message inquiring whether to open the diagnostics report are output. Clicking the [Yes] button in the message box opens the diagnostics report.

Note

If the application is operated as a background service, the diagnostic report cannot be opened from the message box.

Each event log is designated by NetCOBOL SNAP x64 as a source name, a message number as an event ID, a severity code as a type, and a message body as an explanation. The severity codes of the COBOL Error Report messages and the event log types are associated as shown below to accommodate differences in level classifications between the system and the COBOL Error Report.

Table 2.4 Correspondence between the severity codes of COBOL Error Report messages and event log types

Severity code	Event log type
I (INFORMATION)	INFORMATION
W (WARNING)	WARNING
E (ERROR)	
U (UNRECOVERABLE)	ERROR

The event occurrence report is directed by default to the message box. Use the start parameter -l to change the destination. For details about the start parameters, refer to "2.6.3.2 Start parameter".

If diagnostic report output fails, for example, due to inadequate disk space, an error message is issued to the event output destination.

Note

Many services do not perform I-O from screens. If event logs are used under a service that does not perform I-O from screens, specify the "-l" start parameter and specify the event log as the event notification destination.

2.6.4.2 Diagnostic report output information

The COBOL Error Report generates the following items of information in a diagnostic report:

Summary

A summary of the diagnostic information

- Event detected

  A diagnostic report always begins with the following line:

```
The application error occurred:
or
The COBOL runtime message occurred:
```

- Application

  The application name (absolute path name format) and process ID (hexadecimal)

- Exception number

  When an application error occurs, an exception code (hexadecimal) and exception name are generated. For details about the exception code and exception name, refer to "Table 2.5 Exception codes and exception names". When a runtime message occurs, its body is generated.

- Generation time

  The date and time when the error occurred is generated.

- Generation module

  The name of the module in which the error occurred (absolute path name), its creation time, and file size are generated.

Detail

The location at which the error occurred is generated.

- Thread ID

  The thread ID (hexadecimal) of the thread in which the error occurred

- Register

  A listing of the register values (hexadecimal) in effect when the error occurred

- Stack commit

  The state of the stack (all in hexadecimal) when the error occurred

  - Commit size

    Allocated stack size (Commit size = top address - base address)

  - Top address

    Highest-order address of stack

  - Base address

    Lowest-order address of allocated stack

- Instruction

  The machine language codes (hexadecimal) 16 bytes before and after the error location

- Module file

  The name, in absolute path format, of the module in which the error occurred

- Section relative position

  The relative location (hexadecimal) of the module from the beginning of the .text section

- Export relative position

  If the module has export information, the export name having its address closest to the error location and the relative value (hexadecimal) from the beginning of the export name are generated.

  The export name of a COBOL program is shown below:

```
External program :  External program name
ENTRY            :  Entry name
Class            :  _class name_FACTORY
Method           :  __class name_method name@###, or
                    __class name__ENTRY_method name@###
Method (PROPERTY):  __class name__GET_method name@###,
                    __class name__SET_method name@###,
                    __class name__ENTRY__GET_method name@###, or
                    __class name__ENTRY__SET_method name@###
```

  The export name of a non-COBOL program is shown below:

```
Function:  Function name or function name@###
```

  The "###" of "@###" following the method name or function name is a decimal value representing the parameter byte count.

  When no symbol name or program name is generated, the compilation unit can be identified from the export name if an export name has been defined for each compilation unit.

- Symbol relative position

  If the program database file exists, the symbol name and the relative value (hexadecimal) from the beginning of the symbol name are generated.

  The symbol name of a COBOL program is a compilation unit name. The compilation unit names of COBOL programs are shown below.

```
External program :  External program name
Class            :  Class name
Method           :  Class name_method name
Method (PROPERTY):  Class name_GET_method name , or
                    class name_SET_method name
```

- Compilation information

  For a COBOL program, the information at program compilation is generated. For a non-COBOL program, this information is not generated.

  - Code system (ASCII or Unicode)
  - Object format (single thread or multithread)
  - Optimization (OPTIMIZE or NOOPTIMIZE)

- Program name

  For a COBOL program, the external program name or class name and the internal program name or method name are generated. For a non-COBOL program, the function name is generated.

- Source file

  For a COBOL program, the name of the source file of the program that caused the error is generated. For a non-COBOL program, this information is not generated.

- Source line

  For a COBOL program, the line number of the statement that caused the error is generated. For a non-COBOL program, this information is not generated.

- Supplementary information

  In a COBOL program, if an error is located in a statement in a declarative section procedure, the source statement branching to the declarative section is listed; if not, no supplementary information is generated.

- Call stack

  The calling path up to the program that caused the error is generated. If there is no debugging information file, the caller of the internal program is not generated.

System information

General system information about the computer is generated.

- Computer name
- User name
- Windows version
- Version number
- Service pack

Command line

The command character string in effect when the application was run

Environment variable

The environment variable setting in effect when the application was run

Execution environment information

The items of COBOL execution environment information that are generated are listed below. If an initial file does not exist, "NONE" is generated in the place of the initial file name and the program name. If an initial file exists and the program is running in multithread mode, "NONE" is generated in the place of the program name.

- Runtime system

  The version and module type of COBOL runtime system.

- Runtime mode

  The information at execution of the runtime system

  - Code system (ASCII or Unicode)
  - Operating mode (single thread or multithread)
- Program name

  The main program of COBOL recognized by the runtime system (corresponds to the section name in the initial file)
- .CBR file

  The name (absolute path name) and contents of the runtime initial file referenced by the runtime system
- Various information files

  The names (absolute path name) and contents of the following information files
  - Entry information file
  - Logical destination definition file
  - ODBC information file
  - Print information file

Task list

A listing of the process IDs (hexadecimal) and application names of the tasks running on the system

Module list

A listing of each module loaded by the application, including the file name, version information, and creation time. Lists are generated in the order in which the modules were loaded.

Stack summary

The summarized stack information is generated as follows: (No internal program stack information is generated.)

- Frame pointer

  Leading address (hexadecimal) of the stack frame of the called program
- Return address

  Return address (hexadecimal) of the called program
- Parameter

  Parameters (hexadecimal) passed to the called program
- Module file name and program name

  Module file name and program name of the called program

Stack dump

The contents of the stack when the error occurred are listed using hexadecimal and ASCII notation

Thread information

The items of information listed below are generated with regard to the threads other than the thread in which the error occurred.

- Thread ID
- Register
- Stack commit
- Module file
- Section relative position
- Export relative position

- Symbol relative position
- Compilation information
- Program name
- Source file
- Source line
- Call stack
- Stack summary
- Stack dump

The exception codes defined in the system and the exception names for the exception codes that are included in the diagnostic report are listed in "Table 2.5 Exception codes and exception names".

Table 2.5 Exception codes and exception names

Code	Exception name
	Explanation
C0000005	EXCEPTION_ACCESS_VIOLATION
	The program attempted to read or write to a virtual address, but the program did not have the appropriate access authority.
C0000006	EXCEPTION_IN_PAGE_ERROR
	The system failed to load a nonexistent page as the program attempted to access it.
C0000017	EXCEPTION_NO_MEMORY
	It failed in the allocation of the memory because of memory shortage or the heap destruction.
C000001D	EXCEPTION_ILLEGAL_INSTRUCTION
	The program attempted to execute an instruction undefined in the processor.
C0000025	EXCEPTION_NONCOUNTINUABLE_EXCEPTION
	The program attempted to rerun in the wake of an irrecoverable exception.
C0000026	EXCEPTION_INVALID_DISPOSITION
	An exception handler returned an invalid array to the exception dispatcher.
C000008C	EXCEPTION_ARRAY_BOUNDS_EXCEEDED
	An attempt by the program to access an array out of bounds was detected by the hardware.
C000008D	EXCEPTION_FLT_DENORMAL_OPERAND
	One of the operands of a floating-point arithmetic calculation is abnormal. This value is too low to be represented as a standard floating-point value.
C000008E	EXCEPTON_FLT_DIVIDE_BY_ZERO
	The program attempted to divide a given floating-point value by a floating-point value of 0.
C000008F	EXCEPTION_FLT_INEXACT_RESULT
	The result of a floating-point arithmetic calculation cannot be accurately represented as a decimal.
C0000090	EXCEPTION_FLT_INVALID_OPERATION
	This exception represents a floating-point exception other than the one defined in this table.
C0000091	EXCEPTION_FLT_OVERFLOW

Code	Exception name
	Explanation
	The value of the exponent part of a floating-point arithmetic calculation exceeds the upper limit of the corresponding type.
C0000092	EXCEPTION_FLT_STACK_CHECK
	A stack overflow or underflow resulted from a floating-point arithmetic calculation.
C0000093	EXCEPTION_FLT_UNDERFLOW
	The value of the exponent part of a floating-point arithmetic calculation exceeds the lower limit of the corresponding type.
C0000094	EXCEPTION_INT_DIVIDE_BY_ZERO
	The program attempted to divide an integer by 0.
C0000095	EXCEPTION_INT_OVERFLOW
	The most significant bit of an integer calculation overflowed.
C0000096	EXCEPTION_PRIV_INSTRUCTION
	The program attempted to execute an instruction but the calculation is not supported in the current machine mode.
C00000FD	EXCEPTION_STACK_OVERFLOW
	A stack overflow occurred.

Common application errors in COBOL applications are access violation errors (EXCEPTION_ACCESS_VIOLATION) and zero division errors (EXCEPTION_INT_DIVIDE_BY_ZERO). The following are the possible causes of access violation errors:

- Subscript or index values are outside the scope.
- Reference modification pointer values are outside the scope.
- The calling conventions or number of parameters between calling and called programs did not match.

The CHECK function can be used to easily detect these errors. If an error occurs, use the CHECK function to check. Refer to "2.2 Using the CHECK Function".

The output format of the source file names and line numbers of COBOL programs varies depending on the specification of the compiler options NUMBER and OPTIMIZE. The relationships between the compiler options and output formats are summarized in "Table 2.6 Compiler options and output formats".

Table 2.6 Compiler options and output formats

Output object		NOOPTIMIZE option	OPTIMIZE option	
		NUMBER/NONUMBER options	NUMBER option	NONUMBER option
Source file name	Source file	File name only		
	Library file	File name only	Not generated	File name only
	Path of library reading	The file name of the library file read, the file name of the source file, and the line numbers in the source file are generated up to the end of the calling path (*3).	Not generated (source file name generated). (*4)	The file name of the library file read and that of the source file are output, but not the source line numbers (*5).
Line numbers	In the entry code (*1)	IN ENTRY-CODE		

Output object		NOOPTIMIZE option	OPTIMIZE option	
		NUMBER/NONUMBER options	NUMBER option	NONUMBER option
	In the exit code (*2)	IN EXIT-CODE		
	Statement	File-relative-line-number [in-line-sequence-number]	[COPY-qualification-value-]editor-line-number(NUMBER) (*6)	File-relative-line-number

[Supplementation with term]

- *1

  "In the entry code" means the range of the entry code of the program from the position PROLOGUEAD: +4 (hexadecimal) to END OF PROGRAM INITIALIZE ROUTINE in the object program listing.

- *2

  "In the exit code" means the range of the exit code of the program from the position BEGINNING OF GOBACK COMMON ROUTINE to END OF GOBACK COMMON ROUTINE in the object program listing.

[Output Sample]

- *3

```
Source File:  CPY2.cbl <- CPY1.cbl <- SRC.cob
Source Line:  86 <- 55 <- 127
```

- *4

```
Source File:  SRC.cob
Source Line:  2-8600 (NUMBER)
```

- *5

```
Source File:  CPY2.cbl <- SRC.cob
Source Line:  86
```

- *6

  An identifier (NUMBER) placed right after a line number identifies the line number as an editor line number or as a file relative line number.

```
Source Line: 95100 (NUMBER)
```

2.6.5 Dump

2.6.5.1 What is dump?

A dump records the memory contents when an error occurs. This information is a valuable resource for investigating the cause of the error.

The COBOL Error Report outputs the memory contents to a dump file when specific application errors and U level runtime messages are issued.

To suppress dump output, specify "-d NO" in the start parameters.

Information

Without dump information the time required to identify the causes of errors maybe increased, and problems may become long-term. It is recommended that dump output be enabled.

Dumps are read in by WinDbg (debug tool provided by Microsoft) and other debuggers and consequently can be used during debugging. Refer to the WinDbg help for information on using WinDbg.

2.6.5.2 Dump output destination

The dump file name is "Application-name_ProcessID_Error-occurrence-time_COBSNAP" with the extension "DMP".

Example

```
Application name            :  TESTPGM.EXE
Process ID                  :  2D8
Error occurrence time       :  2009.07.10 15:04:26
Dump file name              :  TESTPGM_2D8_20090710-150426_COBSNAP.DMP
```

The standard output destination for dumps is \Fujitsu\NetCOBOL\COBSNAP under the user common application data folder (the folder on each computer where application-specific data is stored).

Generally the dump output destination is created using the following names:

C:\ProgramData\Fujitsu\NetCOBOL\COBSNAP

To change the output destination folder, specify the "-o" start parameter. Refer to "Table 2.3 Start parameters" for details of start parameters.

Note

- The user common application data folder is normally a read-only folder. However, the dump standard output destination folder is generated as a folder that has the following access permissions set for the Everyone group:
  - Modify
  - Read & execute
  - List folder contents
  - Read
  - Write
- Any user who can access the computer can reference the dump standard output destination folder. Depending on the application specifications and its operation, the dump may contain personal information or confidential data. Thoroughly investigate the operational safety of the dump output destination folder from the perspective of security and data protection. If necessary, specify the "-o" start parameter and change the dump output destination folder. If dump output is not required, specify "-d NO" to suppress dump output.
  Refer to "Table 2.3 Start parameters" for details of start parameters.
- The size of each dump file can be extremely large. Therefore, specify a drive folder that is guaranteed to have plenty of space as the dump output destination.
- In the following cases, the dump file might not be output.
  - The COBOL program terminated abnormally while the system was loading.
  - The COBOL program was linked to the other languages and it terminated abnormally.

2.6.5.3 Managing the number of dump files

The upper limit for the number of dump files created by the COBOL Error Report is 10 per folder.

When the COBOL Error Report creates a dump file if there already are 10 files in the folder, it deletes the file with the oldest date.

2.6.6 Notes

This section presents notes on using the COBOL Error Report.

- In addition to the COBOL Error Report, the following functions launch automatically when application errors occur:
  - Visual C++ Just-in-Time Debugger
  - Windows Error Reports

  Even though these functions are preprogrammed to launch on occurrence of application errors, the COBOL Error Report will launch if its startup is specified.
- The COBOL Error Report cannot be used while an application is being debugged using the debugging function of NetCOBOL Studio, or Visual C++ debugger or is being executed on Systemwalker.
- The COBOL Error Report will not be launched if the application itself handles application errors by using an exception handler for structured exception handling. This applies to, for example, applications linked to non-COBOL programs that have an exception handler and applications called from server programs such as a Web server that has an exception handler.
- The COBOL Error Report will not be launched from the system successfully if a stack overflow exception (0xC00000FD) occurs. If diagnostic information about the error is desired, refer to followings:
  - Windows Error Reports
- Statements in a program compiled with the compiler option OPTIMIZE specified may be moved or deleted by the compiler. Hence, inaccurate line numbers may be generated.
- If the following error message is output in the diagnostic report, the description method of the source file is incorrect.

```
"Outputting the language image information for this program failed because the information on
program '$1' in the debugging information file '$2' contains an error."
```

  - $1: Program name
  - $2: Debugging information file name

  To solve this problem, check the following and change the source file. If the problem is not solved, contact technical support.

  - When the program includes the library text that contains the following by the COPY statement
    - Whole program definition (From IDENTIFICATION DIVISION to END PROGRAM)
    - Whole factory definition (From IDENTIFICATION DIVISION to END FACTORY)
    - Whole object definition (From IDENTIFICATION DIVISION to END OBJECT)
    - Whole method definition (From IDENTIFICATION DIVISION to END METHOD)

    It evades by describing the statements described in the above-mentioned library text directly in the program that includes the library text.
  - When the last line in the library text to describe, and to include the COPY statement into procedure part is out-of-line PERFORM statement

    It evades by describing the CONTINUE statement etc. at the end of the library text.
  - When the COPY statement is described in procedure part, and neither the COPY statement the last line of procedure part nor the END PROGARM statement are described

    It evades by describing the END PROGARM statement in the program that describes the COPY statement.
  - When the out-of-line PERFORM statement just behind the out-of-line PERFORM statement the last line in the library text to describe, and to include the COPY statement into procedure part, and the COPY statement

    It evades by describing the CONTINUE statement etc. just behind the end and the COPY statement of the library text.

- When the initial line of the COPY statement just behind the EXIT statement or the EXIT PROGRAM statement and the EXIT METHOD statement, and the taken library text describes the COPY statement in procedure part, and is section-name or paragraph-names

  Section-name or paragraph-name is not an initial line of the library text, and is evaded by describing it in the program that takes the library text.

2.7 Debugging Using Compiler Listings and Debugging Tools

This section explains how to debug using the compiler listings and debugging tools below after an abnormal termination.

Compiler listings

- Object program listing, Source program listing

  For determining the location of the error.

- Data Map Listing

  For referencing data content at the time of the abnormal termination.

Debugging tools

- WinDbg (Debugging Tools for Windows - native x64)

  This is a debug tool provided by Microsoft.

  Debugging Tools for Windows - native x64 is information published on the Microsoft home page.

- Windows Error Reports

  Crash dumps are collected by the system WER function.

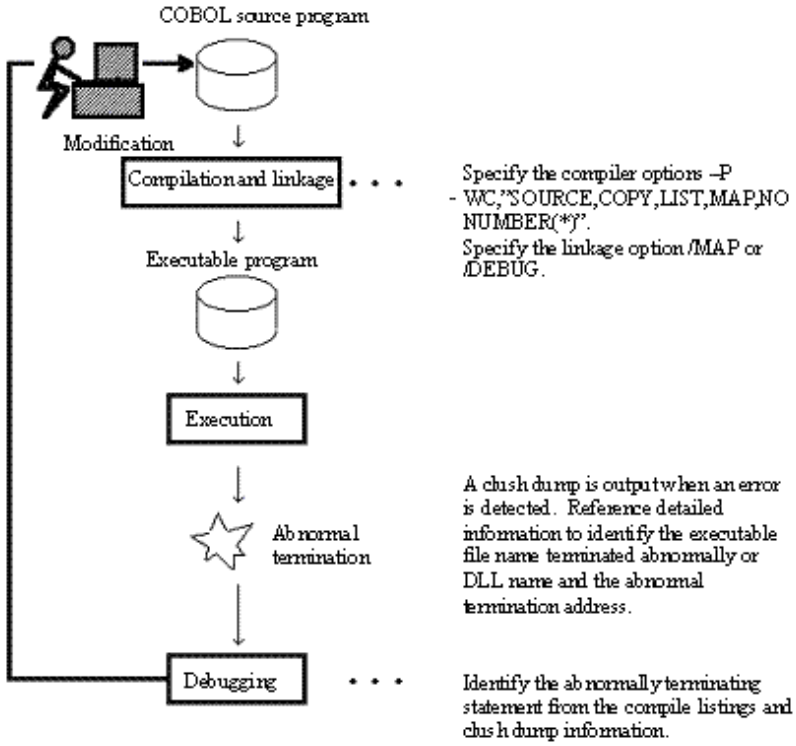
Other files

- Either of the following files output when linking
  - Program database file (.PDB) (When /DEBUG option is specified, output it.)
  - Link MAP file (.MAP) (When /MAP option is specified, output it.)
- Clash dump
  - Crash dump made by WER (Windows Error Report) function.

2.7.1 Flow of Debugging

The flow of using compiler listings and debugging tools to locate an error is shown below.

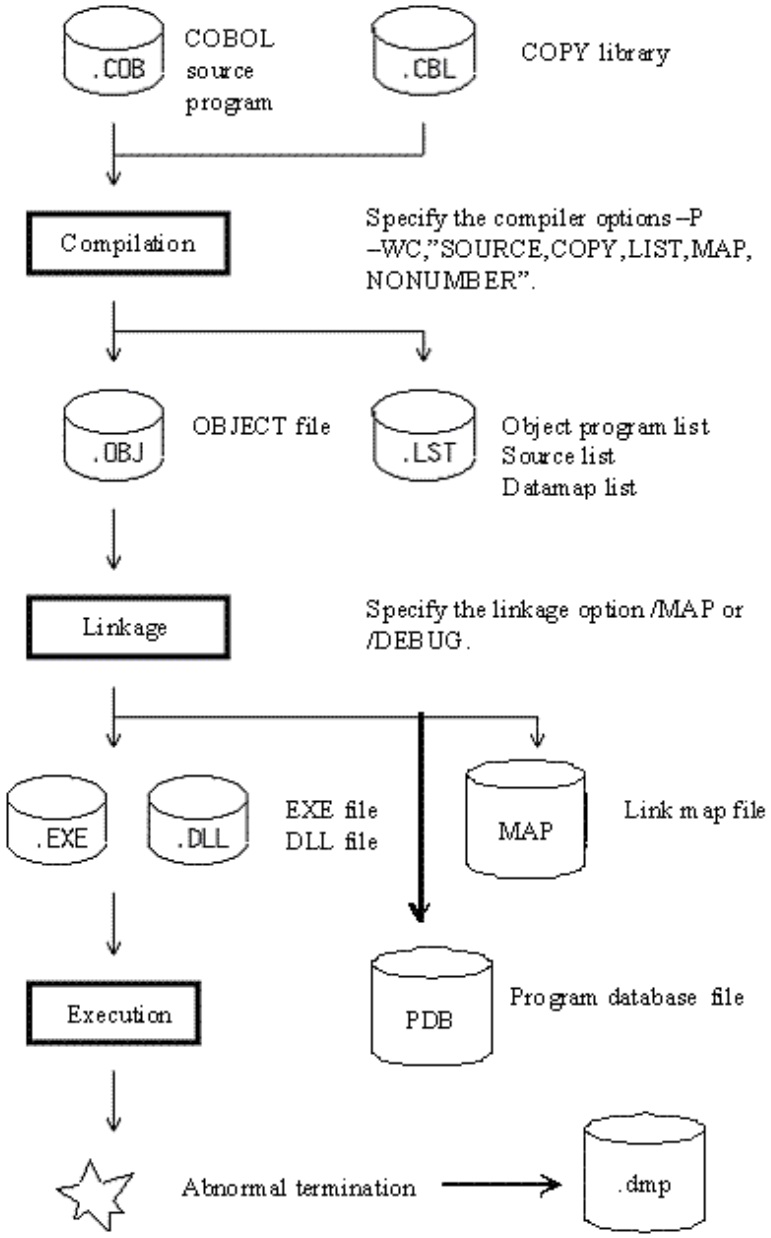
Figure 2.6 Flow of debugging using an Object Program Listing



* : It is recommended that NONUMBER (default value) be made effective when the OBOL source is translated. The following explanations assume and describe the case where NONUMBER is effectively translated.

A file relationship diagram is shown below.

Figure 2.7 A file relationship diagram



Note

- Please refer to the section "2.6.5 Dump" for the method of outputting the crash dump.
- The data that can be referred when terminating abnormally is data used in the method that programs or terminates abnormally terminate abnormally, and data of caller. The data of the program and the method that doesn't appear to "Call Stack" of WinDdbg cannot be referred to.
- Data might not be able to be referred to correctly for the program or the method from which OPTIMIZE of the assembler option is effectively translated because no storage of the execution result in the area and the statement might be moved and be deleted by optimization.
- Because data might be stored in the register to confirm data, the knowledge of the assembler is necessary. The knowledge of the assembler is debugged and it is possible to debug it by machine instruction by using, and outputting Object Program Listing when translating. Please refer to the section "2.7.3 Object Program Listing" for the form of Object Program Listing.

- Inner program is not correctly output to "Call Stack". Please reproduce the same situation by using the debugging function of NetCOBOL Studio when you want to output a correct call relation.

2.7.2 Source Program Listing

When the compile option SOURCE is specified, a source program listing is generated in the compiler list file. In addition, when the compiler option COPY is specified, library text fetched by the COPY statement is generated in the source program listing.

Source program listing output format

The output format of the source program listing is shown below.

```
  LINE   SEQNO  A  B
         [1]     [2]
    1    000100 IDENTIFICATION DIVISION.
    2    000200 PROGRAM-ID. A.
    3    000300*
    4    000400 DATA DIVISION.
    5    000500 WORKING-STORAGE SECTION.
    6    000600     COPY  A1.
  1-1 C  000600 77 answer   PIC 9(2).
  1-2 C  000700 77 divisor  PIC 9(2).
  1-3 C  000800 77 dividend PIC 9(2).
    7    000900*
    8    001000 PROCEDURE DIVISION.
    9    001100*
   10    001200     MOVE  10 TO dividend.
   11    001300     MOVE   0 TO divisor.
   12    001400*
   13    001500     COMPUTE answer = dividend / divisor.
   14    001600*
   15    001700       EXIT PROGRAM.
   16    001800 END PROGRAM A.
```

- [1] Line number

  Line numbers are displayed in either of the following formats:

  1. If the compiler option NUMBER is enabled

     ```
     [COPY-qualification-value-]user-line-number
     ```

     - COPY-qualification-value

       The identification number that is assigned to the library text included in the source program or to a line having a sequence number not in ascending order. COPY-qualification-value is assigned to COPY instructions or sequence numbers not in ascending order in single unit steps beginning with 1.

     - User-line-number

       The value of the sequence number area in the source program. If a non-numeric character is included in the sequence number area, the sequence number of the line is changed to the immediately preceding, valid sequence number plus 1. When the same sequence number appears in sequence, it is accepted without assuming it is invalid.

  2. If the compiler option NONUMBER is enabled

     ```
     [COPY-qualification-value-]source-file-relative-number
     ```

     - COPY-qualification-value

       The identification number that is assigned to the library text included in the source program. COPY-qualification-value is assigned to COPY instructions in single unit steps beginning with 1.

- source-file-relative-number

  The compiler assigns line numbers as source-file-relative-number in ascending order in single unit steps beginning with 1. Source-file-relative-number is also assigned to source files included with a COPY instruction in single unit steps beginning with 1, with "C" inserted between the line number and the source program to designate an inclusion of a source file.

- [2] Source program itself.

2.7.3 Object Program Listing

When the compile option LIST is specified, an object program listing is generated in the compiler list file.

If the compiler option NOOPTIMIZE is enabled (default)

```
  [1]         [2]                  [3]
  ADDRESS     OBJECT CODE          LABEL     INSTRUCTION

                            GLB.9  [4]
--- 10 --- [5]        MOVE [6]
0000000003E0  66C783E40100003130    mov       word ptr [rbx+0x000001E4],0x3031  dividend
--- 11 ---            MOVE
0000000003E9  66C783E20100003030    mov       word ptr [rbx+0x000001E2],0x3030  divisor
--- 13 ---            COMPUTE
0000000003F2  0FB693E5010000        movzx     edx,byte ptr [rbx+0x000001E5] dividend +1
0000000003F9  440FB683E4010000      movzx     r8d,byte ptr [rbx+0x000001E4] dividend
000000000401  4183E00F              and       r8d,0x0F
000000000405  4F8D0480              lea       r8,[r8+r8*4]
000000000409  83E20F                and       edx,0x0F
00000000040C  4E8D3C42              lea       r15,[rdx+r8*2]
000000000410  0FB693E3010000        movzx     edx,byte ptr [rbx+0x000001E3]  divisor +1
000000000417  440FB683E2010000      movzx     r8d,byte ptr [rbx+0x000001E2]  divisor
00000000041F  4183E00F              and       r8d,0x0F
000000000423  4F8D0480              lea       r8,[r8+r8*4]
000000000427  83E20F                and       edx,0x0F
00000000042A  4E8D3442              lea       r14,[rdx+r8*2]
00000000042E  4C89F8                mov       rax,r15
000000000431  4899                  cqo
000000000433  49F7FE                idiv      r14
000000000436  4989C5                mov       r13,rax
000000000439  49C7C764000000        mov       r15,0x00000064
000000000440  4C89E8                mov       rax,r13
000000000443  4C89EA                mov       rdx,r13
000000000446  4C89E9                mov       rcx,r13
000000000449  48F7D9                neg       rcx
00000000044C  4983FD00              cmp       r13,0x00
000000000450  480F4CC1              cmovnge   rax,rcx
000000000454  4C39F8                cmp       rax,r15
000000000457  7C08                  jl        0x000000000461              GLB.10
000000000459  4C89E8                mov       rax,r13
00000000045C  4899                  cqo
00000000045E  49F7FF                idiv      r15
                            GLB.10
000000000461  4989D4                mov       r12,rdx
000000000464  664489A42496000000    mov       word ptr [rsp+0x00000096],r12w TRLP+0
00000000046D  480FBF842496000000    movsx     rax,word ptr [rsp+0x00000096]  TRLP+0
000000000476  4989C2                mov       r10,rax
000000000479  49C1FA3F              sar       r10,0x3F
00000000047D  4983FA00              cmp       r10,0x00
000000000481  790A                  jns       0x00000000048D              GLB.11
000000000483  49F7DA                neg       r10
000000000486  48F7D8                neg       rax
000000000489  4983DA00              sbb       r10,0x00
```

```
                            GLB.11
00000000048D  488DBBE0010000        lea       rdi,[rbx+0x000001E0]         answer
000000000494  48C7C602000000        mov       rsi,0x00000002
00000000049B  4C89D2                mov       rdx,r10
00000000049E  4889C1                mov       rcx,rax
0000000004A1  4C8B9BB0010000        mov       r11,qword ptr [rbx+0x000001B0]
0000000004A8  41FF5378              call      qword ptr [r11+0x78]
```

If the compiler option OPTIMIZE is enabled

```
  [1]         [2]                   [3]
  ADDRESS     OBJECT CODE           LABEL     INSTRUCTION

                            GLB.9 [4]
--- 10 --- [5]        MOVE [6]
<SIMPLE STORE>
--- 11 ---            MOVE
<SIMPLE STORE>
--- 13 ---            COMPUTE
<CONSTANT FOLDING>
<CONSTANT FOLDING>
<REDUNDANT STORE>
<REDUNDANT STORE>
<REDUNDANT STORE>
--- 15 ---            EXIT PROGRAM
0000000003E0  49C7C700000000        mov       r15,0x00000000
0000000003E7  4489BC2408010000      mov       dword ptr [rsp+0x00000108],r15d   LCB+10
0000000003EF  49C7C70F000000        mov       r15,0x0000000F
0000000003F6  4489BC240C010000      mov       dword ptr [rsp+0x0000010C],r15d   LCB+10
0000000003FE  E929FFFFFF            jmp       0x00000000032C                    GLB.8
                                        BBK=00005(000)
                                        NEVER EXECUTED
                                        ............PX
```

- [1] Offset

  An object relative offset of a statement in machine language.

- [2] Object code in machine language

- [3] Assembler instruction

  A statement in machine language represented in x64 architecture assembler language.

- [4] Procedure name and procedure number

  Compiler-generated procedure name and procedure number.

- [5] Line number

  A line number given in the COBOL program.

- [6] Verb name

  A verb name given in the COBOL program.

2.7.4 Listings Relating to Data Areas

Specify the compiler option MAP to output information relating to data areas to the compiler list file.

There are three listings relating to data areas:

- Data map listing
- Program control information listing
- Section size listing

2.7.4.1 Data Map Listing

Format of Data Map Listing

```
[1]   [2]                  [3]     [4] [5]     [6]     [7]     [8]    [9]    [12]
LINE  ADDR        OFFSET REC-OFFSET LVL NAME  LENGTH ATTRIBUTE  BASE   DIM   ENCODING
[10]**MAIN**
 15  heap+00000240                  FD OUTFILE        LSAM       BHG.000000
 16 [heap+000001F8]+00000000     0 01 prt-rec     60 ALPHANUM   BVA.000003   SJIS
 18  heap+000003C0                0 77 answer       8 EXT-DEC    BHG.000000
 19  heap+000003C8                0 77 divisor      4 EXT-DEC    BHG.000000
 21  heap+00000040                0 01 CSTART       8 ALPHANUM   BCO.000000   SJIS
 22  heap-00000048                0 01 CEND         8 ALPHANUM   BCO.000000   SJIS
 23  heap-00000050                0 01 CRES         8 ALPHANUM   BCO.000000   SJIS
 25 [heap+000001E8]+00000000     0 01 dividend     2 EXT-DEC    BVA.000001
[11]**SUB1**
 48 [heap+000001F0]+00000000     0 01 disp         8 EXT-DEC    BVA.000002
```

The data map listing provides data area allocation information and data attribute information for data defined in the source program's DATA DIVISION (the WORKING-STORAGE SECTION, FILE SECTION, CONSTANT SECTION, LINKAGE SECTION, and REPORT SECTION).

The elements of the data map listing shown above are:

- [1] LINE

  1. Displays the line number in the following format:

     When the compiler option NUMBER is specified:

     ```
     [COPY qualification value-] user-line-number
     ```

  2. When the compiler option NONUMBER is specified:

     For details on the COPY qualification value, user-line-number, and relative-line-number see "2.7.2 Source Program Listing".

     ```
     [COPY qualification value-] relative-line-number in source file
     ```

- [2] ADDR, OFFSET

  The address displays the data item area allocated in the object program in the following format:

  ```
  Section name + Relative address
  ```

  Section name

  Displays one of the following:

  - rdat (.rodata)
  - data (.data)
  - stac (stack)
  - heap (heap)
  - hea2 (heap)

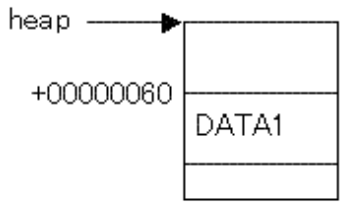
  Relative address

  Provides the relative address from the base address of the section.

  If the section contains a pointer to the actual location of the data, then the location of the pointer is contained in square brackets ([ ]) followed by the offset of the actual data from the address contained in the pointer.

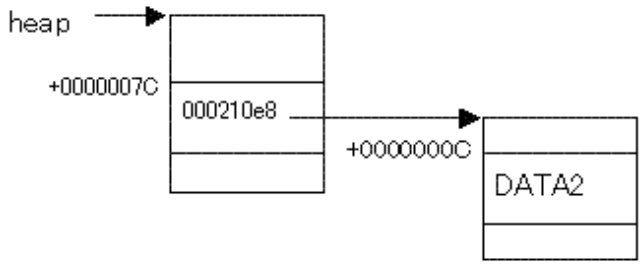
  The method for referencing the data area depends on whether or not a pointer is involved:

1. If there is no pointer e.g. DATA1 has "heap+00000060" in the ADDR column:



   Indicates that the data area DATA1 exists at the location 0x60 from the heap base address.

2. If a pointer is indicated e.g. DATA2 shows "[heap+0000007C]+0000000C" in the ADDR column:



   An address is stored at the location 0x7C from the heap base address (in the example, this address is 000210e8). The data area DATA2 exists at the location 0x0C from this address (in the example, this is the location 0x000210e8+0x0c).

- [3] REC-OFFSET

  Displays the offset in the record as a decimal number.

- [4] LVL

  Displays the level number defined in the source program.

- [5] NAME

  Displays the data name defined in the source program. This name is truncated at 30 bytes. The data name is displayed in uppercase letters when the compiler option ALPHAL is specified.

- [6] LENGTH

  Displays the length of data items as a decimal number.

  Not displayed for file names.

- [7] ATTRIBUTE

  Displays data attributes. These attributes and their meaning are listed in the Table below.

Table 2.7 Meanings of displayed data attribute abbreviations

Displayed Data Attribute	Meaning
GROUP-F	Fixed-length group item
GROUP-V	Variable-length group item
ALPHA	Alphabetic
ALPHANUM	Alphanumeric
AN-EDIT	Alphanumeric edited
NUM-EDIT	Numeric edited

Displayed Data Attribute	Meaning
INDEX-DATA	Index data
EXT-DEC	Display decimal
INT-DEC	Packed decimal
FLOAT-L	Double-precision internal floating-point
FLOAT-S	Single-precision internal floating-point
EXT-FLOAT	External floating point
BINARY	Binary
COMP-5	Binary
INT-BINARY	int type binary data
INDEX-NAME	Index name
INT-BOOLE	Internal Boolean
EXT-BOOLE	External Boolean
NATIONAL	National
NAT-EDIT	National edited
OBJ-REF	Object reference
POINTER	Pointer data

For file description entries, file types and access modes are abbreviated as in Table below:

Table 2.8 Meanings of displayed file types/access mode abbreviations

Displayed Abbreviation	Meaning
SSAM	Sequential file, sequential access
LSAM	Line sequential file, sequential access
RSAM	Relative file, sequential access
RRAM	Relative file, random access
RDAM	Relative file, dynamic access
ISAM	Indexed file, sequential access
IRAM	Indexed file, random access
IDAM	Indexed file, dynamic access
PSAM	Presentation file, sequential access

- [8] BASE

  Displays the base register and base position allocated to the data item.

- [9] DIM

  Displays the number of dimensions of subscripting or indexing.

- [10] and [11] Program name

  Displays the program name used as a delimiter in an internal program.

  Note that, in a class definition, the delimiters for definitions are displayed as follows:

```
**Class name**
** FACTORY **
```

```
** OBJECT **
** MET (Method name)**
```

- [12] Encoding form

  Displays the encoding forms of the following data items:

  - ALPHANUM (Alphanumeric)
  - AN-EDIT (Alphanumeric edited)
  - NATIONAL (National)
  - NAT-EDIT (National edited)

  Displays the encoding forms using the following symbols:

  - SJIS : Shift JIS
  - UTF8 : UTF-8
  - UTF16LE : UTF-16 little endian
  - UTF16BE : UTF-16 big endian
  - UTF32LE : UTF-32 little endian
  - UTF32BE : UTF-32 big endian

2.7.4.2 Program Control Information Listing

Format of Program Control Information Listing

```
     ADDR              FIELD-NAME                      LENGTH
    ** GWA **
      * GCB *
data+00000000          GCB FIXED AREA                       8

      * GMB *
data+00000008          GMB POINTERS AREA                  376
data+00000008            VNAL                             136
     ........            VNAS                               0
data+00000090            VNAO                             240
     ........            FARA                               0
     ........            METHOD ADDRESS AREA                0
     ........            BEA                                0
     ........            BEAD / BEAR                        0
     ........            FMBE                               0
     ........          GMB CONTROL BLOCKS AREA              0
     ........            STRONG TYPE AREA                   0
     ........          FAI AREA                             0
     ........            ATTR INFO FIXED AREA               0
     ........            REUSE INFO TABLE                   0
     ........            METHOD TABLE                       0
     ........            INTERFACE TABLE                    0
     ........            METHOD COPY TABLE                  0
     ........          IAI AREA                             0
     ........            ATTR INFO FIXED AREA               0
     ........            REUSE INFO TABLE                   0
     ........            METHOD TABLE                       0
     ........            INTARFACE TABLE                    0
     ........            METHOD COPY TABLE                  0
     ........          INVOKE PARM INFO                     0
     ........          AS MODIFY INFO                       0

    ** COA **
      * CCB *
```

```
rdat+00000000          CCB FIXED AREA                    4
     ........          STANDARD CONSTANT AREA            0

      * CMB *
     ........          CMB POINTERS AREA                  0
     ........            BEAI                            0
     ........            BVAI                            0
     ........            IPA                             0
rdat+00000010          LITERAL AREA                     40
rdat+00000040          CONSTANT SECTION DATA            24
rdat+00000058          CMB CONTROL BLOCKS AREA         816
rdat+00000058            FMB2                          224
     ........            FMBI                            0
     ........            SMB1                            0
     ........            SMB2                            0
     ........            EDT                             0
     ........            EFT                             0
rdat+00000138            FMB2 ADD-PRM LIST              16
     ........            ERROR PROCEDURE                 0
     ........            ALPHABETIC NAME                 0
     ........            CLASS NAME                      0
     ........            CLASS TEST TABLE                0
     ........            TRANS-TABLE PROTO               0
     ........            CIPB                            0
     ........            DOG TABLE                       0
     ........            EXTERNAL DATA NAME              0
     ........            NATIONAL-MSG F-NAM              0
     ........            FLOW BLOCK INFO                 0
     ........            SQL AREA                        0
     ........            SPECIAL REGISTERS               0
rdat+00000148            EPA CONTROL AREA              576
     ........            SCREEN CONTROL AREA             0
     ........            EXCEPTION PROC LIST             0
     ........            SQL INIT INFO                   0
     ........            OLE PARM INFO                   0
     ........            CALL PARM INFO                  0
     ........            CALL PARM ADD INFO              0
     ........            UWA RECORD INFO                 0
     ........            UWA INFO                        0
     ........            UWA RECORD LIST                 0
     ........            RECORD INFO                     0
     ........          CALL PARM ADDRESS LIST            0
     ........          FCM FMB1 OFFSET LIST              0
     ........          FCM OBJ-REF OFFSET LIST           0
     ........          ICM FMB1 OFFSET LIST              0
     ........          ICM OBJ-REF OFFSET LIST           0
     ........          MCM AREA / OBJ-REF LIST           0
     ........          CFOR OFFSET LIST                  0
     ........          CLASS NAME INFO                   0
     ........          AS MODIFY / PARAM INFO            0
     ........          METHOD NAME INFO                  0
     ........          INIT TABLE                        0

    ** HGWA **
      * HGCB *
heap+00000000          HGCB FIXED AREA                  72

      * HGMB *
heap+00000048          LIA FIXED AREA                  256
     ........          IWA1 AREA                         0
     ........            LINAGE COUNTER                  0
     ........            OTHER AREA                      0
     ........            ALTINX                          0
```

```
     ........           PCT                            0
heap+00000148          LCB AREA                     160
heap+000001E8          HGMB POINTERS AREA            88
     ........           VPA                            0
     ........           PSA                            0
heap+000001E8           BVA                           24
     ........           BEA                            0
     ........           FMBE                           0
heap+00000200           CONTROL ADDRESS TABLE         64
     ........           MUTEX HANDLE AREA              0
heap+00000240          HGMB CONTROL BLOCK AREA      384
heap+00000240           FMB1                         384
     ........           SMB0                           0
     ........           SPECIAL REGISTERS              0
     ........           S-A LIST                       0
     ........           DPA                            0
     ........           SQL CONTROL AREA               0
     ........           DMA                            0
     ........           SCREEN CONTROL AREA            0
     ........           METHOD INIT INFO               0
     ........          CFOR                            0

      * HGWS *
heap+000003C0          DATA AREA                     12

    ** STK **
      * SCB *
stac+00000000          ABIA                          72
stac+00000050          SCB FIXED AREA               112
stac+000000C0          TL 1ST AREA                   32
stac+000000E0          LCB AREA                     144
stac+00000170          SGM POINTERS AREA              8
     ........           VPA                            0
     ........           PSA                            0
     ........           BVA                            0
stac+00000170           BHG                           8
     ........           BOD                            0
stac+00000178          LIA VARIABLE AREA            160
     ........          SOR AREA                        0
     ........          TSG AREA                        0
     ........          TRG AREA                        0
     ........          SGM CONTROL BLOCKS AREA         0
     ........           FMB1                           0
     ........           SMB0                           0
     ........           SPECIAL REGISTER               0
     ........           MIA                            0
     ........           SQL CONTROL AREA               0
stac+00000218          IWA3 AREA                     56
     ........           ALTINX                         0
     ........           USESAVE                        0
stac+00000218           ENTSAVE                       8
     ........           PCT                            0
     ........           CONTENT                        0
     ........           USEOSAVE                       0
stac+00000220           RTNADDR                       16
     ........           RTNAREA                        0
     ........           LINAGE COUNTER                 0
     ........           OTHER AREA                     0
stac+00000230           PARM                          32
     ........           CALL PARM INFO                 0
     ........          DATA AREA                       0
stac+00000250          TL 2ND AREA                   32
     ........          PRESERVED REGISTER              0
```

```
     ........          SCRATCH / REGISTER PARM             0
     ........          RTS RETURN AREA                     0
stac+00000278          LIA FIXED ADDR                      8
stac+00000280          CBL STRING                          8
stac+00000288          RESERVED REGISTER                  64
stac+000002C8          RETURN ADDRESS                      8
     ........          PARM AREA                           0

    ** LITERAL-AREA **
[2]
    ADDR               0 . . .  4 . . .  8 . . .  C . . .    0123456789ABCDEF
rdat+00000010          01000000 08000000 20000000 10000000   ........ .......
rdat+00000020          40000000 00000000 5359534F 55542020   @.......SYSOUT
rdat+00000030          80000000 00000000                     ........
```

- [1] Displays the allocated locations and lengths of all work areas and data areas in the object program (only a small portion of the data is shown in the above excerpt).
- [2] Displays the literal area in the object program.

2.7.4.3 Section Size Listing

Format of Section Size Listing

```
    ** PROGRAM SIZE **
[1]
  .text SIZE        =      10656 BYTES
  .data SIZE        =        440 BYTES

     ** EXECUTION DATA SIZE **
[2]
   heap SIZE        =        976 BYTES
   stack SIZE       =       1168 BYTES
```

- [1] Displays the size of the .text section and .data section in the object program.
- [2] Displays the size of the area required at runtime.

  Note that in a class definition this is displayed as follows:

```
     ** EXECUTION DATA SIZE **
CLASS NAME
   heap SIZE         =          0 BYTES
METHOD NAME
   stack SIZE        =        384 BYTES           [3]
        :
```

- [3] The stack size is displayed for each method definition.

2.7.5 Locating Errors(Program database file)

This section explains how to identify the location of an error occurrence if the "/DEBUG" option was specified at the time of linkage to create a Program database file (PDB file), and if the program ends abnormally under the circumstances (see note below) that enable the PDB file to be referenced.

Note

The PDB file can be referenced under the following circumstances:

- In a development environment, the PDB file can be referenced if it is in a folder output at the time of linkage.
- In an operating environment, the PDB file can be referenced if it is in the same folder as the EXE file or the DLL file.

[LISTDBG.COB]

```
000010 IDENTIFICATION DIVISION.
000020  PROGRAM-ID. LISTDBG.
000030*
000040 DATA DIVISION.
000050  WORKING-STORAGE SECTION.
000060   01  culc.
000070     02  dividend  PIC 9(2).
000080     02  divisor   PIC 9(2).
000090   01  answer      PIC 9(2).
000100 PROCEDURE DIVISION.
000120     MOVE 2 TO dividend.
000130*
000140     CALL "DIVPROC" USING culc RETURNING answer.
000150*
000160     DISPLAY "answer =" answer.
000170     EXIT PROGRAM.
000180 END PROGRAM LISTDBG.
```

[DIVPROC.COB]

```
000010 IDENTIFICATION DIVISION.
000020  PROGRAM-ID. DIVPROC.
000030*
000040 DATA DIVISION.
000050  WORKING-STORAGE SECTION.
000060  LINKAGE SECTION.
000070   01  Al.
000080     02  dividend     PIC 9(2).
000090     02  divisor      PIC 9(2).
000100   01  answer         PIC 9(2).
000110*
000120 PROCEDURE DIVISION USING Al RETURNING answer.
000130*
000140     MOVE 0 TO answer.
000150     COMPUTE answer = dividend / divisor.
000160*
000190     EXIT PROGRAM.
000200 END PROGRAM DIVPROC.
```

- Files
  - Clash Dump
  - Compiler listing specifying compiler option SOURCE, COPY and LIST
  - Program Database file (.PDB)
- Debugging Tools
  - WinDbg (Debugging Tools for Windows - native x64)

1. Use the following methods to check whether a crash dump relates to the investigation target:
   - Check the crash dump filename.

     The file name used for a crash dump collected by the Windows error report function is the name of the application that crashed. Check whether the crash dump filename is the name of the application being investigated.
   - Check the time of issue.

     Check whether the crash dump update date and time is the time that the application ended abnormally.

2. Open the crash dump from WinDbg and identify the location of and the reason for the exception occurrence.

   - Start WinDbg.
   - From the WinDbg "File" menu, select "Open Crash Dump..." and open the investigation target crash dump.

   [WinDbg output]

```
Loading Dump File [C:\werdump\LISTDBG.exe.3584.dmp]
User Mini Dump File with Full Memory: Only application data is available

Symbol search path is: *** Invalid ***
************************************************************************
* Symbol loading may be unreliable without a symbol search path.       *
* Use .symfix to have the debugger choose a symbol path.               *
* After setting your symbol path, use .reload to refresh symbol locations. *
************************************************************************
Executable search path is:
Windows Server 2008/Windows Vista SP1 Version 6001 (Service Pack 1) MP (2 procs) Free x64
Product: Server, suite: Enterprise TerminalServer
Machine Name:
Debug session time: Fri Dec  5 17:46:58.000 2008 (GMT+9)
System Uptime: 10 days 7:46:11.034
Process Uptime: 0 days 0:00:03.000
.....................................
*** ERROR: Symbol file could not be found.  Defaulted to export symbols for ntdll.dll -
This dump file has an exception of interest stored in it.
The stored exception information can be accessed via .ecxr.
(e00.f34): Integer divide-by-zero - code c0000094 (first/second chance not ...)  ... [1]
*** WARNING: Unable to verify checksum for LISTDBG.exe
LISTDBG!DIVPROC+0x431:                                                  ... [3]
00000001`40001b29 49f7fc          idiv    rax,r12                       ... [2]
```

   [1] provides the reason the exception was issued: "Integer divide-by-zero - code c0000094" (zero divisor).

   [2] provides the position of the exception occurrence:"00000001`40001b29", the "idiv rax,r12" instruction.

   "idiv rax,r12" is an instruction that performs signed division. The rdx:rax register contents are divided by the r12 register contents, the quotient is set in rax, and the remainder is set in rdx.

   Use the r command to check the register contents.

   [r command output]

```
0:000> r
rax=0000000000000002 rbx=00000000030354e0 rcx=0000000003035628
rdx=0000000000000000 rsi=0000000000000000 rdi=000000000012fbf0
rip=0000000140001b29 rsp=000000000012f9f0 rbp=000000000012fc60
r8 =0000000140024670  r9=00000000030354e0 r10=0000000000000a90
r11=000000000012fb2a r12=0000000000000000 r13=0000000000000002
r14=000000014001d1a0 r15=0000000003035240
iopl=0         nv up ei pl zr na po nc
cs=0033  ss=002b  ds=002b  es=002b  fs=0053  gs=002b             efl=00010244
LISTDBG!DIVPROC+0x431:
00000001`40001b29 49f7fc          idiv    rax,r12
```

   The above output indicates that "rdx:rax=00000000000000002" was divided by "r12=0000000000000000" but, since r12 is 0, a zero divisor exception was issued.

3. Identify the COBOL source line position.

   The position in the COBOL source where the error occurred, is indicated by [3], "LISTDBG!DIVPROC+0x431".

   The output format for the information at [3] is "module name!symbol name + offset". This information in this example is as follows:

```
Module name : "LISTDBG"
Symbol name : "DIVPROC"
Offset from Symbol : 0x431
```

The extension is deleted from the module name. Use the lm command to check the extension.

[lm command output]

```
0:000> lm v m LISTDBG
start             end                 module name
00000001`40000000 00000001`40025000 LISTDBG C(private pdb symbols)
C:\Work\tel\LISTDBG.pdb
    Loaded symbol image file: LISTDBG.exe
    Image path: C:\Work\tel\LISTDBG.exe                                    ... [4]
    Image name: LISTDBG.exe                                                ... [5]
    Timestamp:        Fri Dec 05 17:46:44 2008 (4938EA74)
    CheckSum:         00000000
    ImageSize:        00025000
    File version:     0.0.0.0
    Product version:  0.0.0.0
    File flags:       0 (Mask 0)
    File OS:          0 Unknown Base
    File type:        0.0 Unknown
    File date:        00000000.00000000
    Translations:     0000.04b0 0000.04e4 0409.04b0 0409.04e4
```

Check the file extension at [4], Image path, or [5], Image name. In this example,"LISTDBG.exe". is shown.

The symbol is formed by combining the COBOL source "PROGRAM-ID", the "CLASS-ID", and the "METHOD-ID". This is output as the label name in the object program list.

The two files LISTDBG.cob and DIVPROC.cob are used to create "LISTDBG.exe". For "LISTDBG!DIVPROC+0x431", obtain the position "0x431" from the Object Program Listing (DIVPROC.LST) of the DIVPROC.cob that contains the symbol "DIVPROC".

[Object Program Listing(DIVPROC.LST)]

```
BEGINNING OF DIVPROC
BEGINNING OF ENTRY POINT CODE
000000000000  3000
000000000002  0700
000000000004  44495650524F43
              "DIVPROC"
00000000000B  08
00000000000C  4E6574434F424F4C
              "NetCOBOL"
000000000014  07
000000000015  5631302E322E30
              "V10.2.0"
00000000001C  3230313030323231
              "20100221"
000000000024  3137343132303030
              "17412000"
00000000002C  2B30303030
000000000031  30313031
000000000035  CCCCCC
                          GLB.1
                          DIVPROC:                                    ... [6]
000000000038  48894C2408               mov     qword ptr [rsp+0x08],rcx  ... [7]
00000000003D  4889542410               mov     qword ptr [rsp+0x10],rdx
000000000042  4C89442418               mov     qword ptr [rsp+0x18],r8
000000000047  4C894C2420               mov     qword ptr [rsp+0x20],r9
00000000004C  55                       push    rbp
00000000004D  4889E5                   mov     rbp,rsp
000000000050  57                       push    rdi
000000000051  56                       push    rsi
```

```
000000000052  53                    push    rbx
000000000053  4154                  push    r12
000000000055  4155                  push    r13
000000000057  4156                  push    r14
000000000059  4157                  push    r15
00000000005B  4881EC38020000        sub     rsp,0x00000238
000000000062  488DBC24E0000000      lea     rdi,[rsp+0x000000E0]
00000000006A  48C7C124000000        mov     rcx,0x00000024
000000000071  48C7C000000000        mov     rax,0x00000000
000000000078  FC                    cld
000000000079  F348AB                rep stosq
00000000007C  488B4510              mov     rax,qword ptr [rbp+0x10]
000000000080  48898424E0010000      mov     qword ptr [rsp+0x000001E0],rax
000000000088  48B8A203000000000000  mov     rax,0x00000000000003A2  PROCEDURE_ENTRY
000000000092  48898424D8010000      mov     qword ptr [rsp+0x000001D8],rax
00000000009A  E9B9000000            jmp     000000000158                    GLB.2
END OF ENTRY POINT CODE   :
```

In the DIVPROC.cob Object Program Listing (DIVPROC.LST), search for "DIVPROC" to obtain the output position [6]. From the line address of the next line of that symbol, obtain the offset position of that symbol, "000000000038" (hexadecimal number), at [7].

Add the address number (offset) obtained above to the offset value from the symbol, "0x431", to obtain the offset value within the list.

```
0x38+0x431 = 0x469
```

In the DIVPROC.cob Object Program Listing(DIVPROC.LST), search for address number "0x469 ".

[Object Program Listing(DIVPROC.LST)]

```
--- 14 ---            MOVE
0000000003FE  66C78424F00100003030   mov     word ptr [rsp+0x000001F0],0x3030  answer
--- 15 ---            COMPUTE                                              ... [9]
000000000408  4C8BBB98010000         mov     r15,qword ptr [rbx+0x00000198]   BVA.1
00000000040F  410FB65701             movzx   edx,byte ptr [r15+0x01]          dividened+1
000000000414  490FB607               movzx   rax,byte ptr [r15]               dividend
000000000418  4883E00F               and     rax,0x0F
00000000041C  488D0480               lea     rax,[rax+rax*4]
000000000420  4883E20F               and     rdx,0x0F
000000000424  488D0442               lea     rax,[rdx+rax*2]
000000000428  66898424C6000000       mov     word ptr [rsp+0x000000C6],ax     TRLP+0
000000000430  410FB65703             movzx   edx,byte ptr [r15+0x03]          divisor+1
000000000435  490FB64702             movzx   rax,byte ptr [r15+0x02]          divisor
00000000043A  4883E00F               and     rax,0x0F
00000000043E  488D0480               lea     rax,[rax+rax*4]
000000000442  4883E20F               and     rdx,0x0F
000000000446  488D0442               lea     rax,[rdx+rax*2]
00000000044A  66898424D6000000       mov     word ptr [rsp+0x000000D6],ax     TRLP+0
000000000452  4C0FBFAC24C6000000     movsx   r13,word ptr [rsp+0x000000C6]    TRLP+0
00000000045B  4C0FBFA424D6000000     movsx   r12,word ptr [rsp+0x000000D6]    TRLP+0
000000000464  4C89E8                 mov     rax,r13
000000000467  4899                   cqo
000000000469  49F7FC                 idiv    r12                              ... [8]
00000000046C  4989C6                 mov     r14,rax
00000000046F  4C8B9BA8010000         mov     r11,qword ptr [rbx+0x000001A8]   BCO.0
000000000476  4D8B6310               mov     r12,qword ptr [r11+0x10]         #
00000000047A  4C89F0                 mov     rax,r14
00000000047D  4C89F2                 mov     rdx,r14
000000000480  4C89F1                 mov     rcx,r14
000000000483  48F7D9                 neg     rcx
000000000486  4983FE00               cmp     r14,0x00
00000000048A  480F4CC1               cmovnge rax,rcx
00000000048E  4C39E0                 cmp     rax,r12
```

```
000000000491  7C08                  jl      00000000049B                      GLB.11
000000000493  4C89F0                mov     rax,r14
000000000496  4899                  cqo
000000000498  49F7FC                idiv    r12
                          GLB.11
00000000049B  4989D5                mov     r13,rdx
00000000049E  664489AC24C6000000    mov     word ptr [rsp+0x000000C6],r13w   TRLP+0
0000000004A7  480FBF8424C6000000    movsx   rax,word ptr [rsp+0x000000C6]    TRLP+0
0000000004B0  4889C6                mov     rsi,rax
0000000004B3  48C1FE3F              sar     rsi,0x3F
0000000004B7  4883FE00              cmp     rsi,0x00
0000000004BB  790A                  jns     0000000004C7                      GLB.12
0000000004BD  48F7DE                neg     rsi
0000000004C0  48F7D8                neg     rax
0000000004C3  4883DE00              sbb     rsi,0x00
                          GLB.12
0000000004C7  488D8C24F0010000      lea     rcx,[rsp+0x000001F0]              answer
0000000004CF  48C7C202000000        mov     rdx,0x00000002
0000000004D6  4989F0                mov     r8,rsi
0000000004D9  4989C1                mov     r9,rax
0000000004DC  488BBBB8010000        mov     rdi,qword ptr [rbx+0x000001B8]
0000000004E3  FF5778                call    qword ptr [rdi+0x78]
```

The instruction at address "000000000469 " (the instruction at [8]) is "idiv r12", which matches the instruction obtained at [2]. Thus, the position of the instruction that ended abnormally can be identified as this one.

Search upwards from this instruction, looking for a line starting with the "--- nnn --- " format. In this example, "--- 15 --- COMPUTE " is found ([9]).

The part corresponding to the "nnn", that is "15", corresponds to the COBOL source line number.

In the DIVPROC.LST source program list, refer to the position at line number "15" ([10]).

[Source Program List(DIVPROC.LST)]

```
    1   000010 IDENTIFICATION DIVISION.
    2   000020 PROGRAM-ID. DIVPROC.
    3   000030*
    4   000040 DATA DIVISION.
    5   000050 WORKING-STORAGE SECTION.
    6   000060 LINKAGE SECTION.
    7   000070 01 Al.
    8   000080   02 dividend  PIC 9(2).
    9   000090   02 divisor   PIC 9(2).
   10   000100 01 answer      PIC 9(2).
   11   000110*
   12   000120 PROCEDURE DIVISION USING Al RETURNING answer.
   13   000130*
   14   000140     MOVE 0 TO answer.
   15   000150     COMPUTE answer = dividend / divisor.              ... [10]
   16   000160*
   17   000170     EXIT PROGRAM.
   18   000180 END PROGRAM DIVPROC.
```

This identifies that the abnormal end occurred at the COMPUTE statement in the 15th line.

2.7.6 Locating Errors (Link Map file)

This section explains how to identify the location where an error occurred if "/MAP" was specified at linkage to create a Link Map File, and if a program ended abnormally when it is impossible to reference the PDB file.

- Files
  - Clash Dump

  - Compiler listing specifying compiler option SOURCE, COPY and LIST
  - Link Map file (.MAP)
- Debugging Tools
  - WinDbg (Debugging Tools for Windows - native x64)

The example used here is the same as in "2.7.5 Locating Errors(Program database file)".

A crash dump is collected when a file is executed if the file was created with "/MAP", rather than "/DEBUG", specified at the time of linkage.

Procedures 1. and 2. below are the same as in "2.7.5 Locating Errors(Program database file)".

1. Check whether the crash dump relates to the investigation target.
2. Use the crash dump to identify the location of and the reason for the exception occurrence.
3. Identify the COBOL source line position.

The method for obtaining the COBOL source line position from the crash dump and the Link Map Listing is explained below.

a. Obtain the COBOL source line position from the WinDbg address information.

[Results output at WinDbg start]

```
Loading Dump File [C:\werdump\LISTDBG.exe.3048.dmp]
User Mini Dump File with Full Memory: Only application data is available

Symbol search path is: *** Invalid ***
*************************************************************************
* Symbol loading may be unreliable without a symbol search path.        *
* Use .symfix to have the debugger choose a symbol path.                *
* After setting your symbol path, use .reload to refresh symbol locations. *
*************************************************************************
Executable search path is:
Windows Server 2008/Windows Vista SP1 Version 6001 (Service Pack 1) MP (2 procs) Free x64
Product: Server, suite: Enterprise TerminalServer
Machine Name:
Debug session time: Mon Dec  8 09:25:24.000 2008 (GMT+9)
System Uptime: 12 days 23:24:36.422
Process Uptime: 0 days 0:00:03.000
.....................................
*** ERROR: Symbol file could not be found.  Defaulted to export symbols for ntdll.dll -
This dump file has an exception of interest stored in it.
The stored exception information can be accessed via .ecxr.
(be8.504): Integer divide-by-zero - code c0000094 (first/second chance not available)
*** WARNING: Unable to verify checksum for LISTDBG.exe
*** ERROR: Symbol file could not be found.  Defaulted to export symbols for LISTDBG.exe -
LISTDBG!DIVPROC+0x431:
00000001`400019a9 49f7fc          idiv    rax,r12                         ... [1]
```

This provides the abnormal end position of "00000001`400019a9 " ([1]).

b. In order to identify the module held at the address "00000001`400019a9 " at [1], use the lm command to output a module list.

[lm command output results]

```
0:000> lm
start             end                 module name
00000000`00020000 00000000`00030000  F4AGLANP  (deferred)
00000000`00190000 00000000`001c5000  F4AGSQL   (deferred)
00000000`001d0000 00000000`00203000  F4AGAESV  (deferred)
00000000`00210000 00000000`00249000  F4AGEFNC  (deferred)
00000000`006e0000 00000000`00754000  F4AGIO    (deferred)
00000000`00760000 00000000`007a4000  F4AGFRM   (deferred)
```

```
00000000`007b0000 00000000`00841000  F4AGLPIO  (deferred)
00000000`00850000 00000000`008b1000  F4AGDBG   (deferred)
00000000`008c0000 00000000`00904000  F4AGPRIO  (deferred)
00000000`00910000 00000000`0098b000  F4AGSCRN  (deferred)
00000000`00990000 00000000`00a11000  F4AGOLER  (deferred)
00000000`00a20000 00000000`00a69000  F4AGOLES  (deferred)
00000000`00a70000 00000000`00abd000  F4AGARMV  (deferred)
00000000`00e40000 00000000`00e50000  F4AGFC64  (deferred)
00000000`10000000 00000000`10005000  F4AGOVLD  (deferred)
00000000`77130000 00000000`7725b000  kernel32  (deferred)
00000000`77260000 00000000`7732d000  user32    (deferred)
00000000`77330000 00000000`774b0000  ntdll     (export symbols)  ntdll.dll
00000001`40000000 00000001`40010000  LISTDBG C (export symbols)  LISTDBG.exe ... [2]
00000001`80000000 00000001`800ea000  F4AGPRCT  (deferred)
000007fe`f9680000 000007fe`f96d8000  winspool  (deferred)
000007fe`faf40000 000007fe`fafe0000  comctl32  (deferred)
000007fe`fc180000 000007fe`fc379000  comctl32_7fefc180000  (deferred)
000007fe`fca70000 000007fe`fca7b000  version   (deferred)
000007fe`fda80000 000007fe`fdc58000  ole32     (deferred)
000007fe`fdc60000 000007fe`fdc77000  imagehlp  (deferred)
000007fe`fdc80000 000007f 0x140000000 =e`fdce3000  gdi32   (deferred)
000007fe`fdde0000 000007fe`fdee1000  msctf     (deferred)
000007fe`fdef0000 000007fe`fdf7c000  comdlg32  (deferred)
000007fe`fdf80000 000007fe`fdfad000  imm32     (deferred)
000007fe`fe0b0000 000007fe`fe0bd000  lpk       (deferred)
000007fe`fe0c0000 000007fe`fe133000  shlwapi   (deferred)
000007fe`fe1a0000 000007fe`fe23c000  msvcrt    (deferred)
000007fe`fe240000 000007fe`fee92000  shell32   (deferred)
000007fe`ff080000 000007fe`ff1bf000  rpcrt4    (deferred)
000007fe`ff340000 000007fe`ff413000  oleaut32  (deferred)
000007fe`ff480000 000007fe`ff588000  advapi32  (deferred)
000007fe`ff590000 000007fe`ff62a000  usp10     (deferred)
```

Since the "00000001`400019a9" at [1] is included in "00000001`40000000 00000001`40010000 LISTDBG C (export symbols) LISTDBG.exe" at [2], we can identify that the abnormal end is in the "LISTDBG.exe" module.

c. The Link Map Listing created at the time of linkage using the "/MAP" specification can be used to identify the relevant part of the module.

[Link Map Listing(LISTDBG.MAP)]

```
LISTDBG
 Timestamp is 493c694d (Mon Dec 08 09:24:45 2008)
 Preferred load address is 0000000140000000                              ... [3]
 Start         Length     Name                   Class
 0001:00000000 000060f2H .text                  CODE
  ...
 0005:00000000 000005d8H .rodata                DATA
  Address         Publics by Value          Rva+Base            Lib:Object
 0000:00000000    ___safe_se_handler_count  0000000000000000    <absolute>
 0000:00000000    ___safe_se_handler_table  0000000000000000    <absolute>
 0000:00000000    __ImageBase               0000000140000000    <linker-defined>
 0001:00000000    main                      0000000140001000 f  LISTDBG.obj
 0001:00000050    LISTDBG                   0000000140001050 f  LISTDBG.obj
 0001:00000578    DIVPROC                   0000000140001578 f  DIVPROC.obj  ... [4]
 0001:00000a50    JMP1PLAN                  0000000140001a50 f  f4agcimp:F4AGPRCT.dll
  ...
```

Check whether the module loading address "00000001`40000000" at [2] is the same as the address at [3], "Preferred load address is 0000000140000000".

- If module loading address at [2] and the address at [3] are the same

  Compare the address "00000001`400019a9" at [1] as is with the "Rva+Base" value and find the closest address that is smaller than the address at [1].

In this example, this is:

```
[4]"0001:00000580 DIVPROC 0000000140001580 f   DIVPROC.obj"
```

Then, use the following calculation to obtain the symbol relative offset.

```
0x1400019a9 - 0x140001578 = 0x431
```

The above results give the following information:

```
Module            : "LISTDBG.exe"
Symbol            : "DIVPROC"
Offset from Symbol: 0x431
```

- If module loading address at [2] and the address at [3] are different

  Calculate the relative offset of each.

  First, obtain the relative offset of the abnormal end position.

```
0x1400019a9 - 0x1400000000 = 0x19a9
```

  Then obtain the relative offsets of the symbol of each.

```
main      0x140001000 - 0x140000000 = 0x1000
LISTDBG   0x140001050 - 0x140000000 = 0x1050
DIVPROC   0x140001578 - 0x140000000 = 0x1578   ... [5]
JMP1PLAN  0x140001a50 - 0x140000000 = 0x1a50
      :
```

  Within the information shown above, find the offset that is closest to and smaller than the offset obtained at 1-.

  In this example, this is:

```
[5]"DIVPROC  0x140001578 - 0x1400000000 = 0x1578"
```

  Then, use the following calculation to obtain the symbol relative offset.

```
0x19a9 - 0x1578 = 0x431
```

  The above results give the following information:

```
Module            : "LISTDBG.exe"
Symbol            : "DIVPROC"
Offset from Symbol: 0x431
```

Subsequent tasks are the same as in "2.7.5 Locating Errors(Program database file)".

2.7.7 Researching Data Values

If the abnormal end location is a COBOL program or method, use the following to reference that program or method data:

- Files
  - Clash Dump
  - Compiler listing specifying compiler option SOURCE, COPY and MAP
- Debugging Tools
  - WinDbg (Debugging Tools for Windows - native x64)

Note

The data that can be referenced is the data used by the program or method that ended abnormally and the calling source data. The data of programs and methods that do not appear in the "Call Stack" cannot be referenced.

Data Area

There are four basic data areas:

- Stack data
- Heap data
- .data
- .rdata

The following data areas are used at the method definition.

- .rodata
- Heap data that object data or factory data uses

Data Area name	Mark(*)	Meanings
Stack data	stac	The stack data area stores data entered in the working-storage section of method definitions, and work data and management data for compiler generation. These areas can be used only during program or method execution. The size can be specified (changed) using the LINK.EXE option (/STACK). These areas extend from high (large) addresses to low (small) addresses. The "rsp" register manages the boundaries of used areas and unused areas. The "rsp" register is referenced as standard when COBOL procedures are executed.
Heap data	heap	The heap data area stores data entered in the working-storage section of program definitions, and work data and management data for compiler generation. The "rbx" register is referenced as standard when COBOL procedures are executed.
.data	data	The .data area is the read-enabled and write-enabled data area. This area stores work data and management data for compiler generation.
.rdata	rdat	The .rdata area is the read-specific data area. This area stores data entered in the constants section, and read-specific data for compiler generation and other data that does not change during procedure execution.
.rodata	-	The .rodata area stores common read-only data in object definitions or factory definitions.
Heap data that object data or factory data uses	hea2	This area stores common data in object definitions or factory definitions.

* : This notation is used in the "address" part explained in the Data Map Listing output format described in "2.7.4 Listings Relating to Data Areas".

Use the following method to obtain the start of each of the data areas:

1. Start WinDbg.
2. From the WinDbg "File" menu, select "Open Crash Dump..." and open the investigation target crash dump.
3. Prepare the Compile Listing that is output by specifying the MAP compile option and refer to "2.7.4.2 Program Control Information Listing".

   [Program Control Information Listing(DIVPROC.LST)]

```
...
  ** HGWA **
    * HGCB *
```

```
heap+00000000          HGCB FIXED AREA                    72

      * HGMB *
heap+00000048          LIA FIXED AREA                    256
     ........          IWA1 AREA                           0
     ........            LINAGE COUNTER                    0
     ........            OTHER AREA                        0
     ........            ALTINX                            0
     ........            PCT                               0
heap+00000148          LCB AREA                           80
heap+00000198          HGMB POINTERS AREA                 72
     ........            VPA                               0
     ........            PSA                               0
heap+00000198            BVA                               8
     ........            BEA                               0
     ........            FMBE                              0
heap+000001A0            CONTROL ADDRESS TABLE            64             ... [1]
     ........            MUTEX HANDLE AREA                 0
  ...

    ** STK **
      * SCB *
stac+00000000          ABIA                               72
stac+00000050          SCB FIXED AREA                    112
stac+000000C0          TL 1ST AREA                        32
stac+000000E0          LCB AREA                           80
stac+00000130          SGM POINTERS AREA                   8
     ........            VPA                               0
     ........            PSA                               0
     ........            BVA                               0
stac+00000130            BHG                               8              ... [2]
     ........            BOD                               0
  ...
```

4. Display the contents of the CONTROL ADDRESS TABLE (control information table) ([1]) to obtain the start address of each of the data areas.

   First, obtain the start address of the heap area.

Information

Obtaining the start address of the heap area

The start address of the heap area is set in the "rbx" register when a procedure is executed. At times other than procedure execution, the start address of the heap area is not set in the "rbx" register.

The value set at [2], BHG(stac+00000130), can be used to check whether or not "the "rbx" register value = heap area start address".

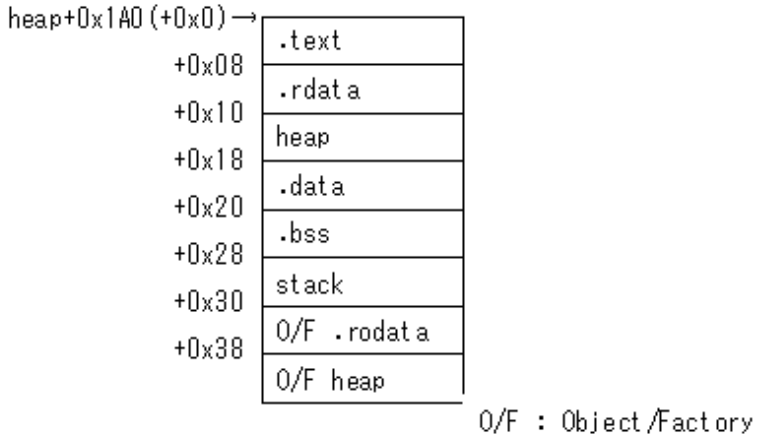
Since "stac" is set in "rsp", use WinDbg to display the "rsp+130" memory contents and the "rbx" register contents and compare them.

```
[rbx register]
-----------------------------------------------------------------
0:000> r rbx
rbx=00000000030354e0
-----------------------------------------------------------------
```

```
[rsp+00000130 memory]
-----------------------------------------------------------------
0:000> dq rsp+130 L(1)
00000000`0012fb20  00000000`030354e0
-----------------------------------------------------------------
```

Once the heap area start address is obtained, contents of the CONTROL ADDRESS TABLE (control information table) are displayed.

The CONTROL ADDRESS TABLE (control information table) structure is as shown below.



[Memory of CONTROL ADDRESS TABLE]

```
0:000> dq rbx+1a0 L(8)
00000000`03035680  00000001`400016c0 00000001`400243a0
                   ~~~~~~~~~~~~~~~~~ ~~~~~~~~~~~~~~~~~
                   .text             .rodata
00000000`03035690  00000000`030354e0 00000001`4001d1a0
                   ~~~~~~~~~~~~~~~~~ ~~~~~~~~~~~~~~~~~
                   heap              .data
00000000`030356a0  :
```

If, for example, the memory contents from the .text start address are displayed:

```
0:000> db 1`400016c0 L(40)
00000001`400016c0  30 00 07 00 44 49 56 50-52 4f 43 08 4e 65 74 43  0...DIVPROC.NetC
00000001`400016d0  4f 42 4f 4c 07 56 31 30-2e 32 2e 30 32 30 31 30  OBOL.V10.2.02010
00000001`400016e0  31 32 30 35 31 37 34 31-32 30 30 30 2b 30 30 30  120517412000+000
00000001`400016f0  30 30 31 30 31 cc cc cc-48 89 4c 24 08 48 89 54  00101...H.L$.H.T
```

Referencing abnormal end data

Here, refer to the program data obtained in "2.7.5 Locating Errors(Program database file)".

[Abnormally ended COBOL source line position]

```
        15   000150     COMPUTE answer = dividend / divisor.
```

Refer to the data used at the COBOL source line position that ended abnormally.

1. Prepare the Compile Listing that is output by specifying the MAP compile option and refer to "Data Map Listing". Refer to "2.7.4 Listings Relating to Data Areas" for the Data Map Listing format.

   [Data Map Listing(DIVPROC.LST)]

```
7  [heap+00000198]+00000000   0 01 Al           4 GROUP-F  BVA.000001
8  [heap+00000198]+00000000   0 02 dividend     2 EXT-DEC  BVA.000001 ... [3]
9  [heap+00000198]+00000002   2 02 divisor      2 EXT-DEC  BVA.000001 ... [4]
10  stac+000001F0             0 01 answer       2 EXT-DEC  BST.000000
```

2. Refer to each of the data contents.

   - Data of dividend([heap+00000198]+00000000)

     - [heap+00000198]

```
0:000> dq rbx+198 L(1)
00000000`03035678  00000000`03035240
```

     - [heap+00000198]+00000000

```
0:000> db 3035240 L(2)
00000000`03035240  30 32                                           02
```

     The above output indicates that "02" is entered using zoned decimal for the "dividend".

   - Data of divisor([heap+00000198]+00000002)

     The contents of [heap+00000198] is the same as "dividend".

     - [heap+00000198]+00000002

```
0:000> db 3035240+2 L(2)
00000000`03035242  00 00
```

     From the above results, essentially a zoned decimal value must be set for the "divisor" but, because a value was not set, X"0000" was entered and this was evaluated as being zero.

The results of these checks indicate that a zero divisor was executed.

2.7.8 Referencing calling source data at abnormal end and identifying the call location

This section explains, with the aid of simple examples, how to reference calling source data and identify the call location.

- Files
  - Clash Dump
  - Compiler listing specifying compiler option SOURCE, COPY and MAP
- Debugging Tools
  - WinDbg (Debugging Tools for Windows - native x64)

Referencing calling source data

1. Start WinDbg.
2. From the WinDbg "File" menu, select "Open Crash Dump..." and open the investigation target crash dump.
3. The Call Stack information is displayed at WinDbg.

```
0:000> k
Child-SP          RetAddr           Call Site
00000000`0012f9f0 00000001`40001438 LISTDBG!DIVPROC+0x431       <- Abnormal end location
00000000`0012fc70 00000001`40001054 LISTDBG!LISTDBG+0x3a8       <- Calling source
00000000`0012fef0 00000001`40001f2b LISTDBG!main+0x14
00000000`0012ff20 00000000`7715495d LISTDBG!__tmainCRTStartup+0x15b
00000000`0012ff60 00000000`77358791 kernel32!BaseThreadInitThunk+0xd
00000000`0012ff90 00000000`00000000 ntdll!RtlUserThreadStart+0x21
```

   This indicates that the abnormally ended location and the calling source program is LISTDBG.

4. Refer to the data of the calling source program, LISTDBG. Refer to the Compile Listing(LISTDB.LST) that was output by specifying the MAP compile option.

   [Data Map Listing(LISTDBG.LST)]

```
6   heap+000001E0             0 01 culc            4 GROUP-F    BHG.000000
7   heap+000001E0             0 02 diviend         2 EXT-DEC    BHG.000000
8   heap+000001E2             2 02 divisor         2 EXT-DEC    BHG.000000
9   heap+000001E8             0 01 answer          2 EXT-DEC    BHG.000000
```

[Program Control Information Listing(LISTDBG.LST)]

```
heap+00000198        CONTROL ADDRESS TABLE           64
      :
stac+00000120        BHG                              8
```

Use the same method as in "Referencing abnormal end data" to refer to the data contents of each.

1. From the call stack, obtain the calling source "child-SP" (in this example, 000000000012fc70) as a stack address, and obtain heap address=BHG (in this example, stac+00000120) from the stack.

   - BHG(heap address)

   ```
   0:000> dq 12fc70+120 L(1)
   00000000`0012fd90  00000000`03035060
   ```

   - Heap of CONTROL ADDRESS TABLE

   ```
   0:000> dq 3035060+198+10 L(1)
   00000000`03035208  00000000`03035060
   ```

2. Refer to the data contents of each.

   - Data of dividend(heap+000001E0)

   ```
   0:000> db 3035060+1e0 L(2)
   00000000`03035240  30 32                                           02
   ```

   - Data of divisor(heap+000001E2)

   ```
   0:000> db 3035060+1e2 L(2)
   00000000`03035242  00 00                                           ..
   ```

The above results indicate that, essentially, a zoned decimal value must be set for the "divisor" but, because a value was not set, X"0000" was entered and zero was passed to the calling destination.

Identifying the call location

1. Start WinDbg.
2. From the WinDbg "File" menu, select "Open Crash Dump..." and open the investigation target crash dump.
3. The Call Stack information is displayed at WinDbg. The Call Stack information indicates that the call position of the calling source is as follows:

   ```
   "LISTDBG!LISTDBG+0x3a8"
   ```

4. Prepare the Compile Listing that is output by specifying the LIST compile option, and refer to "2.7.3 Object Program Listing".
5. Search for the LISTDBG offset in the "Object Program Listing".

   ```
                            LISTDBG:
   000000000050  48894C2408              mov       qword ptr [rsp+0x08],rcx
   ```

6. Add the LISTDBG offset and the call position offset "0x3a8".

   ```
   0x3a8 + 0x50 = 0x3f8
   ```

7. Identify the call location.

   Search for the calculated position, "0x3f8", in the Object Program Listing (LISTDBG.LST).

```
--- 13 ---            CALL
0000000003DE  488D83E0010000    lea    rax,[rbx+0x000001E0]           culc
0000000003E5  48890424          mov    qword ptr [rsp],rax            PARM-1B8
0000000003E9  4C8BBBB0010000    mov    r15,qword ptr [rbx+0x000001B0] BGW.0
0000000003F0  488B0C24          mov    rcx,qword ptr [rsp]
0000000003F4  41FF5758          call   qword ptr [r15+0x58]           DIVPROC
0000000003F8  48898424C0000000  mov    qword ptr [rsp+0x000000C0],rax TRLP+0
000000000400  0FB78424C0000000  movzx  eax,word ptr [rsp+0x000000C0]  TRLP+0
000000000408  668983E8010000    mov    word ptr [rbx+0x000001E8],ax   answer
00000000040F  4C8BB3A0010000    mov    r14,qword ptr [rbx+0x000001A0] BCO.0
000000000416  410FB64621        movzx  eax,byte ptr [r14+0x21]        X"00"
00000000041B  0FB68B70010000    movzx  ecx,byte ptr [rbx+0x00000170]  LCBC+0
000000000422  39C1              cmp    ecx,eax
```

Since the "0x3f8" position is a return position, the called instruction is the previous "0x3F4" call instruction.

8. Identify the position in the source program.

   Search upwards from the called instruction position in the object program, looking for line information. In this example, "--- 13 --- CALL" is found.

   A search for this CALL statement in the Source Program Listing finds the following:

   [Source Program Listing(LISTDBG.LST)]

```
         13   000130     CALL "DIVPROC" USING culc RETURNING answer.
```

   When DIVPROC is called, this CALL statement passes the "dividend" and "divisor" included in the "calculation" as arguments. Since a value is not set for the "divisor" in the calling source program "LISTDBG", a zero division was issued.

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