FUJITSU Software
NetCOBOL V11.0

Debugging Guide

Windows

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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 Debugging in Windows System	Details of the debugger for the 32 bit Windows environments.
Chapter 3 Debugging Mixed COBOL and PowerCOBOL	Details of debugging mixed COBOL and PowerCOBOL applications.
Chapter 4 Debugging Visual Basic calling COBOL	Details of debugging mixed Visual Basic and COBOL applications.
Chapter 5 NetCOBOL Debugging Functions	Details of using COBOL debugging functions.
Appendix A Debugger Command Lists	Lists of the commands supported in the different environments that can be entered into the command-line windows.

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.
<u>Program-name</u>	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	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.

Example of Convention	Description
COBOL ALL	

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

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
Windows® 8 Windows® 8 Pro Windows® 8 Enterprise	Windows 8
Windows® 7 Home Premium Windows® 7 Professional Windows® 7 Enterprise Windows® 7 Ultimate	Windows 7
Windows Server 2012 R2 Windows Server 2012 Windows Server 2008 R2 Windows 8.1(x64) Windows 8(x64)	Windows

Product Name	Abbreviation
Windows 7(x64)	
Microsoft(R) Visual C++(R) development system	Visual C++
Microsoft(R)Visual Basic(R) programming system	Visual Basic
Oracle Solaris	Solaris

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:

- SequeLink
- MeFt/Web
- Print Walker/OVL option
- System Walker/List Works

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- The permission of the Microsoft Corporation has been obtained for the use of screen images.

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.

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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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August 2015

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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 Debugger for the Windows system (32 bit applications)
- COBOL Debug Functions

The debugging function of NetCOBOL Studio and COBOL Debugger 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 debugger products support many common interface features such as the ability to record and play back sequences of debugging operations and a command-line interface.

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

1.2 Features of the Debugger for Windows

The debugger for the Windows system provides the following features:

- Displays the original program source.
- Colors code to indicate comments, verbs, data-names and other syntax features.
- Clearly indicates the current execution point, breakpoint settings, pass count settings and execution route trace point.
- Gives convenient access to all functions through menus, a toolbar, a shortcut menu, accelerator keys and a command-line window.
- Records and displays the CALL stack status.
- Lists all programs loaded in memory and allows you to switch easily among them.
- Supports storage of different file types in multiple directories or in a single folder.
- Provides navigation around the program source through Find and Jump to line number functions.
- Provides different levels of code execution control including stepping line-by-line, automated line-by-line execution while you watch, and full speed execution to the next breakpoint.
- Code can be executed up to the point indicated by the cursor, up to the next program and up to a long list of specific execution conditions such as particular verbs being executed, particular files being accessed and entry to or exit from the program.
- The current execution point can be set to any statement in the program.
- Breakpoints can be set on any statement. The breakpoint can be set to occur only if a particular condition is true or after the line has been executed a particular number of times.
- Passage counts can be set on any statement so you can check the number of times particular lines are being executed.
- The values of data items can be inspected, changed and monitored throughout execution.
- Unassigned linkage items can be assigned storage space so that debugging can continue.
- Execution path can be recorded for later tracing so you can confirm how a particular point in the code was arrived at.

- Debugging operations, and their results, can be recorded in a log file for later inspection or for later replay of either the whole debugging session or repeated sequences of operations.
- Useful lists of breakpoints, pass counts, monitored data items, active programs and other information are provided to help you control your debugging session.

With this full set of features bugs are quickly tracked down and eradicated.

1.3 Features of the COBOL Debugging Functions

There are COBOL debugging functions as follows:

- TRACE
- CHECK
- COUNT
- Memory Check
- COBOL Error Report
- Compiler Listings

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

1.3.1 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.

1.3.2 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.

1.3.3 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.

1.3.4 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.

1.3.5 COBOL Error Report

COBOL Error Report output diagnostic information for the following problems:

- Application errors and runtime messages of U-level
- No response
- Area destruction

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

1.3.6 Compiler Listings

When the compile option LIST is specified, object program list is generated for each object program.

Object program list check lets you check the statement that caused the program to terminate abnormally.

Chapter 2 Debugging in Windows System

This chapter explains how to use the interactive debugger. The sections are:

- Overview of the Debugger
- Preparing Programs for Debugging
- Environment Variables of the Debugger
- Starting the Debugger
- Overview of the Debugger Windows
- Using the Debugger
- Debug Functions Based on Program Features
- Debug Functions for Object-Oriented Programming
- Debugger Compatibility with Multithreading
- Handling of Unicode by the Debugger
- Notes
- How to use the Interactive Remote Debugger
- Start procedure for remote debugging
- How to use the Remote Debugger Connector
- Environment Variables of the Remote Debugger
- Starting the Remote Debugger
- Using the Remote Debugger
- Notes about the Remote Debugger

2.1 Overview of the Debugger

The COBOL debugger is a full function, interactive source code debugger. You can easily debug your COBOL source programs displayed on the screen, by using the keyboard and mouse to select menu commands and toolbar buttons.

The debugger provides functions for:

- Controlling code execution
- Watching and changing data values
- Setting breakpoints at specific locations
- Setting breakpoints on specific conditions
- Counting the number of times lines are executed
- Retracing execution paths
- Recording and replaying debugging commands
- Operating the debugger automatically
- Navigating around the source code
- Configuring the colors of different source code items
- Viewing the program CALL sequence

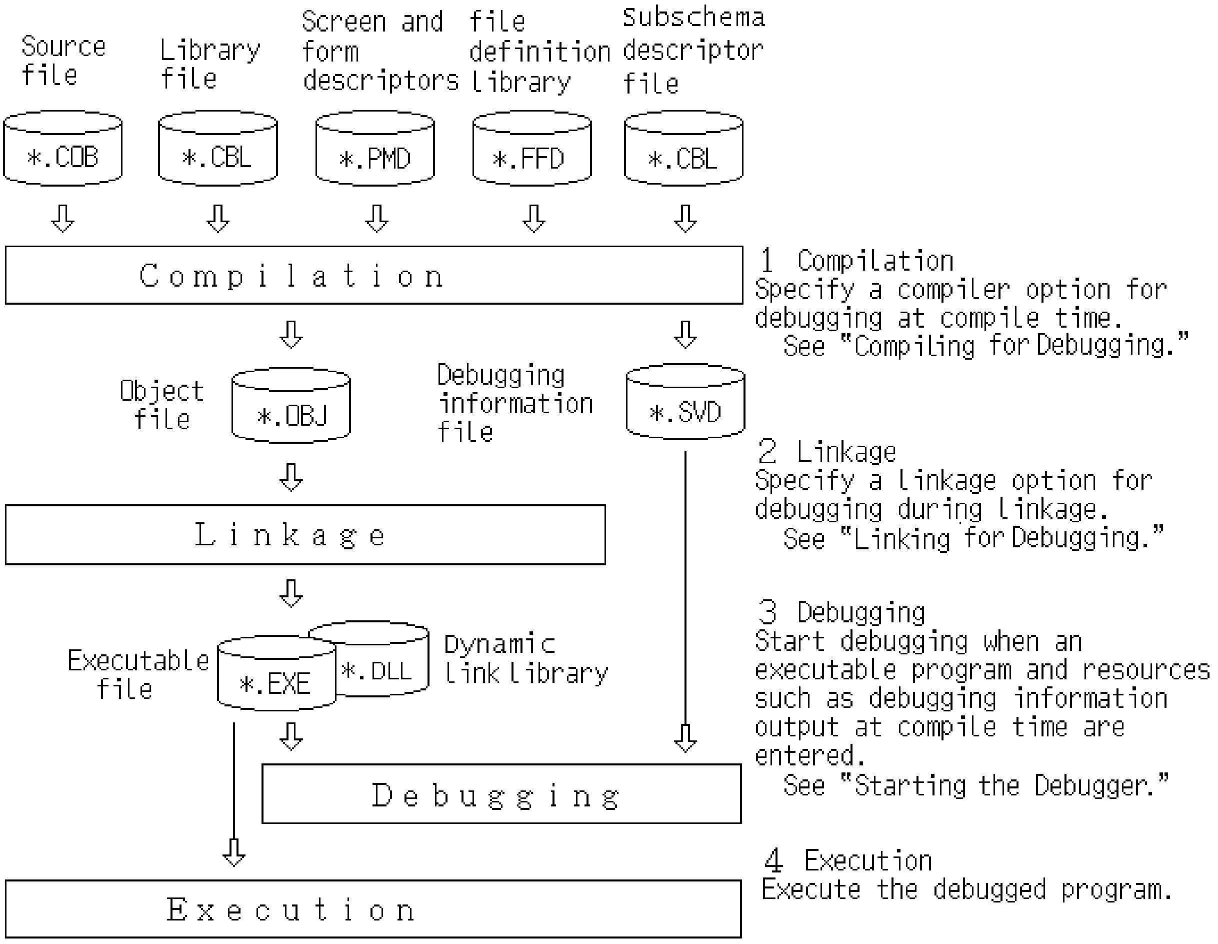
Access is provided to these functions in several ways, allowing you to choose the access method that works best for you. The toolbar contains the most frequently used functions and there are accelerator keys for most immediate actions. All the functions are available from the drop down menus. A shortcut menu provides functions best invoked by mouse-only actions. A command line interface provides compatibility with earlier versions of Fujitsu debuggers and supports automated debugging.

You can debug not only the program running on the same computer as the debugger, but also the program running on another computer on the network. This section explains how to use the normal interactive debugger. For information regarding the interactive remote debugger, see "How to Use the Interactive Remote Debugger".

2.2 Preparing Programs for Debugging

This section explains how to prepare COBOL programs for use with the debugger. The figure below gives an overview of the debugging procedure.

Figure 2.1 Overview of the debugging procedure

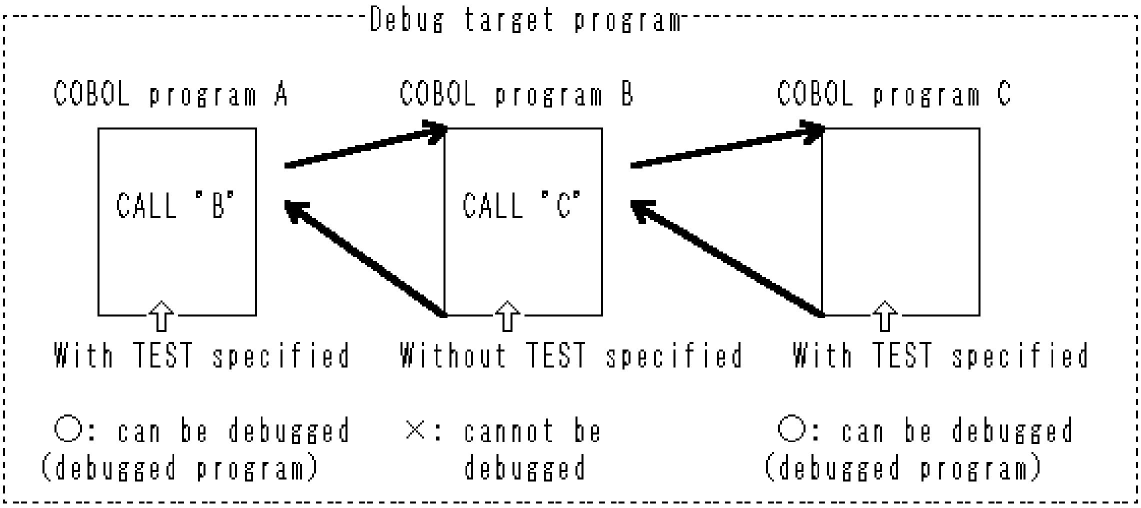

Source file
*.COB
Library file
*.CBL
Screen and form descriptors
*.PMD
file definition Library
*.FFD
Subschema descriptor file
*.CBL
Compilation
Object file
*.OBJ
Debugging information file
*.SVD
Linkage
Executable file
*.EXE
*.DLL
Dynamic Link Library
Debugging
Execution
1 Compilation
Specify a compiler option for debugging at compile time.
See "Compiling for Debugging."
2 Linkage
Specify a linkage option for debugging during linkage.
See "Linking for Debugging."
3 Debugging
Start debugging when an executable program and resources such as debugging information output at compile time are entered.
See "Starting the Debugger."
4 Execution
Execute the debugged program.

2.2.1 Debug Program Types

The debugger can debug executable programs (EXE) and dynamic link libraries (DLL) called from executable programs. This chapter refers to these executable programs and dynamic link libraries as debug target programs.

Usually, a debug target program consists of multiple COBOL source programs. For the debugger to recognize one of these programs for debugging, you need to create a debugging information file by compiling with the TEST option. Since the debugger maintains user resource compatibility, you can use it without having to recompile and re-link old resources.

Figure 2.2 Debugging programs with and without TEST



2.2.2 Compiling for Debugging

To prepare a program for debugging, specify the compiler option TEST when compiling the COBOL source program. When the compiler option TEST is specified, the compiler writes the information needed to carry out debugging to an object file and creates a debugging information file.

The file name used for the debugging information file is the name of the COBOL source program with the extension SVD added.

Programs to be debugged can be easily created using the project management function. For more information, refer to "Creating a Debug Module" in the "NetCOBOL User's Guide".

COBOL source programs compiled with the TEST option specified can be debugged with the debugger functions. COBOL source programs compiled without the TEST option specified or non-COBOL programs can be run under the debugger but cannot be debugged. COBOL source programs compiled with both the TEST and OPTIMIZE options specified cannot be debugged, since a debugging information file is not available. Refer to "TEST (Whether the interactive debugger and the COBOL Error Report should be used)" in the "NetCOBOL User's Guide".

2.2.3 Linking for Debugging

To link an object file for debugging, specify the link option /DEBUG. If you specify these options, the linker outputs the debugging information that is output in the object file by the compiler in an executable file or dynamic link library file.

The format of the option /DEBUG is:

```
/DEBUG
```

Note

If you do not want to view certain programs in the debugger, omit the /DEBUG option.

2.3 Environment Variables of the Debugger

This section describes how to set environment variables to be used by the debugger.

The environment variables to be used by the debugger are for batch debugging, and it is unnecessary to specify them except for batch debugging. For information on batch debugging, refer to "2.5.2.1.11 Automating Debug Operations".

Use either of the following methods to set environment variables:

- Set them by the system of the control panel.

- Set them by the SET command.

For how to use the SET command, refer to the "Setting Runtime Environment Information" in the "NetCOBOL User's Guide".

For how they can be set in AUTOEXEC.BAT or by the control panel, refer to Help on your system.

2.3.1 @SVD_PERFORM_CHECK(to watch PERFORM nest)

```
@SVD_PERFORM_CHECK = {YES|NO}
```

Specify whether the debugger watch PERFORM nest. (YES/NO)

By specifying this environment variable, the initial value to decide whether to watch PERFORM nest can be set in the value specified by the environment variable.

When the environment variable is not specified, the default becomes the following.

At batch debugging

Do not watch PERFORM nest.

At operations except batch debugging

The default conforms to the values that were set when the debugger last ended.

2.3.2 @SVD_ENV(to specify a debugging environment)

```
@SVD_ENV = [DIFF|SAME[({ALL|WORD})][{BREAK|CONTINUE}][SIGNAL({BREAK|CONTINUE})][THREADEND({BREAK|
CONTINUE})]
```

Specify a debugging environment.

This environment variable is provided for batch debugging by means of a command file that was created for Debugger V50L10 or earlier debugger. By specifying this environment variable, the initial values for the debugging environment can be set to the value specified by the environment variable instead of the values that were set when the debugger last ended.

DIFF

Uppercase and lowercase letters are distinguished in handling data names or program names in line commands.

SAME(ALL)

Uppercase and lowercase letters are not distinguished in handling data names or program names in line commands.

SAME(WORD)

In line commands, lowercase letters in data names are taken as the corresponding uppercase letters while lowercase letters in program names are not taken as the corresponding uppercase letters.

BREAK

Execution of the program is interrupted before processing an exception procedure when an exception condition occurs. BREAK can be abbreviated as B.

CONTINUE

Execution of the program is not interrupted before processing an exception procedure when an exception condition occurs. CONTINUE can be abbreviated as CONT or C.

SIGNAL(BREAK)

Execution of the program is interrupted when the first signal was received. SIGNAL can be abbreviated as SIG. BREAK can be abbreviated as B. For reception of the first signal, refer to "2.6.2 Debug functions for signals handled by the exception handler".

SIGNAL(CONTINUE)

Execution of the program is not interrupted when the first signal was received. SIGNAL can be abbreviated as SIG. CONTINUE can be abbreviated as CONT or C. For reception of the first signal, refer to "2.6.2 Debug functions for signals handled by the exception handler".

THREADEND (BREAK)

The program execution is interrupted at all thread ends. THREADEND can be abbreviated as THE. BREAK can be abbreviated as B.

THREADEND (CONTINUE)

The program execution is interrupted at only the implicit thread end. THREADEND can be abbreviated as THE. CONTINUE can be abbreviated as CONT or C.

When the environment variable is not specified or each parameter is omitted, the default becomes the following.

At batch debugging

- Uppercase and lowercase letters are distinguished in handling data names or program names in line commands.
- Execution of the program is interrupted before processing an exception procedure when an exception condition occurs.
- Execution of the program is not interrupted when the first signal is received from the operating system (such as problem signals and callbacks).
- The program execution is interrupted at only the implicit thread end.

At operations except batch debugging

- The default environment is the values that were set when the debugger last ended.

2.3.3 @SVD_COMPATIBILITY(to specify compatibility)

```
@SVD_COMPATIBILITY = {[COBOL97] VxxLyy | NetCOBOL Vx.xLyy}
```

You can restrict the functions of the debugger with this variable. By specifying this environment variable, the initial value for the compatibility of the debugger can be set in the value specified by the environment variable. When the environment variable is not specified, the default conforms to the values that were set when the debugger last ended.

In the environment variable, specify the product type and version level of the debugger in use at the time the command file was created.

If you select "About NetCOBOL for Windows " from the debugger Help menu, you can check the product type and version level of the debugger.

[COBOL97] VxxLyy

If you specify COBOL97, there are three types of behavior depending on what is set for the version and level number (VxxLyy). These are shown as follows.

- When a version and level earlier than V50L10 is specified: Compatibility with V40 series or earlier is maintained.
- When V50L10 is specified: Compatibility with V50L10 is maintained.
- When V61L10 or later is specified: Compatibility with V61L10 is maintained. (This is the latest behavior.)

NetCOBOL Vx.xLyy

If you specify NetCOBOL, the behavior is shown as follows.

- When V7.0L10 or later is specified: This is the latest behavior. Compatibility with V7.0L10, the release specified in this, and associated, manuals is maintained.

2.4 Starting the Debugger

This section explains how to start the debugger and provide the information required for debugging.

2.4.1 Start debugging

Essentially, there are three methods used to start debugging.

- Debugging for general programs

  Start the debugger, and specify the program you want to debug. Start the debug.

- Debugging for programs that run in server environments such as Interstage

  Start the debug from program you want to debug. Since the COBOL program is called from the server product, you must use this as the start method, as the programs cannot be debugged using the method for general programs.

- Debugging using the just-in-time debugging function

  When an application error occurs or a runtime message occurs in the program, the debugger starts automatically and debugs the program.

2.4.1.1 How to start debugging for general programs

This starts the debugger and starts debug for the program you want to debug. The following are general methods:

- Select "Debug" from the Project menu of the Project Manager window.
- Select "Win32" in the Project Manager window, Tools menu, "Debugger type". Next, use one of the following methods to start the debug:
  - Select "Debugger" in the Project Manager window, Tools menu.
  - At the command prompt, type in the command to invoke the debugger. Refer to "2.4.2.2 Specifying Options on the Command Line" for the details of the command line format.

When the debugger starts, the Main window of the debugger will appear. To start a debugging session, bring up the Start Debugging dialog box, provide the required information, and click the [OK] button. This starts a debugging session. Then, the dialog box closes and the Main window is activated. Thus, you can perform debugging by selecting menus and buttons in the Main window, or by entering a line command.

2.4.1.2 How to start debugging for programs that run in server environments such as Interstage

This is the method for starting the debugger from the program you want to debug.

You can start debug for programs that run on servers such as Interstage and Web servers from the command in the environment variable. For details, refer to “How to start remote debugging for programs that run in server environments such as Interstage”.

2.4.1.3 How to start debugging using the just-in-time debugging function

This start method automatically starts the debugger and debugs the program if an application error or runtime message occurs in the program.

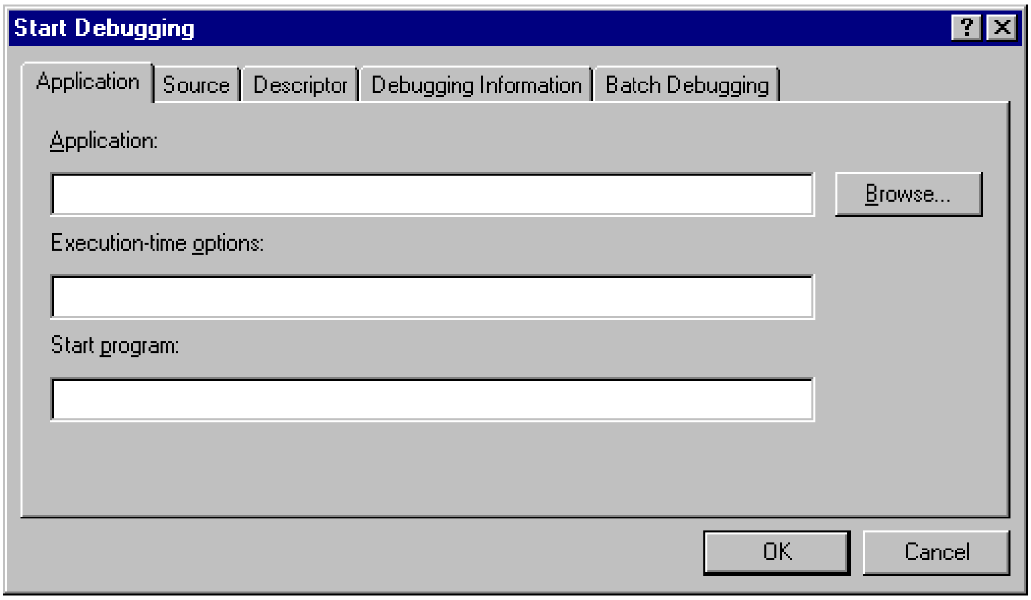
Use the environment variable @CBR_JUSTINTIME_DEBUG to start the debugger when an application error or runtime message occurs and debug the program. Refer to "@CBR_JUSTINTIME_DEBUG (Specify inspection using the debugger or the COBOL Error Report at abnormal termination)" in the "NetCOBOL User's Guide".

When an application error or runtime message occurs in the program as it is run, the debugger is activated, and the Main window of the debugger will appear. To start a debugging session, bring up the Start Debugging dialog box and click the [OK] button. When debugging starts, the program pauses with the application error or runtime message occurring.

2.4.2 Starting to Debug a Program

To start debugging a program, select File, "Start Debugging". This brings up the Start Debugging dialog box.

2.4.2.1 The Start Debugging Dialog Box



The Start Debugging dialog box lets you input all the information the debugger requires to execute your program. You only need to enter the information that applies to your program. The information requested on each tab is as follows:

Table 2.1 Start Debugging Dialog Box Parameters

Parameter		Description
Application	Application:	Name of the EXE file to be loaded. This is the only mandatory parameter. Default: Extension of EXE.
	Execution-timeoptions:	Any options expected on the command line of the program.
	Start program:	Name of the first program to be debugged (must be a program prepared for debugging). Default: the first program for debugging executed in the EXE or a DLL called by it.
Source	Source file storage folders:	Directories containing the source of the programs to be debugged. Default: the folder containing the EXE or DLL file.
	Copy library storage folders:	Directories containing copy libraries used by the debug target programs. Default: If this parameter is omitted or cannot be found in the specified folders, a search for the parameter will be made in order from (1) the directories specified by environment variable COB_COBCOPY and (2) the folder containing the EXE or DLL file. For copy library files with IN/OF specified, a search for the parameter will be made in order from (1) the directories specified by the environment variable COB_library-name and (2) the folder containing the EXE or DLL file.
	Subschema descriptor file storage folders:	Directories containing subschema used by the debug target programs. Default: If this parameter is omitted or cannot be found in the specified folders, a search for the parameter will be made in order from (1) the directories specified by environment variable COB_AIMLIB and (2) the folder containing the EXE or DLL file.
Descriptor	Screen and form descriptor:	Directories and extension of form descriptors used by the debug target programs.

Parameter		Description
		Default: If this parameter is omitted or cannot be found in the specified folders, a search for the parameter will be made in order from (1) the directories specified by environment variable FORMLIB and (2) the folder containing the EXE or DLL file. Extension PMD.
	File descriptor:	Directories and extension of file descriptors used by the debug target programs. Default: If this parameter is omitted or cannot be found in the specified folders, a search for the parameter will be made in order from (1) the directories specified by environment variable FILELIB and (2) the folder containing the EXE or DLL file. Extension FFD.
Debugging Information	Debugging information file storage folders	Directories containing debugging information file(.SVD files) Default: the folder containing the EXE or DLL file.
Batch Debugging	Use Batch Debugging	Batch Debugging is performed.
	Command file	File to drive the debugging session. Default extension: LOG
	History file	File to save actions and results from the debugging session. Default extension: LOG

Details of the Start Debugging Dialog Box Options

Relative file names

When you use relative path names, the debugger adds the folder that was current when the debugger started to the path name.

Multiple folder names

For fields that accept multiple directories, separate the folder names by semicolons ";". The debugger searches for files in order of the specified directories.

The search procedure when the folder specification is omitted or when files cannot be found in the specified folders depends on each file.

For source files and debugging information files, the directories containing the executable files or the dynamic link libraries are searched.

For copy library files, subschema descriptor files, screen and form descriptors, and file descriptors, the folders are searched in order from (1) the directories specified by the environment variable and (2) the directories containing the executable files or the dynamic link libraries. Refer to "Setting Environment Variables" in the "NetCOBOL User's Guide" for details about environment variables used for specifying folders of the various files.

Command and history files

When the "Use Batch Debugging" check box is on, Command file and History file parameters are mandatory.

Do not specify the same file in both the Command file and History file parameters.

If the file specified for the History file already exists, it is overwritten.

Refer to "2.5.2.1.11 Automating Debug Operations" for details on batch debugging and command files.

2.4.2.2 Specifying Options on the Command Line

This section explains how to start the debugger using command format.

To start a debugger with the winsvd command, select it from "Debugger type" in the Tools menu of the Project Manager window. Select the correct type of debugger before executing the start command.

To start the debugger from the command line, use the WINSVD command with the following format:

```
winsvd [start-parameter] application-name [execution-time-option]
```

You must specify the parameters in the order shown above.

If you only enter "winsvd", you need to provide the application information in the Start Debugging dialog box.

You must specify application-name if you want to enter any other information after "winsvd".

When you start the debugger with information on the command line, it comes up with the Start Debugging dialog box opened and the command line information entered in the appropriate fields.

To start debugging, enter any further information in the Start Debugging dialog box, and click the OK button.

See the list below for the supported start parameters.

Table 2.2 Start Parameters

Specification Format	Field in Start Debugging dialog box
/G start- program-name	Start program
/S source-file-storage-folder-name	Source file storage folders
/C copy-library-storage-folder-name	Copy library storage folders
/A subschema- descriptor-file-storage-folder-name	Subschema descriptor file storage folders
/M screen-and form-descriptors-storage-folder-name	Screen and form descriptor folders
/E screen-and form-descriptors-extension	Screen and form descriptor extension
/H file-descriptors-storage-folder-name	File descriptor folders
/O file-descriptors-extension	File descriptor extension
/D debugging-information- file-storage-folder-name	Debugging information file storage folders
/B command-file-name	Command file
/L history- file-name	History file
/N	Starts debugging without opening the Start Debugging dialog box.

"-" (hyphen) can be used instead of "/ " (slash) as the first character of a start parameter.

The start parameter letter can be upper case or lower case.

To specify multiple start parameters, provide one or more blanks between start parameters.

Example

To enter a command with the following parameters and options:

- Application name: E:\EXE\SAMPLE1.EXE
- Source file storage folder name: D:\SOURCE
- Debugging information file storage folder name: E:\SVD
- Execution-time option: PARAM1

The command line would be:

```
winsvd /S d:\source /D e:\svd e:\exe\sample1.exe param1
```

2.5 Operation of the Debugger

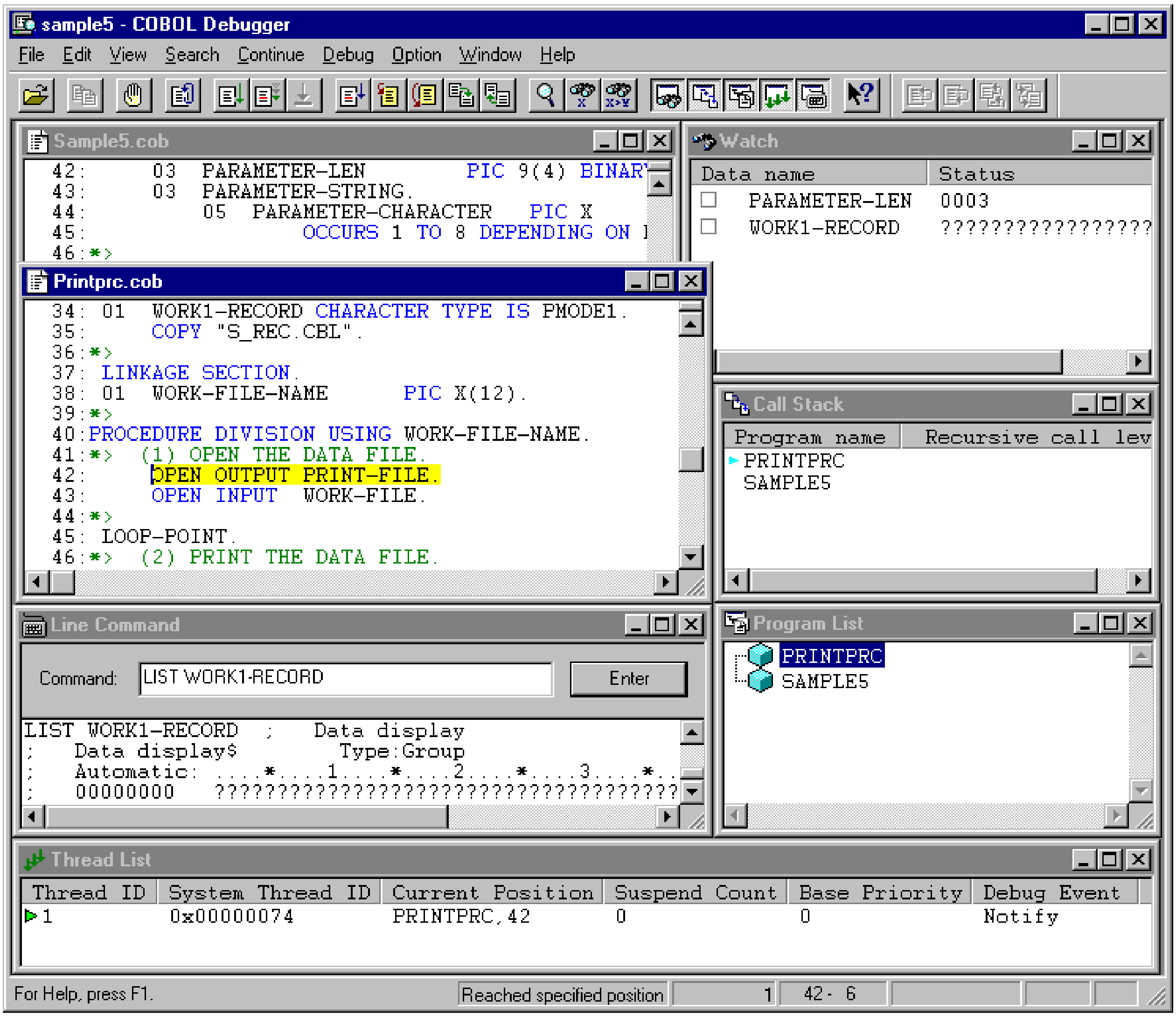
2.5.1 Overview of the Debugger Windows

2.5.1.1 Main Window

The main window of the debugger contains the Source File window, the Program List window, the Watch window, the Call Stack window, the Thread List window, and the Line Command window. The status bar at the bottom of the window displays program status information and an expanded explanation about the item under the mouse pointer.

The figure below shows an example of the main window.

Figure 2.3 Debugger Main Window



```
      03  PARAMETER-LEN          PIC 9(4) BINAR
      03  PARAMETER-STRING.
          05  PARAMETER-CHARACTER    PIC X
                 OCCURS 1 TO 8 DEPENDING ON I
*>
```

```
 01  WORK1-RECORD CHARACTER TYPE IS PMODE1.
     COPY "S_REC.CBL".
*>
 LINKAGE SECTION.
 01  WORK-FILE-NAME       PIC X(12).
*>
PROCEDURE DIVISION USING WORK-FILE-NAME.
*>   (1) OPEN THE DATA FILE.
     OPEN OUTPUT PRINT-FILE.
     OPEN INPUT   WORK-FILE.
*>
 LOOP-POINT.
*>   (2) PRINT THE DATA FILE.
```

Data name	Status
□ PARAMETER-LEN	0003
□ WORK1-RECORD	????????????????

Program name	Recursive call lev
▸ PRINTPRC	
SAMPLE5	

Command: LIST WORK1-RECORD

```
LIST WORK1-RECORD   ;    Data display
;   Data display$         Type:Group
;   Automatic:  ....*....1....*....2....*....3....*..
;   00000000    ?????????????????????????????????????
```

PRINTPRC
SAMPLE5

Thread ID	System Thread ID	Current Position	Suspend Count	Base Priority	Debug Event
▶ 1	0x00000074	PRINTPRC.42	0	0	Notify

For Help, press F1. | Reached specified position | 1 | 42 - 6

You can invoke debugging operations in five ways:

1. Using menu commands: Refer to Help for details of each command.
2. Using accelerator keys: The drop down menus show the accelerator keys beside the functions they invoke.
3. Using toolbar buttons: Refer to Help for details of each button. You can detach and move the toolbar anywhere in the main window by dragging.
4. Using the shortcut menu: You display the shortcut menu by clicking the right mouse button. Refer to Help for details on the shortcut menu commands.

5. Using the Line Command window: You enter commands in this window. Refer to Help for details on the supported line commands.

2.5.1.2 Source File Window

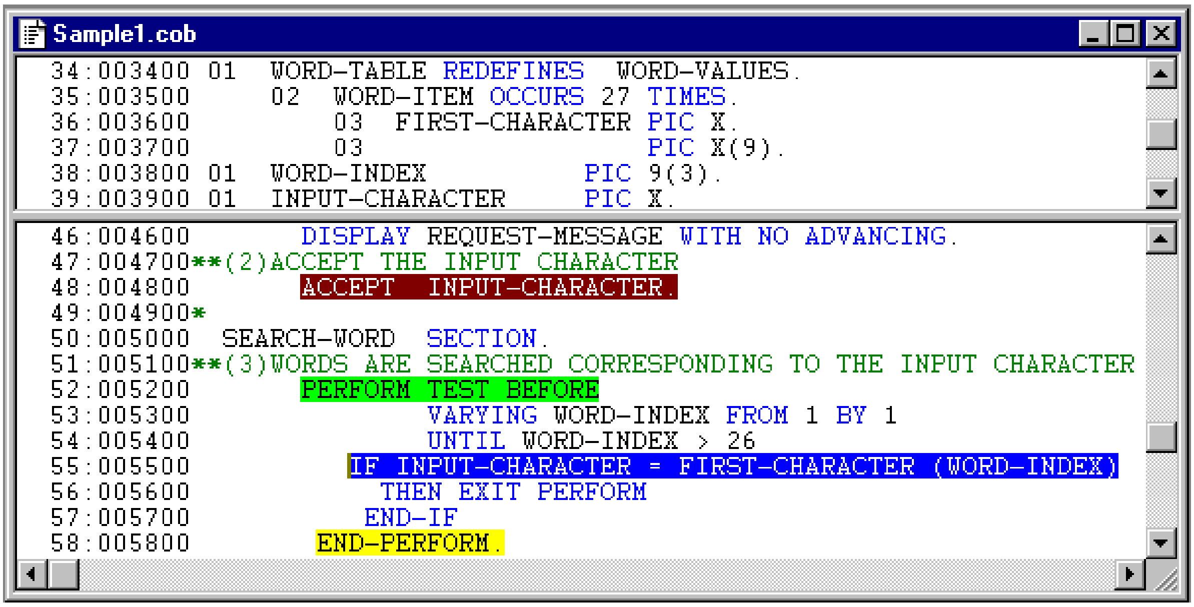
The Source File window displays the program source and expanded copy libraries. The debugger opens one window for each program being debugged. It opens these windows automatically when execution is interrupted in programs prepared for debugging.

You can use the Program List window to open Source File windows.

You can use the shortcut menu to open library files.

See the figure below for an example of the Source File window.

Figure 2.4 A Split Source File Window



```
003400 01  WORD-TABLE REDEFINES  WORD-VALUES.
003500     02  WORD-ITEM OCCURS 27 TIMES.
003600         03  FIRST-CHARACTER PIC X.
003700         03              PIC X(9).
003800 01  WORD-INDEX          PIC 9(3).
003900 01  INPUT-CHARACTER     PIC X.
```

```
004600       DISPLAY REQUEST-MESSAGE WITH NO ADVANCING.
004700**(2)ACCEPT THE INPUT CHARACTER
004800       ACCEPT  INPUT-CHARACTER.
004900*
005000  SEARCH-WORD  SECTION.
005100**(3)WORDS ARE SEARCHED CORRESPONDING TO THE INPUT CHARACTER
005200       PERFORM TEST BEFORE
005300               VARYING WORD-INDEX FROM 1 BY 1
005400               UNTIL WORD-INDEX > 26
005500          IF INPUT-CHARACTER = FIRST-CHARACTER (WORD-INDEX)
005600            THEN EXIT PERFORM
005700           END-IF
005800        END-PERFORM.
```

You can use a division bar to split the Source File window and view two parts of the same source file simultaneously. The division bar starts as a small bar, called the split box, at the top of the vertical scroll bar. To split the screen click on the split box and drag it down.

The following statements are displayed in color, which can be changed, so as to distinguish them from other statements:

- Current statement - the next statement to be executed: The currently stopped statement is colored. Unless the setup is changed, the current statement color is yellow.

- Current trace statement: The currently backward-traced statement is colored. Unless the setup is changed, the backward-traced statement color is blue.

- Statement with a breakpoint set: A statement on which a breakpoint is set is colored. Unless the setup is changed, a statement with a breakpoint is colored red.

- Statement with a passage count set: When a passage count point is set on a statement, it is colored. (The default setup uses green.) If the program is executed after a passage count point is set, the executed statements will not have a different color from that of already executed statements. If, however, the passage count point is set after execution has begun, a statement not already passed is indicated in green and a statement that has already been passed is indicated in dark green.

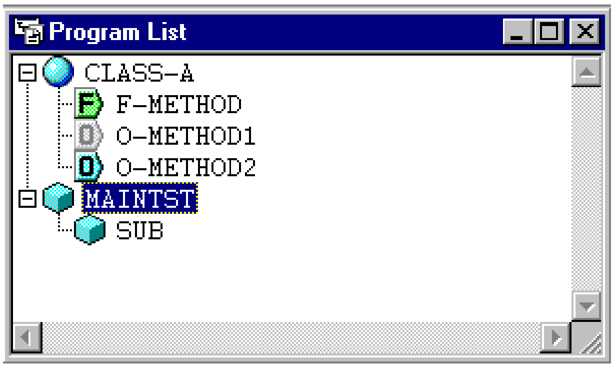
The debugger colors the source code to distinguish user-defined text, reserved words and comments.

2.5.1.3 Program List Window

The Program List window lists all programs loaded in memory for debugging. To display this window, select "Program List" on the Window menu.

The Program List window can be used to view programs or classes to be debugged, or to open source files.

Figure 2.5 The Program List Window



```
⊟ CLASS-A
    F-METHOD
    O-METHOD1
    O-METHOD2
⊟ MAINTST
    SUB
```

2.5.1.4 Watch Window

The Watch window displays the following kinds of information:

- Data name and contents whose values and contents are monitored to determine if they have been changed
- Conditional expressions in which the establishment and status of conditions is monitored

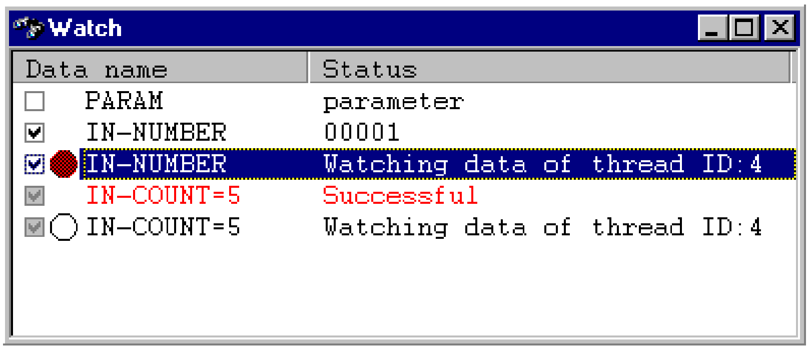
The Watch window opens automatically when data or condition monitoring starts and also appears when "Watch" is selected from the Window menu.

The Watch window is used to identify data changes or monitored conditions or to halt program execution when monitored data change.

More than one set of data or conditions can be programmed for monitoring.

See the figure below for an example of a Watch window.

Figure 2.6 The Watch Window

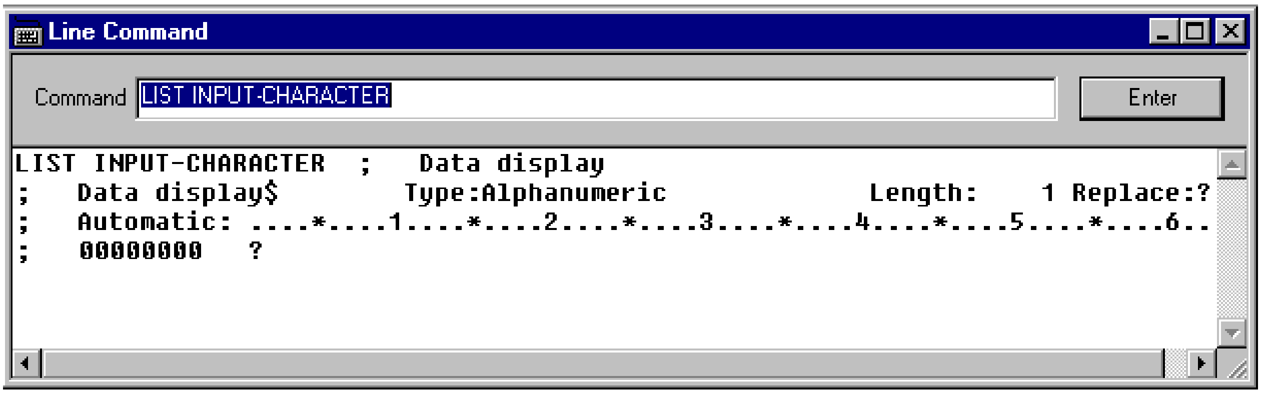


Data name	Status
□ PARAM	parameter
☑ IN-NUMBER	00001
☑ ● IN-NUMBER	Watching data of thread ID:4
☑ IN-COUNT=5	Successful
☑ ○ IN-COUNT=5	Watching data of thread ID:4

2.5.1.5 Line Command window

The Line Command window accepts line commands and displays the results. To display the Line Command window select "Line Command" from the Window menu.

Figure 2.7 The Line Command Window



Command LIST INPUT-CHARACTER

```
LIST INPUT-CHARACTER   ;   Data display
;   Data display$       Type:Alphanumeric             Length:    1 Replace:?
;   Automatic: ....*....1....*....2....*....3....*....4....*....5....*....6..
;   00000000    ?
```

Refer to "Debugger Command Lists" in Appendix A for a list of line commands.

Refer to Help for detailed specifications of the line commands.

2.5.1.6 Call Stack window

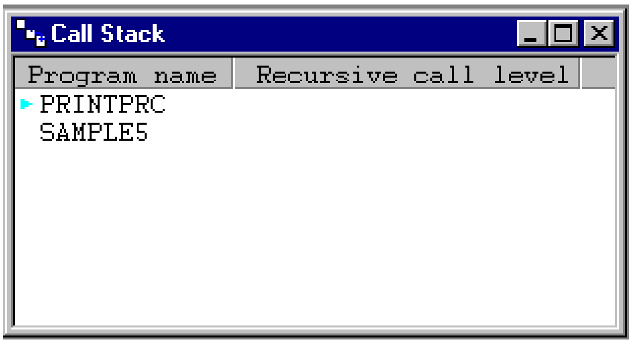
The Call Stack window displays a list of the active programs in the call stack. The program currently being debugged is at the top of the calling path, and calling programs are displayed in sequence. A mark indicating an active program is displayed to the left of the program name.

To display the Call Stack window, select "Call Stack" from the Window menu. The debugging environment can be configured to disable the Call Stack window from being updated while animation is in progress.

The Call Stack window can be used to identify a calling program or to open a source file.

The figure below illustrates a typical Call Stack window.

Figure 2.8 The Call Stack Window



	Program name	Recursive call level
▶	PRINTPRC	
	SAMPLE5	

2.5.1.7 Thread List window

The Thread List window displays a listing of the active threads and the threads from which a thread end event has been received.

To display the Thread List window, select "Thread List" from the Window menu. The debugging environment can be configured to disable the Thread List window from being updated while animation is in progress.

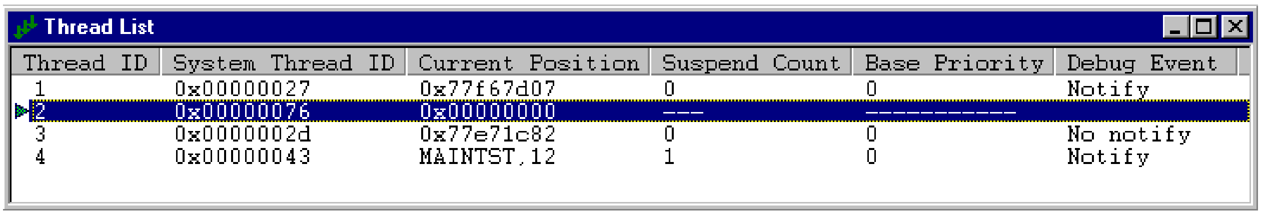
The Thread List window is used to check the status of the active threads or change the implicit thread.

Note

System and server applications may have some threads other than COBOL applications threads. This window displays all thread information (included with their threads) of the process.

See the figure below for an example of a Thread List window.

Figure 2.9 The Thread List Window



	Thread ID	System Thread ID	Current Position	Suspend Count	Base Priority	Debug Event
	1	0x00000027	0x77f67d07	0	0	Notify
▶	2	0x00000076	0x00000000	---	------------	
	3	0x0000002d	0x77e71c82	0	0	No notify
	4	0x00000043	MAINTST.12	1	0	Notify

2.5.1.8 Status Bar

The status bar displays the following information:

- An expanded explanation of the menu command or toolbar button under the mouse pointer.
- The event that interrupted execution.

- The thread ID of the current implicit thread.
- The cursor position in the Source File window.
- Whether the debugger treats lowercase letters as EQUAL or NOT EQUAL to uppercase letters on line commands.
- Whether TRACE is on or off.
- Whether the operation history log is being written.

2.5.2 Function of the Debugger

2.5.2.1 Using the Debugger

This section explains how to use the debugger for the following tasks:

- Setting breakpoints
- Checking and changing data contents
- Breaking execution when data changes
- Changing the statement execution sequence
- Tracing the execution path
- Tracing the program calling path
- Breaking into an executing program
- Allocating linkage section items
- Checking test coverage
- Restarting the debugging session
- Automating debugging operations
- Configuring the debugger
- Splitting the source screen
- Configuring source code font and colors
- Checking the status of debugger items
- Data File Input/Output

2.5.2.1.1 Setting Breakpoints

You can set breakpoints at specific locations, at the entry or exit of programs, and on specific conditions being satisfied.

You set simple breakpoints at the current cursor location by using the toolbar Set/Delete Breakpoint button

✋

or the breakpoint function on the shortcut menu. More complex breakpoints are set using the Debug menu Breakpoint function.

In the Line Command window, use the BREAK command.

The Specific Execution Condition on the Continue menu offers another way of executing to a particular point in the program. This function allows you to execute the program up to a particular verb, location or access point of a particular file. Use the Continue, Specific Execution function to execute up to the selected point(s).

2.5.2.1.2 Checking and Changing Data Contents

Use the Data function on the Debug or shortcut menus to check and change the contents of data items.

Data,

🔍

, is also available on the toolbar.

In the Line Command window, LIST and SET correspond to the Data function.

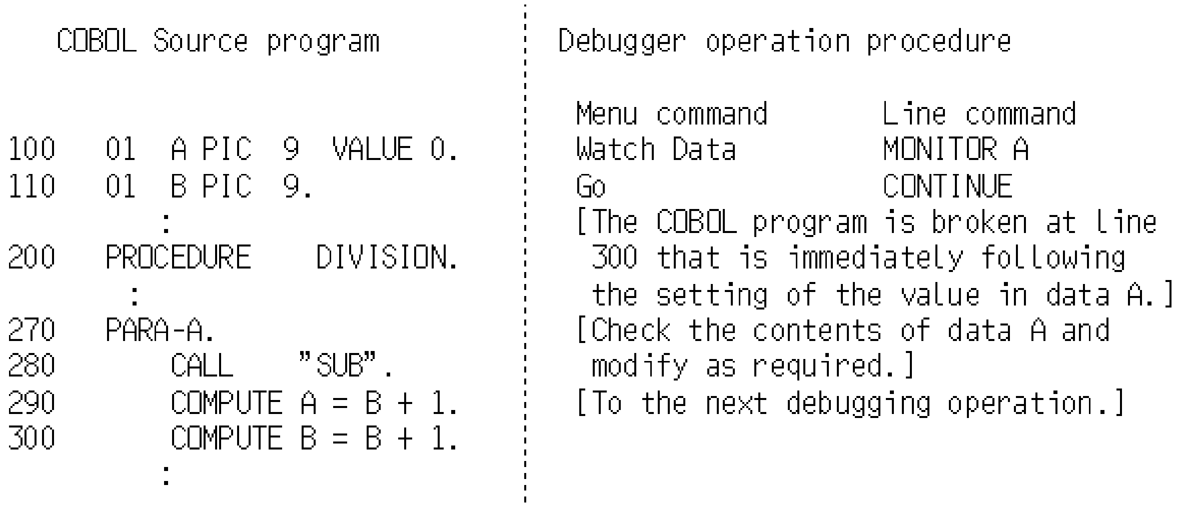
2.5.2.1.3 Breaking Execution when Data Changes

Sometimes you know that a data item does not have the correct value but it is not obvious where the incorrect value is coming from. In these situations you need to use the Data Monitor function. Data Monitor monitors the data item and interrupts execution when the contents change.

You switch on the monitoring of a data item from the Watch window or by using the MONITOR line command.

For example, to find out where the application updates data item A, consider the following figure.

Figure 2.10 Finding Data Modification Locations



```
   COBOL Source program           Debugger operation procedure

                                   Menu command       Line command
100   01  A PIC  9  VALUE 0.       Watch Data         MONITOR A
110   01  B PIC  9.                Go                 CONTINUE
          :                        [The COBOL program is broken at line
200   PROCEDURE    DIVISION.        300 that is immediately following
        :                           the setting of the value in data A.]
270   PARA-A.                      [Check the contents of data A and
280       CALL    "SUB".            modify as required.]
290       COMPUTE A = B + 1.       [To the next debugging operation.]
300       COMPUTE B = B + 1.
          :
```

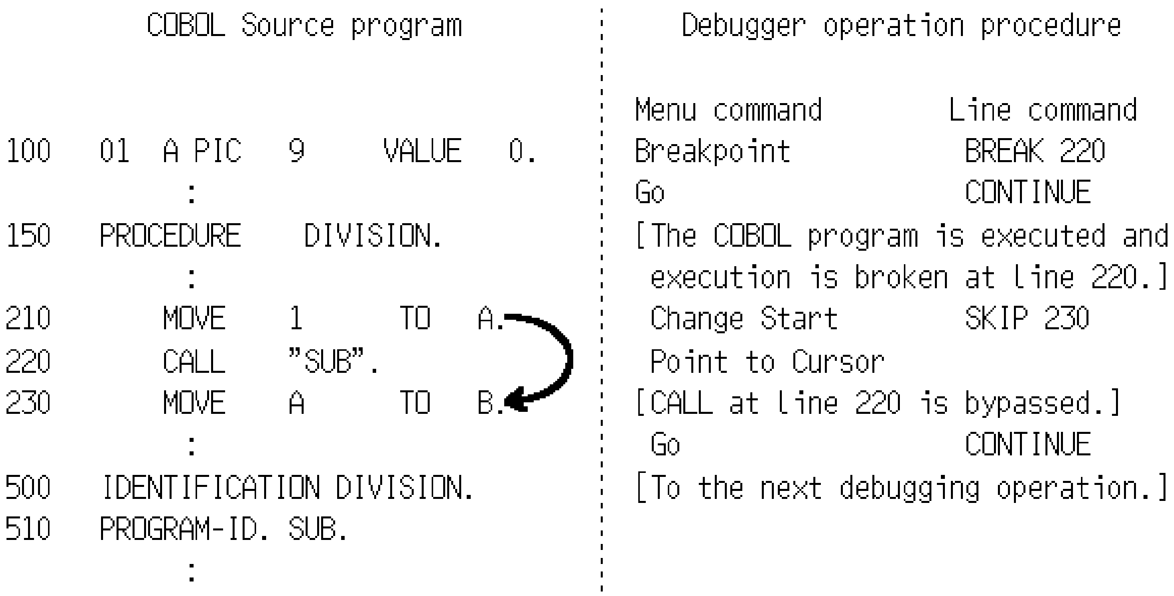
2.5.2.1.4 Changing the Statement Execution Sequence

The debugger can bypass statements that contain errors and pass control to statements that are not in the original execution sequence.

Use the Change Start-Point to Cursor function, on the Continue or shortcut menus, to change the program execution sequence.

For example, to bypass line 220 in the program below:

Figure 2.11 Changing the Statement Execution Sequence



```
         COBOL Source program          :    Debugger operation procedure
                                       :
                                       : Menu command        Line command
100   01  A PIC   9     VALUE   0.     : Breakpoint            BREAK 220
          :                            : Go                    CONTINUE
150   PROCEDURE    DIVISION.           : [The COBOL program is executed and
          :                            :  execution is broken at line 220.]
210       MOVE    1      TO   A.       :  Change Start         SKIP 230
220       CALL    "SUB".               :  Point to Cursor
230       MOVE    A      TO   B.       : [CALL at line 220 is bypassed.]
          :                            :  Go                   CONTINUE
500   IDENTIFICATION DIVISION.         : [To the next debugging operation.]
510   PROGRAM-ID. SUB.                 :
          :                            :
```

2.5.2.1.5 Tracing the Execution Path

You can often encounter situations where you can stop a program at the point an error occurs, but there are many possible routes to that point. The Backward Trace function highlights (colors) the statement currently being traced. As a colored statement shifts, you can visually review the flow of program controls.

The Trace function enables the recording of the flow of control. When execution is interrupted, you can use the Backward Trace functions to retrace the path of execution.

There are four trace functions:

Previous Statement: Steps backward from the current trace sentence to the sentence that was executed before it.

Next Statement: Steps forwards from the current trace sentence to the sentence that was executed after it.

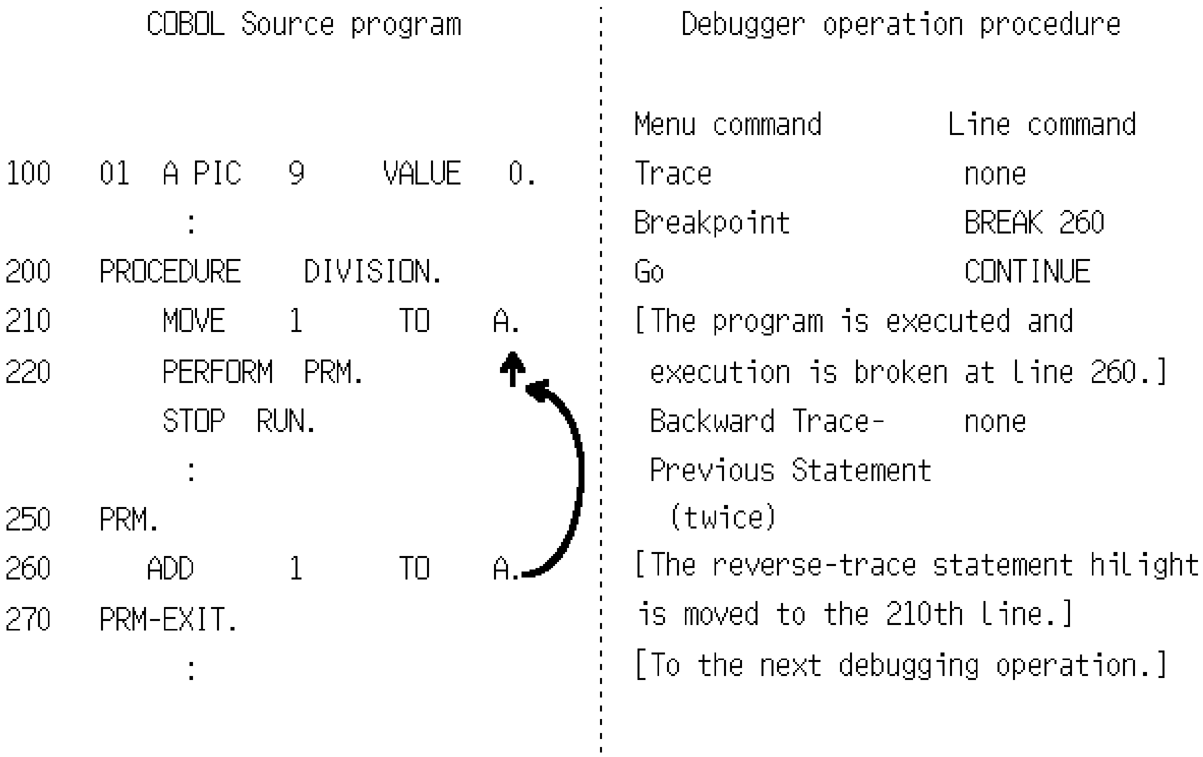
Previous Procedure: Jumps backwards from the current trace statement to the first statement in the procedure containing the statement, and then to the first statement in the procedure that was executed before the current trace procedure.

Next Procedure: Jumps forwards to the first statement in the procedure that was executed after the current trace procedure.

The Trace function is not available as a line command.

For example, to confirm which location calls procedure PRM, consider the following figure.

Figure 2.12 Tracing an Execution Path



COBOL Source program

```
100   01  A PIC   9     VALUE   0.
           :
200   PROCEDURE    DIVISION.
210       MOVE    1      TO    A.
220       PERFORM  PRM.
          STOP  RUN.
           :
250   PRM.
260       ADD      1      TO    A.
270   PRM-EXIT.
           :
```

Debugger operation procedure

```
Menu command          Line command
Trace                   none
Breakpoint              BREAK 260
Go                      CONTINUE
[The program is executed and
 execution is broken at line 260.]
 Backward Trace-        none
 Previous Statement
   (twice)
[The reverse-trace statement hilight
is moved to the 210th line.]
[To the next debugging operation.]
```

2.5.2.1.6 Tracing the Program Calling Path

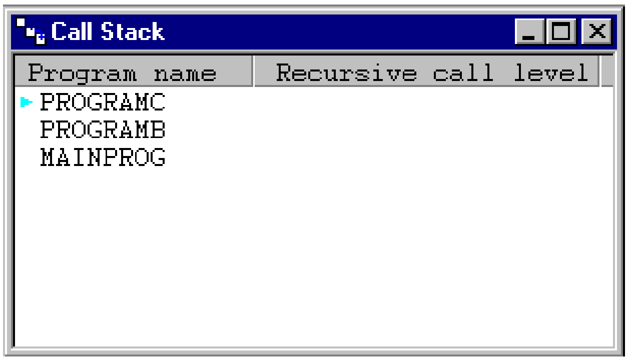
When data in the linkage section is incorrect or the timing of a program call is incorrect, you often need to confirm which program made the call. The debugger lets you check the calling path using the Call Stack function available from the Window menu and the toolbar.

Call Stack displays a list of the active programs in the call stack. For example, suppose the application executes the following sequence:

```
            MAINPROG     CALLS    PROGRAMA
    PROGRAMA    CALLS    PROGRAMC
      PROGRAMC    EXITS
    PROGRAMA    EXITS
MAINPROG    CALLS    PROGRAMB
    PROGRAMB    CALLS    PROGRAMC
    Breakpoint encountered in PROGRAMC.
```

Then the Call Stack list looks like this:

Figure 2.13 Call Stack Window



Program name	Recursive call level
▸ PROGRAMC	
PROGRAMB	
MAINPROG	

Note that PROGRAMA does not appear in the list, as it is no longer active in the CALL hierarchy.

2.5.2.1.7 Breaking into an Executing Program

You can break into looping programs, or regain control of programs being run, by pressing the esc key. You can also select the Break function from the Continue menu or the toolbar.

If you are working with a Windows application, for example using PowerCOBOL generated code, you may need to take an action in the user window before control returns to the debugger.

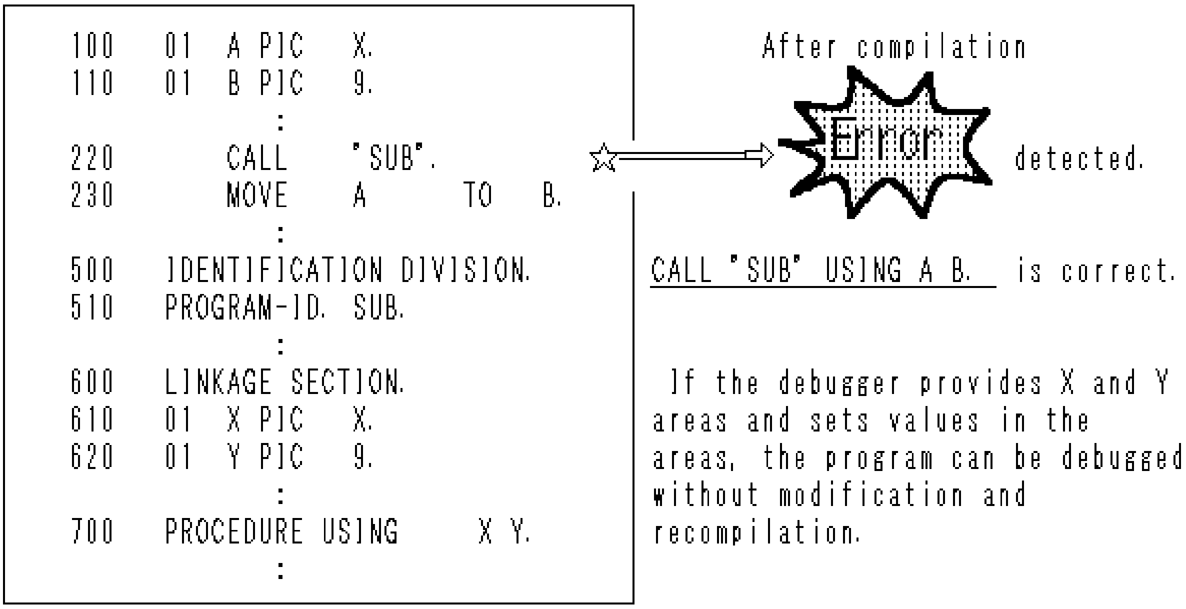
2.5.2.1.8 Allocating Linkage Section Items

Finding linkage section allocation errors in the midst of debugging large program suites is potentially time consuming. You need to correct and recompile program source, rebuild the application, and restart debugging. The debugger provides the Linkage function to ease such situations.

For example, if a calling program omits a parameter from the CALL statement, debugging of the subprogram can continue without interrupting the debugging session. Use the Linkage function to allocate an area in memory for the missing linkage section item.

The debugger deal locates the allocated area when it returns control to the calling program from the subprogram.

Figure 2.14 Allocating Linkage Section Items



```
100   01  A PIC   X.
110   01  B PIC   9.
              :
220       CALL    "SUB".
230       MOVE    A      TO   B.
              :
500   IDENTIFICATION DIVISION.
510   PROGRAM-ID. SUB.
              :
600   LINKAGE SECTION.
610   01  X PIC   X.
620   01  Y PIC   9.
              :
700   PROCEDURE USING     X Y.
              :
```

After compilation Error detected.

CALL "SUB" USING A B. is correct.

If the debugger provides X and Y areas and sets values in the areas, the program can be debugged without modification and recompilation.

2.5.2.1.9 Checking Test Coverage

When testing programs, you often want to be sure that certain sections or lines of code have at least been executed. The Passage Count function lets you do this.

First, determine the points in your programs that you want to check. Then, set passage counts by either selecting the Passage Count function on the Debug menu or the Set Passage Count function on the shortcut menu. Execute the program. Selecting Debug, Update Passage Count Display, causes the highlight color to change for executed statements. Alternatively, you can select Debug, Passage Count that displays the Passage Count window. This window gives a list of all passage count statements and the number of executions for each statement.

2.5.2.1.10 Restarting the Debug Session

You can restart debugging the same program, without terminating the debugger, by using the Continue, Re-debug function. All data is re-initialized and you can choose whether to retain or reset the following:

- Breakpoints
- Passage counts
- Watch Data
- Watch conditional expression.

2.5.2.1.11 Automating Debug Operations

If you need to demonstrate your debugging steps, or to perform the same debugging procedures frequently, you can automate your debug operations. The debugger supports two types of automated debugging: batch and automatic.

Both types use a command file that contains debugger commands.

Batch Debugging

In this mode, you specify a command file at the start of debugging. The command file drives the whole debugging session; you do not have to interact with the debugger.

Automatic Debugging

With automatic debugging, you select a command file during a debugging session, and the debugger executes the commands in the file. Control returns to you when all the commands have been executed. Automatic debugging is useful when you want to repeat the execution of a string of commands.

Creating Command Files

You create command files by:

- Using a text editor
- Specifying a history file in the Start Debugging dialog (Batch Debugging tab)
- Starting and stopping history file creation during a debugging session using the Option, Output Log menu function or the ENV command.

You can use the history files, created by the debugger, as command files with no changes. Alternatively, you can use a text editor to make appropriate changes to the history files, or to select particular sections for use in batch or automated debugging.

The following example shows a command file to set a breakpoint, and display a data value before and after the breakpoint.

```
    break 47      ; Set a breakpoint
list data-out ; Display data
cont          ; Run
list data-out ; Display data
cont          ; Run
quit          ; Quit
```

The debugger treats characters following semicolons as comments.

2.5.2.1.12 Configuring the Debugger

You can use the Option, Environments function to configure the following aspects of the debugging environment:

The environments other than the statement identification number mode and replacement character will be enabled the next time the debugger is started.

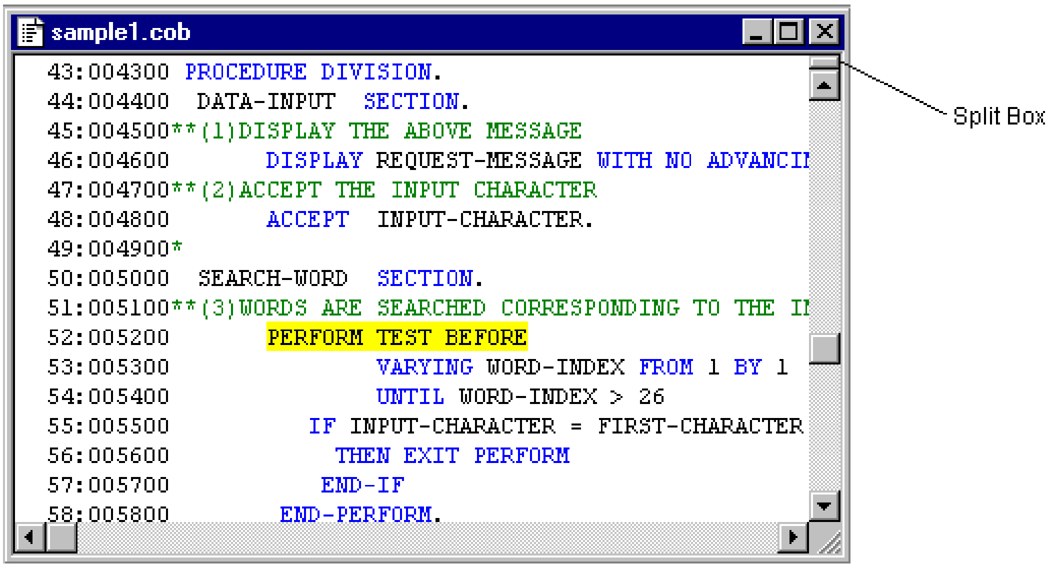
- Animation speed: Speed at which the Animate function executes statements.
- Display source text of subprogram: Whether or not Animate and Backward Trace show the code of subprograms.
- Display all threads: Specifies whether backward trace and animation will be carried out with the implicit thread only or with all the threads.
- Watch the PERFORM statements: Whether to watch the PERFORM statements. When the PERFORM statements are to be watched, the detection of out-of-line PERFORM errors can be handled, and the number of internal PERFORM statements for which Animate and Backward Trace will display the code can be controlled.
- Suspend execution when an exception event occurs: Indicates whether to suspend execution before the exception procedure is executed when an exception condition occurs. Refer to "Defining Exception Processes " in the "NetCOBOL User's Guide."
- Suspend execution when the first signal is received: Indicates whether to suspend execution when the first signal is received. Refer to "2.6.2 Debug functions for signals handled by the exception handler".
- Suspend execution when thread end: Indicates whether to suspend execution when thread end.

- Capital/small letter on line commands: Whether the debugger handles uppercase letters and lowercase letters as equivalent on line commands.
- Line number display method: Display the number in the COBOL source file, or a sequential line number generated by the compiler.
- Display the line number: Whether or not the line number in the Source File window is displayed.
- Window update during animation: Specifies whether the Call Stack window and the Thread List window will be updated during animation.
- Replacement character for non-displayable values: This is the character that the debugger substitutes for non-displayable byte values when displaying, printing and monitoring data.
- State of debugger when suspended: Specifies whether the debugger should be activated or not when execution is suspended.
- Windows to be opened during batch debugging: Specifies windows to be opened in the Main window during batch debugging.
- Alarm on suspension: Specifies whether the beeper should beep or not when execution is suspended.
- Alarm on suspension during batch debugging: Specifies whether the beeper should beep or not when execution is suspended during batch debugging.
- Compatibility: Specifies whether the scope of debugger functionality will be restricted to the specific version range.

2.5.2.1.13 Splitting the Source File Window

You can split the Source File window into two separately scrollable windows. To do this, click and drag the Split box that is in the top right hand corner of the window, immediately above the scroll bar.

Figure 2.15 The Split Box



```
43:004300 PROCEDURE DIVISION.
44:004400  DATA-INPUT  SECTION.
45:004500**(1)DISPLAY THE ABOVE MESSAGE
46:004600        DISPLAY REQUEST-MESSAGE WITH NO ADVANCII
47:004700**(2)ACCEPT THE  INPUT CHARACTER
48:004800        ACCEPT  INPUT-CHARACTER.
49:004900*
50:005000  SEARCH-WORD  SECTION.
51:005100**(3)WORDS ARE SEARCHED CORRESPONDING TO THE II
52:005200        PERFORM TEST BEFORE
53:005300                VARYING WORD-INDEX FROM 1 BY 1
54:005400                UNTIL WORD-INDEX > 26
55:005500           IF INPUT-CHARACTER = FIRST-CHARACTER
56:005600             THEN EXIT PERFORM
57:005700            END-IF
58:005800         END-PERFORM.
```

2.5.2.1.14 Configuring Source Code Font and Colors

The Font and Color commands under View bring up dialog boxes that let you configure the font for the source code and the color of fifteen different attributes of the COBOL source display.

2.5.2.1.15 Checking the Status of the Debugger

The debugger maintains information about a number of items: breakpoints, passage counts, watch data, and the watch conditional expression. It displays these in the dialog box for each function.

The Breakpoint dialog box displays a list of the breakpoints set and whether they are enabled or disabled.

The Passage Count dialog box displays a list of statements with passage counts, and the counts for these statements.

The Watch window displays a list of data items being watched or monitored and a list of the conditional expressions being monitored.

2.5.2.1.16 Data File Input/Output

The Data File I/O capability is available to read/write data values to/from a file. Brief descriptions of these functions follow.

Reading from a File

This sets a data item to the value read from a file. This is useful when you set a large number of values, because you can store them in a file in advance, instead of using the SET command to change data.

The typical usage is to identify process routes. To do this, you need to prepare values that let your program take every route. Reading such values from a file saves you the time it would take to enter values during a test, thus making the task much easier.

Writing into a File

This writes values of data items into a file. Because you can reference values previously stored in a file, instead of using the LIST command for displaying data, this is useful when you need to reference many values at a time.

The typical usage is to review processing results that might vary depending on process routes or entered data. Writing into a file allows you to focus on checking process routes during a test, because you can take the time to review processing results after the test is completed.

Using the Fujitsu Data Editor is recommended when you create or check a data file that is to be used for the Data File I/O capability.

Example

In this example, we identify the process route the subprogram takes, and review all the return values from the parameters after the debugging activities are completed.

1. Create a file for reading

   Create a file (INFL) in which the values required to take every route are set to the data item (A), assuming the data area (LINK) in the linkage section to be one record.

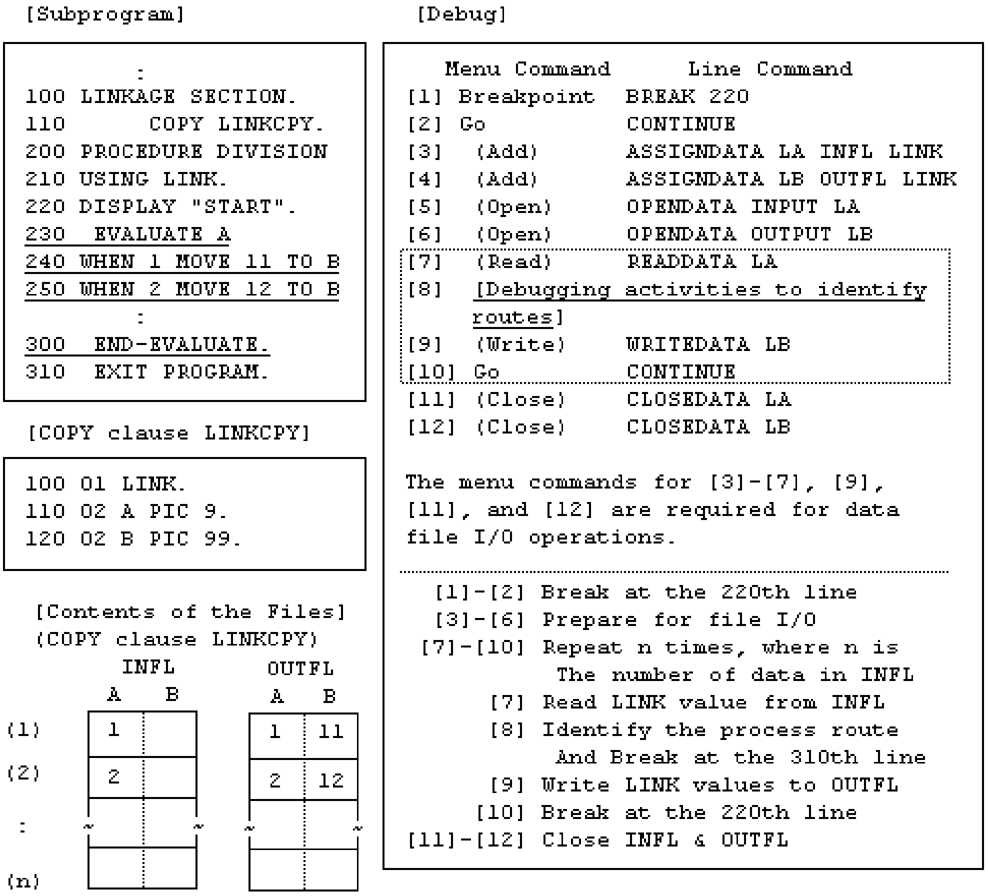
2. Debug

   At the entry point of the subprogram, read values stored in a file (INFL) into the data area (LINK) in the linkage section to identify the route.

   At the exit of the subprogram, write values stored in the data area (LINK) in the linkage section into a file (OUTFL).

3. Review the written file

   Check the file (OUTFL) to review the values in the data area (LINK) in the linkage section that were changed by the subprogram.



[Subprogram]

```
        :
100 LINKAGE SECTION.
110      COPY LINKCPY.
200 PROCEDURE DIVISION
210 USING LINK.
220 DISPLAY "START".
230  EVALUATE A
240 WHEN 1 MOVE 11 TO B
250 WHEN 2 MOVE 12 TO B
        :
300  END-EVALUATE.
310  EXIT PROGRAM.
```

[COPY clause LINKCPY]

```
100 01 LINK.
110 02 A PIC 9.
120 02 B PIC 99.
```

[Contents of the Files]
(COPY clause LINKCPY)

	INFL		OUTFL	
	A	B	A	B
(1)	1		1	11
(2)	2		2	12
:				
(n)				

[Debug]

```
   Menu Command      Line Command
[1] Breakpoint   BREAK 220
[2] Go           CONTINUE
[3]  (Add)       ASSIGNDATA LA INFL LINK
[4]  (Add)       ASSIGNDATA LB OUTFL LINK
[5]  (Open)      OPENDATA INPUT LA
[6]  (Open)      OPENDATA OUTPUT LB
[7]  (Read)      READDATA LA
[8]  [Debugging activities to identify
     routes]
[9]  (Write)     WRITEDATA LB
[10] Go          CONTINUE
[11] (Close)     CLOSEDATA LA
[12] (Close)     CLOSEDATA LB

The menu commands for [3]-[7], [9],
[11], and [12] are required for data
file I/O operations.

  [1]-[2] Break at the 220th line
  [3]-[6] Prepare for file I/O
 [7]-[10] Repeat n times, where n is
          The number of data in INFL
      [7] Read LINK value from INFL
      [8] Identify the process route
          And Break at the 310th line
      [9] Write LINK values to OUTFL
     [10] Break at the 220th line
[11]-[12] Close INFL & OUTFL
```

2.6 Debug Functions Based on Program Features

This section explains the debug functions based on the program features.

2.6.1 Debug functions for dynamic structured programs

Dynamic structured programs can be debugged in the same way as static structured programs. However, the following points must be noted. Refer to "Dynamic Linkage" in the "NetCOBOL User's Guide."

Dynamic-link structure

For a dynamic-link structure, required DLLs will also be loaded when the calling program is loaded. As a result, the DLLs will also be objects of debugging. DLLs can be debugged in the same way as static structured programs.

Dynamic-program structure

For a dynamic-program structure, a required DLL is loaded when called from the calling program. The DLL becomes an object of debugging when it is loaded.

To set a breakpoint in a program that includes a DLL, the breakpoint must be set before DLL is called. When a breakpoint is set, the debugger will not be able to display source files of programs that have not been loaded. Therefore, use a command or dialog box to specify the name of the program to be loaded. The set breakpoint is valid when a program that has been unloaded is reloaded as long as you do not delete the set breakpoint.

For example, to set a breakpoint at line 5000 of program PROG05, specify the command as follows:

```
BREAK 5000 IN(PROG05)
```

2.6.2 Debug functions for signals handled by the exception handler

For the debugger, application errors (exceptions) such as invalid memory access or zero division that occur when an application is executed are called signals.

Signals occur when invalid processing is executed. However, signals can also be caused by calling a system API that, in turn, causes signals. Handling of signals can be described as an exception handler. These system mechanisms are referred to as structured exception handling.

If the caller of a COBOL program provides an exception handler, an application error that has occurred in the COBOL program will also be handled as a signal. As a result, invalid processing might not be known if it was executed. For example, if an application executed invalid processing for a server program such as a Web server, the exception handler may handle the signal to prevent the server program from being affected.

The debugger can also report the signals handled by the exception handler. The debugger reports the signals using the following two timings:

First signal reception

The debugger reports the signals before the system searches for the exception handler. This applies regardless of the presence or absence of an exception handler. Reporting using this timing is provided so that the signals handled by the exception handler can be known.

Signal reception

The debugger reports the signals when they are received. This applies when an exception handler is not provided or signals are not handled by an exception handler. The debugger does not report the signals if they are handled by an exception handler.

Use the Operation page in the Environments dialog box to set whether to suspend execution of applications at first signal reception. For signal reception, always suspend execution of applications.

Signals are not always problem signals (signals caused by exceptions). Examples are signals caused by calling system API for generating signals or signals that are handled by the exception handler so that processing can be continued. Thus, signals reported using the first signal reception are not always problem signals. Whether a signal is a problem signal must be determined from such items as the signal code and location where the signal occurred. Typically it should be set so that execution of applications will not be suspended for the first signal reception. It is recommended that execution of applications be suspended for the first signal reception only when the exception handler seems to be handling the problem signals.

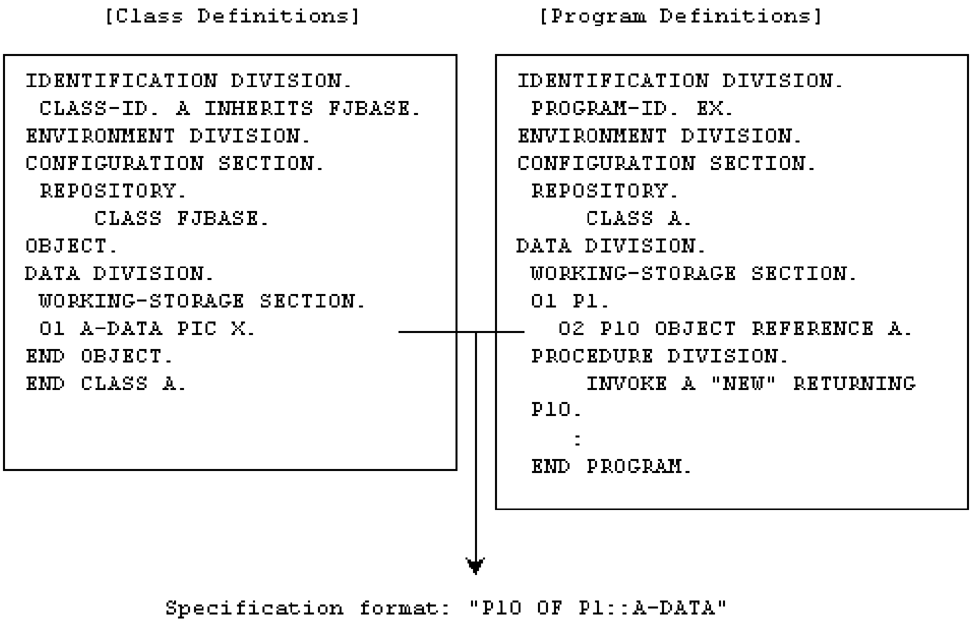
After execution of an application has been suspended using signal reception, the signal will occur again when the application execution is resumed. This occurs because execution is resumed from the machine instruction that caused the signal.

2.6.3 Debug Functions for Object-Oriented Programming

The debugger uniquely provides an extended format for specifying identifiers. You can reference factory data or object data (which could not normally referenced by programs) by using an identifier with an object reference qualifier in the extended specification format. An example of an identifier with an object reference qualifier follows.

Example

To reference object data of class A, consider the following diagram.



[Class Definitions]

```
IDENTIFICATION DIVISION.
 CLASS-ID. A INHERITS FJBASE.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
 REPOSITORY.
     CLASS FJBASE.
OBJECT.
DATA DIVISION.
 WORKING-STORAGE SECTION.
 01 A-DATA PIC X.
END OBJECT.
END CLASS A.
```

[Program Definitions]

```
IDENTIFICATION DIVISION.
 PROGRAM-ID. EX.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
 REPOSITORY.
     CLASS A.
DATA DIVISION.
 WORKING-STORAGE SECTION.
 01 P1.
   02 P10 OBJECT REFERENCE A.
 PROCEDURE DIVISION.
     INVOKE A "NEW" RETURNING
 P10.
    :
 END PROGRAM.
```

Specification format: "P10 OF P1::A-DATA"

This identifier can be also specified through the interactive Subordinate item reference dialog box.

See Help for the details of identifiers and the Subordinate item reference dialog box.

2.6.4 Debugger Compatibility with Multithreading

This section describes the scheme of debugger compatibility for debugging multithread programs.

2.6.4.1 Basic operation of the debugging function in multithreading

When multiple threads are running in a process of a debugged program, debugging can be essentially performed on only one thread at a time. The thread on which debugging can be performed is called the implicit thread. Any thread can be debugged by switching the implicit thread to it. The implicit thread can be switched from the Thread List window.

Because the debugger window or dialog box displays information on the implicit thread, multithread programs can be debugged in the same manner as single-thread programs.

System and server applications may have some threads other than COBOL applications threads. It is necessary to use the same actions as with multithread applications when these applications are debugged.

2.6.4.2 Multithread-specific operations of the debugging function

While the debugging function basically works on the implicit thread as if it were a single thread, the following operations are specific only to multithreads:

- Breakpoints
- Passage count points
- Execution
- Watch data/Watch conditional expression
- Backward trace

2.6.4.2.1 Breakpoints

Because a breakpoint is effective for all threads, all threads stop at the specified breakpoint. Moreover, the passage count of each thread is counted. The passage count is initialized to zero by subsequent execution of any procedure after a thread ends, though the passage count is maintained until the time the thread ended.

2.6.4.2.2 Passage count points

Because a passage count is effective for all threads, the number of times a thread passes the passage count point is counted. The passage count is initialized to zero by subsequent execution of any procedures after a thread ends, though the passage count is maintained until the time the thread ended.

To check the passage count when threads other than the implicit thread end, therefore, specify on the [Operation] page in the [Environment] dialog box, a program execution break at thread end.

2.6.4.2.3 Execution

When a program is executed unconditionally, all threads are run simultaneously.

If a program is executed to a target position, the implicit thread is run under specified conditions. All threads other than the implicit thread are run unconditionally at this time.

2.6.4.2.4 Watch data/Watch conditional expression

While watching data shared by threads, the watch data or watch conditional expression function detects successful monitoring when a thread changes the data being monitored.

While watching data not shared by threads, the function also detects successful monitoring, even when the data is changed by another thread.

2.6.4.2.5 Backward trace

The backward trace function can be executed in one of two modes: in one mode the function traces back only the implicit thread, and in another mode the function traces back all threads.

In multithread trace mode, the backward trace function traces threads in order of execution. The thread currently traced is automatically displayed in the Source File window.

You can visually review the flow of control among the threads.

2.6.4.3 Functions to aid in debugging multithreads

The following debug functions help to debug multithread programs efficiently:

- Enable/disable debugging event notifying
- Suspend/resume

2.6.4.3.1 Enable/disable debugging event notifying

Notification of debugging events, such as monitoring and breakpoint halts, can be enabled or disabled for each individual thread.

When debug event notification is disabled for a thread, the thread is run, but interruption events for debugging, such as monitoring and arrival at a breakpoint, will not be notified.

This function can be specified from the Thread List window.

2.6.4.3.2 Suspend/resume

The suspend/resume function limits the action of threads during program execution.

If a thread is suspended, it remains at the current position when the program is run. If a suspended thread is resumed, it comes into operation the next time a program is run.

This function can be specified from the Thread List window.

2.6.4.4 Automating debug operations in a multithread environment

With batch debugging and automatic debugging functions, the debugger can reproduce debugging procedures.

Though these functions can also be used for debugging multithread programs, certain points deserve special notice in reproducing debugging procedures for multithread programs:

- Generate threads in the same order as that in which debugging procedures are recorded.

  The debugger identifies each individual thread on the basis of the order in which it is generated in the process. This order is known as a thread ID. Debugging procedures are performed on threads that are identified by their thread IDs. To reproduce a debugging procedure performed on a given thread, the order in which the thread is generated must be set to equal the order in which the debugging procedure is recorded. Threads might not be generated in order, according to the system and the server application. In that case, it is not possible to automate debugging.

- Notify debugging events to only one thread during program execution.

  When multiple threads are run concurrently, debugging events may be notified to different threads between the two instances of recording and reproduction, depending on how the OS allocates CPU time to the individual threads. Where a program is run with unconditional execution or breakpoint execution specified, having non-implicit threads to which debugging events may be notified or suspended can avert this problem.

2.6.5 Handling of Unicode by the Debugger

This section explains how to debug programs compiled using Unicode.

2.6.5.1 Debug functions of Unicode programs

The debugger will automatically handle Unicode when debugging Unicode programs.

For Unicode programs, the debugger can basically use the same operations as those for non-Unicode programs.

2.6.5.2 Notes on handling Unicode

Note the following points when debugging Unicode programs:

Handling Unicode native characters

Unicode native characters are also displayed in the Data dialog box and Watch window. However, Unicode native characters cannot be input. To input Unicode native characters, specify them using hexadecimal format.

Displaying and updating data values

Big-endian is used as the encoding form of data values for manipulating national data items and national edited data items using hexadecimal format. For details of big-endian, refer to "Encoding Form" in the "NetCOBOL User's Guide".

Batch debugging, automatic debugging, and output log

ASCII is also used as the coding system of command files and history files for Unicode. As a result, Unicode native characters are replaced with a "_" and output.

2.7 Notes

This section provides you some notes/suggestions you should take into account when using the interactive debugger.

- The target application should be a 32-bit application.
- When the debugger interrupts execution of a Windows application, it stops that application's processing. Therefore, it cannot refresh the displays on its windows. If you want to inspect their current states, arrange your windows so the application windows are always visible.
- The Line Command window keeps up to about 5,000 lines of command results.
- You can specify statement identification numbers in two different ways: editor line numbers or relative line numbers. You can only use both methods when debugging programs compiled with the NUMBER option. Programs compiled with NONUMBER can only use relative line numbers. To change between using editor line numbers and relative line numbers, you can either use the ENV line command, or the Option, Environments, Input dialog box.

  When a program which has duplicate numbers consecutively in the sequence number area is compiled with the NUMBER compiler option, you might not be able to set a breakpoint where you want, if you have specified the editor line number as a statement identification number. To prevent this problem, select the relative line number as statement identification number, or recompile your program with the compiler option NONUMBER specified to prepare for debugging. (Better yet, renumber the source code before compilation!)

Example

```
001000 IDENTIFICATION DIVISION.
000200 PROGRAM-ID.  MAIN.
        :
001000 PROCEDURE DIVISION.
001100     DISPLAY "*** INITIALIZE ***".      [1]
001100     MOVE ZERO TO DATA-1.               [2]
001100     MOVE ZERO TO DATA-1.               [3]
        :
003600 END PROGRAM  MAIN.
```

In the above example, a breakpoint will be set on the DISPLAY statement ([1]) even if you try to set it at the MOVE statements ([2] and [3]).

- You can set breakpoints and passage counts at EXEC SQL in the PROCEDURE DIVISION.

  However, you cannot set a breakpoint or a passage count at EXEC SQL including non-execution statements such as the WHENEVER statement.

  In addition, you cannot set breakpoints and passage counts directly in embedded SQL statements.

- When programs contain the clauses REPLACING, DISJOINING or JOINING, the debugger displays the original source without applying these clauses. If the position of statements or procedure names changes as a result of the source substitutions, it is not possible to debug the programs correctly.

- As the COPY statement creates program restrictions, you cannot debug programs correctly in the following cases. The way to avoid this trouble is shown in each case.

  - Programs including library text containing the following definitions in the COPY statement:

    - Entire program definitions (from IDENTIFICATION DIVISION to END PROGRAM)

    - Entire factory definitions (from IDENTIFICATION DIVISION to END FACTORY)

    - Entire object definitions (from IDENTIFICATION DIVISION to END OBJECT)

    - Entire method definitions (from IDENTIFICATION DIVISION to END METHOD)

    The way to avoid this trouble is to define the statements described in the above library text directly in the program that imports the library text.

  - Describing the COPY statement in the PROCEDURE DIVISION, and the PERFORM statement is in the end line of the imported library text:

    The way to avoid this trouble is to define the CONTINUE statement at the end of the library text.

  - Describing the COPY statement in the PROCEDURE DIVISION, and the COPY statement is in the end line, and the END PROGRAM statement has not been described:

    The way to avoid this trouble is to define the END PROGRAM statement in the program in which the COPY statement has been described.

  - Describing the COPY statement in the PROCEDURE DIVISION, and the PERFORM statement is in the end line of the imported library text, and the PERFORM statement is immediately after the COPY statement:

    The way to avoid this trouble is to define the CONTINUE statement immediately after the library text and the COPY statement.

  - Describing the COPY statement in the PROCEDURE DIVISION, and the COPY statement is immediately after the EXIT statement, EXIT PROGRAM statement, or EXIT METHOD statement, and the start line of the import library text contains the section-name or paragraph-name:

    The way to avoid this trouble is to describe the section-name or the paragraph-name in the program that imports the library text, not in the start line of the library text.

- A stored procedure cannot be debugged.
- Do not perform the following operations when the debugger is running:
    - Change a screen setting on [Display Properties].
    - Change a setting on the Control Panel.
    - Terminate the Windows system.
- Pressing the F12 key in the application window during application execution will generate a signal and interrupt the execution, resumption of which will terminate the application.
- The debugger may access a resource such as a file or database while application execution is suspended in the system or COBOL runtime system. If the debugger under this situation is terminated or restarted, the resource may be destroyed. If the debugger is terminated or restarted during synchronous processing in the COBOL runtime system, a runtime message such as JMP0034I-U may be output. If this occurs while a multithread application is being debugged, the probability increases as the number of threads increases. The application must be terminated normally. To ensure safety, a backup copy of the resources used for debugging should be made in advance.
- Threads other than the thread that executes the COBOL program might exist, depending on the system, the server application, etc. When such an application is debugged, it is necessary to treat it as a multithread application. For details, refer to "2.6.4 Debugger Compatibility with Multithreading".
- The COBOL debugger cannot be used while an application is being debugged using the PowerCOBOL debugger or Visual C++ debugger or is being executed on Systemwalker.
- The just-in-time debugging function will not operate 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. To check for application errors that occur in such applications, use the general debugger starting method or debugger starting method of the program to be debugged.
- Corrective action you should take if "Execution was terminated before start of program was reached." is displayed is shown below.
    - The program specified in the debugging start program ended without being executed. Alternatively, there is an error in the specified program name:

      Make sure that the debugging start program name is correct.
    - The program is not a debug target program:

      Refer to "2.2 Preparing Programs for Debugging", and then create the program again.
    - The debugging information file is not found:

      The debugging information file is searched for in the folder storing the executable files and dynamic link libraries. If the file exists in a different folder, specify the debugging information file storage folder.

2.8 How to use the Interactive Remote Debugger

This section explains the way to debug programs using the interactive remote debugger.

In this section, the following words are used:

- "IP address" means "IP address or host name" unless otherwise noted.
- "Windows" means "32-bit Windows" unless otherwise noted.

2.8.1 Overview of the remote debugger

The remote debugger can debug programs that run on different computers on the network.

In this section, the two computers on the network are expressed as follows:

- Computers that run COBOL programs : server
- Computers that display the COBOL debugger window : client

The remote debugger supports Windows and Solaris as the server OS. If the server is Windows, use the Win32 remote debugger. If the server is Solaris, use the Solaris remote debugger.

The functions of remote debuggers can vary depending on the server OS. In cases where remote debuggers must be distinguished from one another, the remote debugger that is called is as follows:

- Solaris remote debugger if the server OS is Solaris

In the following explanation, it is assumed that the server is Windows.

If the server is Solaris, refer to the parts related to "NetCOBOL User's Guide for Solaris" where necessary.

Note

To use the remote debug function, there must be support for TCP/IP protocol in both the server and client.

2.8.1.1 Benefits of introducing the remote debugger

The following cost reductions and improvements in development can be achieved by introducing the remote debugger.

- You can debug COBOL programs that run in server environments such as Interstage and Web servers from the client environment that you normally use.

  In this way, cost reductions and improvements in development can be achieved without having to set up an expensive server environment for each developer and having several developers having to debug at the same time.

- If the server is Solaris, you can now debug using the same operation as the Windows edition COBOL debugger.

  There are two ways to use and debug programs that run on Solaris on the Windows client.

  - Introduce the expensive Windows X windows server, and use screen mode for the svd command.
  - Using a TTY terminal, use line mode for the svd command.

  The remote debugger does not need the expensive X windows server, and shares the same operation as the Windows edition COBOL debugger. For these reasons, it can be used to achieve cost reductions and improvements in development.

2.8.1.2 Storage location for resources when doing remote debugging

When you do remote debugging, you must store the resources that are required for debugging in either the server or the client, or both.

The resources that are required for debugging are shown in table below.

Table 2.3 Storage location for resources when doing remote debugging

Debug resource	Client	Server
Executable programs	-	Yes
Dynamic link library (*1)	-	Yes
Shared object file (*2)	-	Yes
Debugging information file	-	Yes
Source file	Yes (*5)	-
Library text	Yes (*5)	-
Screen form descriptor	Yes (*5)	Yes
File descriptor (*3)	Yes (*5)	Yes
Subschema descriptor (*4)	Yes (*5)	-
Command file	Yes (*5)	-
History file	Yes (*5)	-

*1: Server is Windows

*2: Server is Solaris

*3: Server is Windows or Solaris

*4: Server is Windows

*5: Character code of resources in the client is always ASCII

2.8.1.3 How to create the debug target program for remote debugging

For details on how to create a program that can be debugged with a remote debugger, refer to the "NetCOBOL User's Guide" for the appropriate system on the server side.

2.8.2 Start procedure for remote debugging

As for normal debugging, there are three methods used to start remote debugging.

- Remote debugging for general programs

  Start the remote debugger, and specify the program you want to debug. Start the debug.

- Remote debugging for programs that run in server environments such as Interstage

  Start the remote debug from program you want to debug. Since the COBOL program is called from the server product, you must use this as the start method, as the programs cannot be debugged using the method for general programs.

- Remote debugging using the just-in-time debugging function

  When an application error occurs or a runtime message occurs in the program, the remote debugger starts automatically and debugs the program.

  This start method can be used if the server is Windows.

2.8.2.1 How to start remote debugging for general programs

This starts the remote debugger and starts debug for the program you want to debug.

Before you can debug a general program, you must start the remote debugger connector in the server in advance.

To operate the server computer directly, log on to the server computer. To log on to a computer on the server side, use TELNET. If the server OS is Windows, use the terminal service.

The procedure to start the remote debugger for debugging general programs is shown below:

1. Start the remote debugger connector in the server.

   At this time, restrict the permission for connection to the computer where necessary. For details, refer to the "2.8.3.1 How to use the server remote debugger connector", and "2.8.3.5 Restricting connection to computers that allow remote debugging".

   When the remote debugger connector starts, information such as the IP address and port number are displayed, and the order from the client to start debugging is monitored.

2. Start the remote debugger in the client.

   The methods that are generally used are as follows:

   - Solaris remote debugger: In the Project Manager window, in the Project menu, select "Remote debug".

   - Windows or Solaris remote debugger: In the Project Manager window, in the Tools menu, select "Debugger type" to select the debugger. Next, start the debugger according to one of the following methods:

     - In the Project Manager window, in the Tools menu, select "Debugger".

     - In the command prompt, input the command format and then start the remote debugger. For details, refer to "2.8.5.2 Specifying Options on the Command Line for the Remote Debugger".

   - Solaris remote debugger: Select a COBOL project in the "Structure view" or "Dependency view" of NetCOBOL Studio. Select "Remote development" from the Project menu, and then select "Debugger".

3. Specify the required information in the Start Debugging dialog box.

   After the remote debugger starts, the debugger main window opens.

   If the Start Debugging dialog box does not appear when the debugger starts, select "Start Debugging" from the File menu of the remote debugger.

   In the Start Debugging dialog box, make entries for the application, source file storage folder, server IP address, and other necessary information for starting debugging, and then click the OK button. For details, refer to "2.8.5 Starting the Remote Debugger".

4. Use the remote debugger to debug.

   The Start Debugging dialog box is closed, and debugging begins.

   The operation method of the remote debugger is the same as that of the ordinary debugger.

   For details, refer to "2.5.2.1 Using the Debugger".

   While the server remote debugger connector is starting, you can debug as many times as you like simply by specifying the program to debug using the remote debugger.

5. Close the remote debugger.

   To close the remote debugger, in the File menu, select Exit.

6. Close the server remote debugger connector.

   To close the server remote debugger, hold down the Ctrl and C keys together.

2.8.2.2 How to start remote debugging for programs that run in server environments such as Interstage

This is the way to start the remote debugger from the program you want to debug.

This start method is mainly used for remote debug for COBOL programs that run in a server environment such as Interstage and Web servers.

The start procedure is shown below:

1. Make the settings for remote debugging.

   - Client settings

     Start the remote debugger connector in the client.

     The remote debugger connector starts with the same settings the previous time it was started, and resides in the task tray.

     Where necessary, modify the port number, and restrict the permission to connect to the computer.

     For details, refer to 2.8.3.4 How to use the client remote debugger connector", and "2.8.3.5 Restricting connection to computers that allow remote debugging".

   - Server settings

     Specify the IP address and port number of the client computer that is displayed in the client remote debugger connector, Connect information page in the environment variable @CBR_ATTACH_TOOL. For details, refer to "@CBR_ATTACH_TOOL (Invoke debugger or COBOL Error Report from application)" in the "NetCOBOL User's Guide".

     If several developers are to debug at the same time, you must specify a different IP address and port number for each developer in @CBR_ATTACH_TOOL.

     You can specify a different IP address and port number for each developer in @CBR_ATTACH_TOOL in the following cases:

     - Each developer has a special folder, and it contains the executable files or dynamic link library you want to debug and the runtime initialization file (COBOL85.CBR).

     - You specify @CBR_ATTACH_TOOL in the runtime initialization file.

     If you debug a dynamic link library that is called from a server product such as Interstage or a Web server, you must specify that on runtime initialization file that has been stored in the same folder as the dynamic link library must be referred to. For details, refer to "Using the runtime initialization file under DLL" in the "NetCOBOL User's Guide".

2. Execute the program you want to debug.

   Execute the operation for running the COBOL program you want to debug, such as input from a Web server.

3. Start the remote debugger in the client.

   After the remote debugger starts, the debugger main window opens in the client.

   To start debugging, in the Start Debugging dialog box, enter the required information and then click OK. For details, refer to "2.8.5 Starting the Remote Debugger".

   If you specify the start parameter in the server environment variable @CBR_ATTACH_TOOL, the contents are displayed in the Start Debugging dialog box on startup. For this reason, you do not have to specify them each time.

4. Use the remote debugger to debug.

   The remote debugger operation is the same as for the normal debugger.

   For details, refer to "2.5.2.1 Using the Debugger".

   While the client remote debugger connector is starting, you can execute a program to debug it as many times as you like.

5. Close the remote debugger.

   To close the remote debugger, in the File menu, select Exit.

6. Close the client remote debugger connector.

   Right-click the icon of the remote debugger connector that resides in the task tray, and in the menu that is displayed select Exit.

If the server is Solaris, the following points are different:

- Environment variable @CBR_ATTACH_TOOL

  The name of this environment variable is CBR_ATTACH_TOOL. Note that the "@" mark is not part of the name.

  In addition, if the specification "host/TEST" does not include the "host" part, the "TEST" part must also be omitted.

- Runtime initialization file (COBOL85.CBR)

  The name of the runtime initialization file is COBOL.CBR.

- Referring to the runtime initialization file that is stored in the same folder as the shared object file.

  Refer to the "NetCOBOL User's Guide for Solaris". The relevant section is "Using runtime initialization files in the library storage folder".

2.8.2.3 How to start remote debugging using the just-in-time debugging function

This automatically starts the remote debugger for debugging the program if an application error or runtime message occurs in the program.

You can only use this start method if the server is Windows.

This start method is the same as for "2.8.2.2 How to start remote debugging for programs that run in server environments such as Interstage" except for the environment variable @CBR_JUSTINTIME_DEBUG. For details, refer to "@CBR_JUSTINTIME_DEBUG (Specify inspection using the debugger or the COBO Error Report at abnormal termination)" in the "NetCOBOL User's Guide".

If an application error or a runtime message occurs when you execute the program, the remote debugger starts up and the remote debugger main window opens. To start debugging, click OK in the Start Debugging dialog box. After debugging starts, the application error or runtime message is interrupted.

2.8.3 How to use the Remote Debugger Connector

To achieve remote debugging, you must use a program that monitors orders to start debugging from different computers on the network.

There are two types of remote debugger connectors in this program. These are shown below:

- Server remote debugger connector

  This is a program that monitors orders to start debugging from a client that runs on the server.

  For details, refer to "2.8.2.1 How to start remote debugging for general programs".

- Client remote debugger connector

  This is a program that monitors orders to start debugging from a server that runs on the client.

  For details, refer to "2.8.2.2 How to start remote debugging for programs that run in server environments such as Interstage", and "2.8.2.3 How to start remote debugging using the just-in-time debugging function".

In these programs, restrict the permission to connect to the computer where necessary. For details, refer to "2.8.3.5 Restricting connection to computers that allow remote debugging".

2.8.3.1 How to use the server remote debugger connector

If executing a remote debug with "2.8.2.1 How to start remote debugging for general programs", use the server remote debugger connector.

This program is run on the server.

2.8.3.2 How to start the remote debugger connector on the server

The start format for the server remote debugger connector is shown below.

start format for the server remote debugger connector

- If the server is Windows

```
cobrds32 [port] [connect-restrictions]
```

- If the server is Solaris

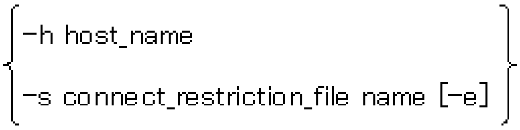
```
svdrds [port] [connect-restrictions]
```

Port Format

```
-p port-number
```

- Specify the port number for monitoring using a number from 1024 to 65535.
- If -p is omitted, the standard port (59998) will be monitored.

Connect restriction format:



```
{ -h host_name                               }
{ -s connect_restriction_file name [-e]      }
```

Table 2.4 Connect restriction contents

Format	Contents
-h host_name	Specify a host name or an IP address to allow connection.
-s connect_restriction_file_name	Specify the connect restriction file.
-e	The processing result of the contents of the specified connect restriction file are displayed.

- If -s and -h are both omitted, connection will be allowed from all computers.
- After the remote debugger connector is started, the IP address and port number are displayed, and orders from the client to start debugging are monitored.
- To close the remote debugger connector, hold down the Ctrl and C keys together.

Information

- If you have to specify an environment variable for the program you want to debug, set this before you start the remote debugger connector.
- If you have to start each program that you want to debug in a different environment, you have to run the remote debugger connector in each environment.

  Like the environment variable, the environment here determines the operation when the remote debugger connector is started, and its settings cannot be modified later.
- If you have to start each program that you want to debug in a different environment, or if several developers debug at the same time, specify-p when the remote debugger connector starts, and then use a different port.

Examples of starting the server remote debugger connector

- Several developers debug at the same time

```
cobrds32 -p 10001 -h client-1
cobrds32 -p 10002 -h client-2
cobrds32 -p 10003 -h client-3
```

  This is the case when three developers use the remote debugger at the same time.

  Choose the port number to be used by each developer and specify this using -p.

  Specify -h to accept only the specific computer's request for remote debugging and to reject incorrect connections by other developers.

2.8.3.3 Format of the connect restriction file

Specify the format of the connect restriction file as shown below:

format of the connect restriction file

```
[ ALLOW={ ALL | connection-target [connection-target...] } ]
[ DENY={ ALL | connection-target [connection-target...] }]
```

- This allows connection from the connection target specified in ALLOW. If this is omitted, it is assumed that ALL has been specified.
- This denies connection from the connection target specified in DENY. If this is omitted, it is assumed that ALL has been specified.
- If you specify ALL, connection is allowed or denied from all computers.
- If ALLOW and DENY are both specified, and ALLOW is described, ALLOW has priority.
- If this is register on several lines, write "\" at the end of the line.

Example

```
ALLOW=192.168.0.1 192.168.0.3 \
192.168.0.8-192.168.0.10
```

The connection target format is shown below.

Table 2.5 Connection target format (IPv4)

Format	Example	Example of IP address application range
IP address	192.168.0.1	192.168.0.1
Range	192.168.0.1-192.168.0.10	192.168.0.1 to 192.168.0.10
Wildcard (*1)	192.168.0.*	192.168.0.0 to 192.168.0.255

Format	Example	Example of IP address application range
Host name (*2)	Hostname	192.168.0.1

1 : You can specify "" instead of the decimal parts (8-bit) delimited by "."

*2 : This example assumes that a host name called "Hostname" has been assigned for an IP address of 192.168.0.1.

Table 2.6 Connection target format (IPv6)

Format	Example	Example of IP address application range
IP address	fe80::1:23:456:789a	fe80::1:23:456:789a
Range	fe80::1:23:456:1-fe80::1:23:456:789a	fe80::1:23:456:1 to fe80::1:23:456:789a
Wildcard (*3)	fe80::1:23:*:789a	fe80::1:23:0:789a to fe80::1:23:ffff:789a
Host name (*4)	Hostname	fe80::1:23:456:789a

3 : You can specify "" instead of the hexadecimal parts (16-bit) delimited by ":"

*4 : This example assumes that a host name called "Hostname" has been assigned for an IP address of fe80::1:23:456:789a.

For details about typical examples, refer to "2.8.3.5 Restricting connection to computers that allow remote debugging".

For details of IPv6, refer to " For IPv6 of debugging" in the "NetCOBOL User's Guide".

Note

If there is an error in the contents of the connect restriction file, the specified details will be invalid, and connection will be allowed from all computers.

2.8.3.4 How to use the client remote debugger connector

If executing a remote debug with "2.8.2.2 How to start remote debugging for programs that run in server environments such as Interstage", and "2.8.2.3 How to start remote debugging using the just-in-time debugging function", use the client remote debugger connector.

This program is run on the client.

2.8.3.4.1 How to start the remote debugger connector on the client

The start format for the client remote debugger connector is shown below:

- In the Project Manager window, Tools menu, select "Remote debugger connector".

After the remote debugger connector starts, the following icon is displayed in the task tray, and the settings are the same as those the previous time the remote debugger connector was started. The order from the server to start debugging is monitored.

To modify the settings or check the settings contents, right-click the task tray icon and then select Environments from the displayed menu. To close the remote debugger connector, right-click the task tray icon, and then select Exit from the displayed menu.

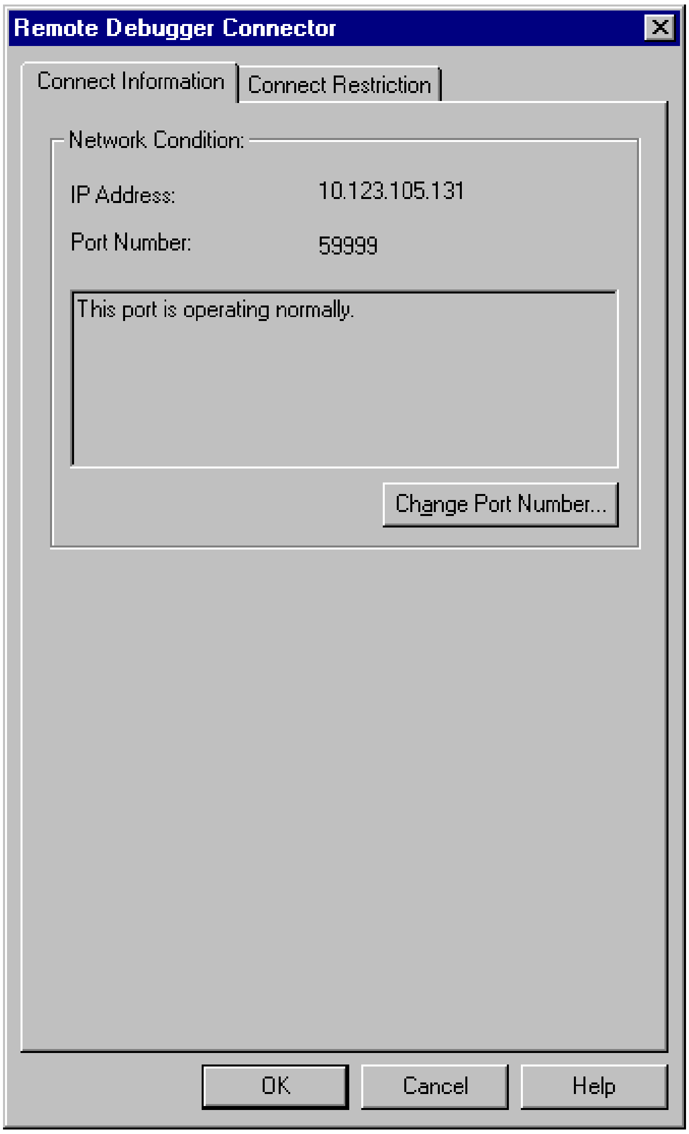
Information

The remote debugger connector can also be started from NetCOBOL Studio. For details, refer to the "NetCOBOL Studio User's Guide".

2.8.3.4.2 The Remote Debugger Connector dialog box settings

This section explains how to make the Remote debugger connector settings.

Figure 2.16 Remote Debugger Connector Dialog Box



Network Condition:

IP Address: 10.123.105.131

Port Number: 59999

This port is operating normally.

Using the Remote Debugger Connector dialog box, you can modify the settings for the remote debugger connector and check the settings contents.

The information requested on each tab is as follows:

Table 2.7 Remote Debugger Connector Dialog Box Parameters

Parameter		Description
Connect Information	Network Condition:	IP address of the machine or hostname where the remote debugger connector is activating, and the port number monitored by the remote debugger connector are displayed. When you select Change Port Number, Change Port Number dialog box opens.
Connect Restriction	Connect Allowed Target:	Set the connect-allowed targets. If you select Allow All the Connection, all computers are allowed to connect. Allow Target displays the list of the connect-allowed targets. Using each button, Add, Edit and Remove, you can modify the list of connect-allowed targets.

Parameter		Description
	Connect Denied Target:	Set the connect-denied target. If you select Deny All the Connection, all computers are denied to connect. Deny target displays the list of the connect-denied targets. Using each button, Add, Edit and Remove, you can modify the list of the connect-denied targets.

For details about typical examples, refer to "2.8.3.5 Restricting connection to computers that allow remote debugging".

2.8.3.5 Restricting connection to computers that allow remote debugging

The way to restrict connections to computers that allow remote debugging is shown in table below. This table uses the IPv4 address. The IPv6 address can also be used. Refer to "For IPv6 of debugging" in the "NetCOBOL User's Guide".

In this table, the server remote debugger connector is expressed by "server", and the client remote debugger connector is expressed by "client".

The connect restriction file is used in the server. For details, refer to "2.8.3.3 Format of the connect restriction file".

In the client, make the settings in the Connect Restriction page of the Remote Debugger Connector dialog box. For details, refer to "2.8.3.4.2 The Remote Debugger Connector dialog box settings".

Table 2.8 Typical examples of restricting connection

Format	Server	Client

This allows connection for only a specific target.
The IP address to be allowed connection is as follows:
192.168.0.1
	ALLOW=192.168.0.1
	DENY=ALL
		Setting for "Connect Allowed Target":
		- Select "Allow Target".
		- Set as follows in the edit box:
		192.168.0.1
		Setting for "Connect Denied Target":
		- Select "Deny All the Connection".

This allows connection for several specific targets.
The IP addresses to be allowed connection are as follows:
192.168.0.1
192.168.0.2
192.168.0.10
	ALLOW=192.168.0.1 \
	192.168.0.2 192.168.0.10
	DENY=ALL
		Setting for "Connect Allowed Target":
		- Select "Allow Target".
		- Set as follows in the edit box:
		192.168.0.1
		192.168.0.2
		192.168.0.10
		Setting for "Connect Denied Target":
		- Select "Deny All the Connection".

This allows connection for a specific range.
The range of IP addresses to be allowed connection is as follows:
Lower limit: 192.168.0.1
Upper limit: 192.168.0.10
	ALLOW=192.168.0.1-192.168.0.10
	DENY=ALL
		Setting for "Connect Allowed Target":
		- Select "Allow Target".
		- Set as follows in the edit box:
		192.168.0.1-192.168.0.10
		Setting for "Connect Denied Target":
		- Select "Deny All the Connection".

This allows connection in octet units.	ALLOW=192.168.*
	DENY=ALL
		Setting for "Connect Allowed Target":
		- Select "Allow Target".

Format	Server	Client
The range of IP addresses to be allowed connection is as follows: Lower limit: 192.168.0.0 Upper limit: 192.168.0.255		- Set as follows in the edit box: 192.168.0.* Setting for "Connect Denied Target": - Select "Deny All the Connection".

This allows connection for all computers.	ALLOW=ALL
	DENY=ALL
		Setting for "Connect Allowed Target":
		- Select "Allow All the Connection".
		Setting for "Connect Denied Target":
		- Select "Deny All the Connection".

2.8.4 Environment Variables of the Remote Debugger

The environment variables that the Win32 remote debugger uses are the same as the environment variables that the normal Win32 debugger uses. For details about environment variable settings, refer to "2.3 Environment Variables of the Debugger".

This section explains environment variables that the Solaris remote debugger uses.

Since environment variables are used for batch debugging, you do not have to specify an environment variable that the Solaris remote debugger uses unless you are intending to do batch debugging. The same is true for normal debuggers.

For details about batch debugging, refer to "2.5.2.1.11 Automating Debug Operations".

2.8.4.1 @SVD_COMPATIBILITY(to specify compatibility)

```
@SVD_COMPATIBILITY={COBOL97 V61L10|NetCOBOL VersionLevel}
```

You can restrict the functions of the Solaris remote debugger with this variable.

By specifying this environment variable, the initial value for the compatibility of the Solaris remote debugger can be set in the value specified by the environment variable.

When the environment variable is not specified, the default conforms to the values that were set when the debugger last ended.

In the environment variable, specify the version level of the Solaris remote debugger when the command file was created.

COBOL97 V61L10:

If you specify COBOL97, the following behavior occurs:

This is similar behavior to the COBOL97 V61L10 svd command.

If you make a few changes to the history file created using this operating mode, you can use this as the command file of the svd command that runs on Solaris.

NetCOBOL VersionLevel:

If you specify NetCOBOL, the following behavior occurs:

This is the latest behavior.

V7.0L10 or later can be specified for VersionLevel.

For details, refer to Help of the Solaris remote debugger, about the Compatibility page of Environments dialog box.

Note

- Environment variable @SVD_COMPATIBILITY is not for making svd's original command file be available for batch debugging using the Solaris remote debugger. When you use svd's original command file for batch debugging, use the svd command on Solaris.
- If you do a lot of batch debugging using Solaris remote debugger, it might exert a heavy burden on the network. In this case, it is recommended that you use the svd command on Solaris for batch debugging.

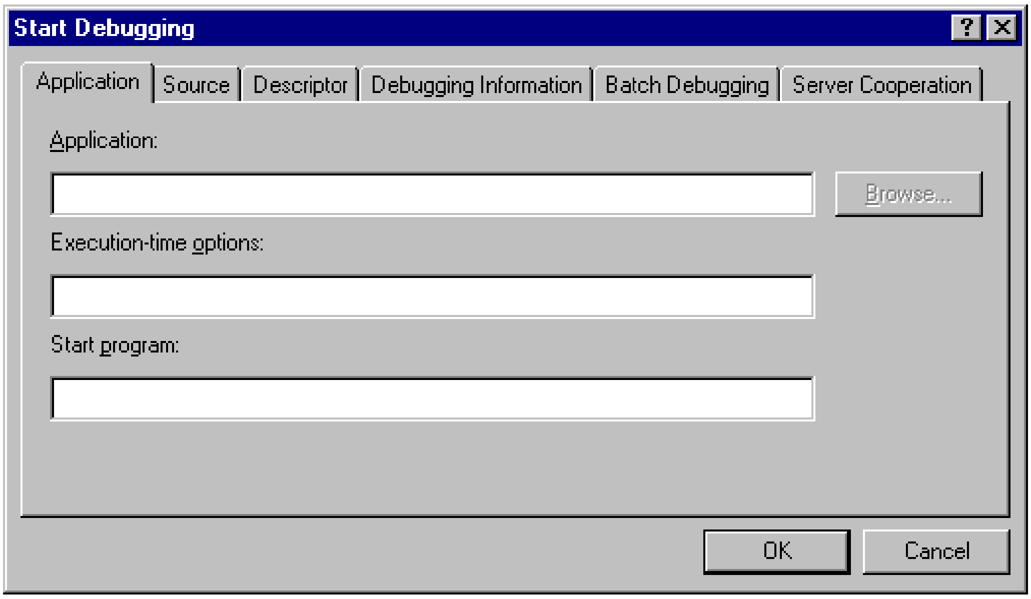
2.8.5 Starting the Remote Debugger

This section explains how to start the remote debugger and provide the information required for debugging.

2.8.5.1 Specification for Remote Debugging using the Start Debugging dialog box

To start remote debugging a program, select File, "Start Debugging". This brings up the Start Debugging dialog box.

Figure 2.17 The Start Debugging Dialog Box



The Start Debugging dialog box lets you input all the information the remote debugger requires to execute your program. You only need to enter the information that applies to your program.

For most items, this is the same as for the normal debugger. However, you must store the resources that are required for debugging in the server or in the client properly.

For details about the storage location for resources that are required for remote debugging, refer to "2.8.1.2 Storage location for resources when doing remote debugging".

The information requested on each tab is as follows:

Table 2.9 Start Debugging Dialog Box Parameters

Parameter		Description
Application	Application:	Name of the EXE file to be loaded. This is the only mandatory parameter. When you use the Win32 remote debugger and omit the extension, it is assumed that the extension is EXE. When you use the Solaris remote debugger and omit the extension, it is assumed that the file has no extension.
	Execution-time-options:	Any options expected on the command line of the program.
	Start program:	Name of the first program to be debugged (must be a program prepared for debugging). Default: the first program for debugging executed in the EXE or a DLL called by it.
Source	Source file storage folders:	Folders containing the source of the programs to be debugged..
	Copy library storage folders:	Folders containing copy libraries used by the debug target programs.

Parameter		Description
		Default: If this parameter is omitted or cannot be found in the specified folders, a search for the parameter will be made from the folders specified by environment variable COB_COBCOPY. For copy library files with IN/OF specified, a search for the parameter will be made from the folders specified by the environment variable COB_library-name.
	Subschema descriptor file storage folders:	For the Win32 remote debugger only. Folders containing subschema used by the debug target programs. Default: If this parameter is omitted or cannot be found in the specified folders, a search for the parameter will be made from the folders specified by environment variable COB_AIMLIB.
Descriptor	Screen and form descriptor:	Folders and extension of form descriptors used by the debug target programs. Default: If this parameter is omitted or cannot be found in the specified folders, a search for the parameter will be made from the folders specified by environment variable FORMLIB. Extension PMD.
	File descriptor:	For Win32 and Solaris remote debuggers only. Folders and extension of file descriptors used by the debug target programs. Default: If this parameter is omitted or cannot be found in the specified folders, a search for the parameter will be made from the folders specified by environment variable FILELIB. Extension FFD.
Debugging Information	Debugging information file storage folders	Folders containing debugging information file. (.SVD files) Default: If this parameter is omitted or cannot be found in the specified folders, when using the Win32 remote debugger, a search for the parameter will be made from the folders containing executable file or dynamic link library. When using the Solaris remote debugger, a search for the parameter will be made from the folders specified in Server Folder in Server Cooperation page.
Batch Debugging	Use Batch Debugging	Batch Debugging is performed.
	Command file	File to drive the debugging session. Default extension: LOG
	History file	File to save actions and results from the debugging session. Default extension: LOG
Server Cooperation	Host	Specify the port number and host of the server remote debugger connector in the connect destination If you start as described in "2.8.2.2 How to start remote debugging for programs that run in server environments such as Interstage" or "2.8.2.3 How to start remote debugging using the just-in-time debugging function", the server IP address is displayed automatically and this cannot be modified.
	Server Folder	Specify the current folder when the application is running. If you start as described in "2.8.2.2 How to start remote debugging for programs that run in server environments such as Interstage" or "2.8.2.3 How to start remote debugging using the just-in-time debugging function", the current when the application started is displayed automatically and this cannot be modified.

Parameter		Description
	Delete	The currently displayed connect destination is deleted from Host drop-down combo box.

Details of the Start Debugging Dialog Box Options

Specifying Folder Name and File Name

When you specify a folder name or a file name, the syntax of the name depends on the conventions of the server or the client upon which it resides.

For Application, folders or files included in Execution-time-options, Debugging information file, storage folders and Server Folder, specify them according to the conventions of the server.

If you specify the relative path in the Application page, Application, Execution-time options, or Debugging Information page, Debugging information file storage folders, this is handled as the relative path from the server folder specified here.

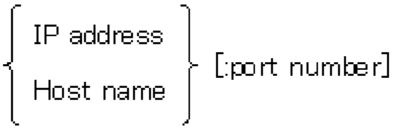
For Source file storage folders, Copy library storage folders, Subschema descriptor file storage folders, Screen and form descriptor, File descriptor, Command file and History file, specify them according to the conventions of the client.

Multiple folder names

For fields that accept multiple folders, separate the folder names by semicolons ";". The debugger searches for files in order of the specified folders.

How to specify Host

Specify host in the following format:



The IP address is IPv4 format or IPv6 format.

The port number must be from 1024 to 65535. If you omit the port number, it will default to 59998.

The IPv6 format can specify the scope address. The scope address specifies the scope identifier after the address.

When you set the IPv6 address to the port number, you must enclose the address with [ ].

For details of IPv6, refer to "For IPv6 of debugging" in the "NetCOBOL User's Guide".

Example

```
[IPv4 address(192.168.0.1) and port number(2000)]
  192.168.0.1:2000
[IPv6 address(fe80::1:23:456:789a) and port number(2000)]
  [fe80::1:23:456:789a]:2000
[IPv6 address (fe80::1:23:456:789a) and scope identifier (%eth0)]
  fe80::1:23:456:789a%eth0
[IPv6 address (fe80::1:23:456:789a), scope identifier (%5) and port number (2000)]
   [fe80::1:23:456:789a%5]:2000
[Host name(server-1) and port number(2000)]
  server-1:2000
[Port number omitted(IPv4)]
  192.168.0.1
[Port number omitted(IPv6)]
  fe80::1:23:456:789a
```

2.8.5.2 Specifying Options on the Command Line for the Remote Debugger

This section explains the way to start the remote debugger using command format.

Since you must start the remote debugger using the winsvd command, in the Project Manager window, Tools menu, select Debugger type, and then Win32 remote or Solaris remote.

For most items, this is the same as for the normal debugger. However, you must store the resources that are required for debugging in the server or in the client as appropriate.

For details about the storage location for resources that are required for remote debugging, refer to "2.8.1.2 Storage location for resources when doing remote debugging".

You can also specify a start parameter for the host.

To start the remote debugger from the command line, use the WINSVD command with the following format:

```
winsvd [start-parameter] [application-name] [execution-time-option]
```

You must specify the parameters in the order shown above.

If you only enter "winsvd", you need to provide the application information in the Start Debugging dialog box.

You must specify application-name if you want to enter any other information after "winsvd".

When you start the remote debugger with information on the command line, it comes up with the Start Debugging dialog box opened and the command line information entered in the appropriate fields.

To start remote debugging, enter any further information in the Start Debugging dialog box, and click the OK button.

See the list below for the supported start parameters.

Table 2.10 Start-Parameters

Specification Format	Field in Start Debugging dialog box
-U host	Specify the host for remote debugging. The format of the specification is same as that described in "How to specify Host" in "2.8.5.1 Specification for Remote Debugging using the Start Debugging dialog box", except for the case of omission. When this is omitted, it is assumed that the port number that was available at the last connection is specified. For the first connection, it will be 59998. You cannot specify this parameter in the @CBR_ATTACH_TOOL or @CBR_JUSTINTIME_DEBUG environment variable.
-G start- program-name	Start program
-S source-file-storage-folder-name	Source file storage folders
-C copy-library-storage- folder -name	Copy library storage folders
-A subschema- descriptor-file-storage- folder -name (Note)	Subschema descriptor file storage folders. For the Win32 remote debugger only.
-M screen-and form-descriptors-storage- folder -name	Screen and form descriptor folders
-E screen-and form-descriptors-extension	Screen and form descriptor extension
-H file-descriptors-storage- folder -name	File descriptor folders.
-O file-descriptors-extension	File descriptor extension.
-D debugging-information- file-storage- folder -name	Debugging information file storage folders
-B command-file-name	Command file
-L history- file-name	History file
-N	Starts debugging without opening the Start Debugging dialog box.

In the case of the Win32 remote debugger, the start character of the start parameter is handled the same whether it is a slash (/) or a hyphen (-). In the case of the Solaris remote debugger, you can only use a hyphen (-) as the start character. Additionally, the parameter name that continues after the start character can be handled if it contains upper-case letters and lower-case letters. If you have specified several start parameters, leave at least one space between each.

Example

- To enter a command with the following parameters and options for Win32 remote debugger:
  - Server: server-1
  - Application name: E:\EXE\SAMPLE1.EXE
  - Execution-time option: PARAM1
  - Source file storage folder name: D:\SOURCE
  - Debugging information file storage folder name: E:\SVD

  The command line would be:

```
winsvd /U server-1 /S d:\source /D e:\svd e:\exe\sample1.exe param1
```

- To enter a command with the following parameters and options for Solaris remote debugger:
  - Server: server-1
  - Application name: /home/usr1/sample1
  - Execution-time option: PARAM1
  - Source file storage folder name: D:\SOURCE
  - Debugging information file storage folder name: /home/usr1/svd

  The command line would be:

```
winsvd -U server-1 -S d:\source -D /home/usr1/svd /home/usr1/sample1 param1
```

Note

- Specify the folder name or file name in the execution-time option according to the server folder conventions.
- Note the following points in the case of a Solaris remote debugger:
  - You cannot use a slash (/) in the start character of the start parameter.
  - Since the server file name and folder name are case sensitive, take care when you specify upper-case letters and lower-case letters.
  - The start parameters that you can specify are different from those of the svd command.

2.8.6 Using the Remote Debugger

After you have started the debugger, the operation is generally the same as for a normal debugger. For details, refer to "2.5.2.1 Using the Debugger".

In the case of a Solaris remote debugger, there are some differences. For details, refer to Help.

2.8.7 Notes about the Remote Debugger

This section explains points to note when using the remote debugger.

To use the remote debug function, there must be support for TCP/IP protocol in both the server and client.

2.8.7.1 Notes about the Win32 Remote Debugger

This section explains points to note when using the Win32 remote debugger.

For details about common points with the normal debugger, refer to "2.8.7.2.2 Notes on handling Unicode", and "2.7 Notes".

- Note the storage location for the resources that are required for debugging. For details, refer to "2.8.1.2 Storage location for resources when doing remote debugging".
- Specify the application name and debugging information file storage folder according to the server folder conventions.
- Specify the folder name and file name in the execution-time options according to the server folder conventions.

2.8.7.2 Notes about the Solaris Remote Debugger

This section explains points to note when using the Solaris remote debugger.

2.8.7.2.1 Deciding the Character Code at execution-time

The Solaris remote debugger decides the character code at execution- time using one of the following methods:

- When starting remote debugging for general programs:

  The operation is the same as for the character code for starting server remote debugger connector.
- When starting remote debugging for programs that run in server environments such as Interstage:

  The operation is the same as for the character code that runs on servers such as Interstage and Web servers.

2.8.7.2.2 Notes on handling Unicode

In the Solaris remote debugger, note the following points when debugging Unicode programs:

Handling Unicode native characters

Unicode native characters are also displayed in the Data dialog box and Watch window. However, Unicode native characters cannot be input. To input Unicode native characters, specify them using hexadecimal format.

Batch debugging, automatic debugging, and output log

ASCII is also used as the coding system of command files and history files for Unicode. As a result, Unicode native characters are replaced with a "_" and output.

2.8.7.2.3 Other Notes

For details about points in common with the normal debugger, refer to the "NetCOBOL User's Guide for Solaris".

- Note the storage location for the resources that are required for debugging. For details, refer to "2.8.1.2 Storage location for resources when doing remote debugging".
- Specify the application name and debugging information file storage folder according to the server folder conventions.
- Specify the folder name and file name in the execution-time options according to the server folder conventions.
- Since the server file name and folder name are case sensitive, take care when you specify upper-case letters and lower-case letters.
- If you omit the application name extension, an EXE extension will not be provided for the name. Solaris assumes no extension.

Chapter 3 Debugging Mixed COBOL and PowerCOBOL

This chapter covers the details of debugging applications that contain mixtures of COBOL and PowerCOBOL code. Details covered are:

- How to prepare programs for debugging
- How to start the debugging process
- What to look out for when debugging

3.1 Overview

You can use the COBOL Debugger to debug applications that contain a mix of COBOL and PowerCOBOL code. This chapter explains how to use the COBOL debugger to debug such applications and covers some common situations you may encounter.

You prepare PowerCOBOL and COBOL code for debugging as if you were working solely with one type of code. You bring up the main program under the COBOL debugger and debugging proceeds as normal.

There is one difference in that the COBOL Debugger shows you the full, expanded, PowerCOBOL code. The debugger displays the main event loop, which PowerCOBOL usually hides, and some statements that you code within PowerCOBOL are expanded into MOVEs and CALLs to subroutines. Once you understand this additional code, you are essentially debugging a COBOL application.

Note

When the main program is a PowerCOBOL sheet, you can use the PowerCOBOL Debug function to debug the PowerCOBOL code. This has the advantage that you do not see the expanded PowerCOBOL code, but the disadvantage that you cannot view and debug the COBOL code. Check the PowerCOBOL documentation for information about the PowerCOBOL Debug function.

3.2 Preparing Programs for Mixed COBOL Debugging

You code, compile and link both COBOL and PowerCOBOL programs as if you were working with only one type of COBOL.

3.2.1 Building COBOL Programs for Debugging

To prepare COBOL programs for debugging, compile them with the TEST directive and link them with the /DEBUG option. Project Manager includes the linker options automatically for you when you specify the TEST compiler directive.

3.2.2 Building PowerCOBOL Programs for Debugging

PowerCOBOL programs to be debugged must have the "Build program for debug" option checked in the Compile Options dialog box. Checking this option also ensures that the programs are linked in the appropriate manner.

3.2.3 COBOL Runtime Options

NetCOBOL tailors its behavior at runtime by checking the settings of a number of environment variables and runtime options. You can set these variables in a variety of ways, documented in the "NetCOBOL User's Guide".

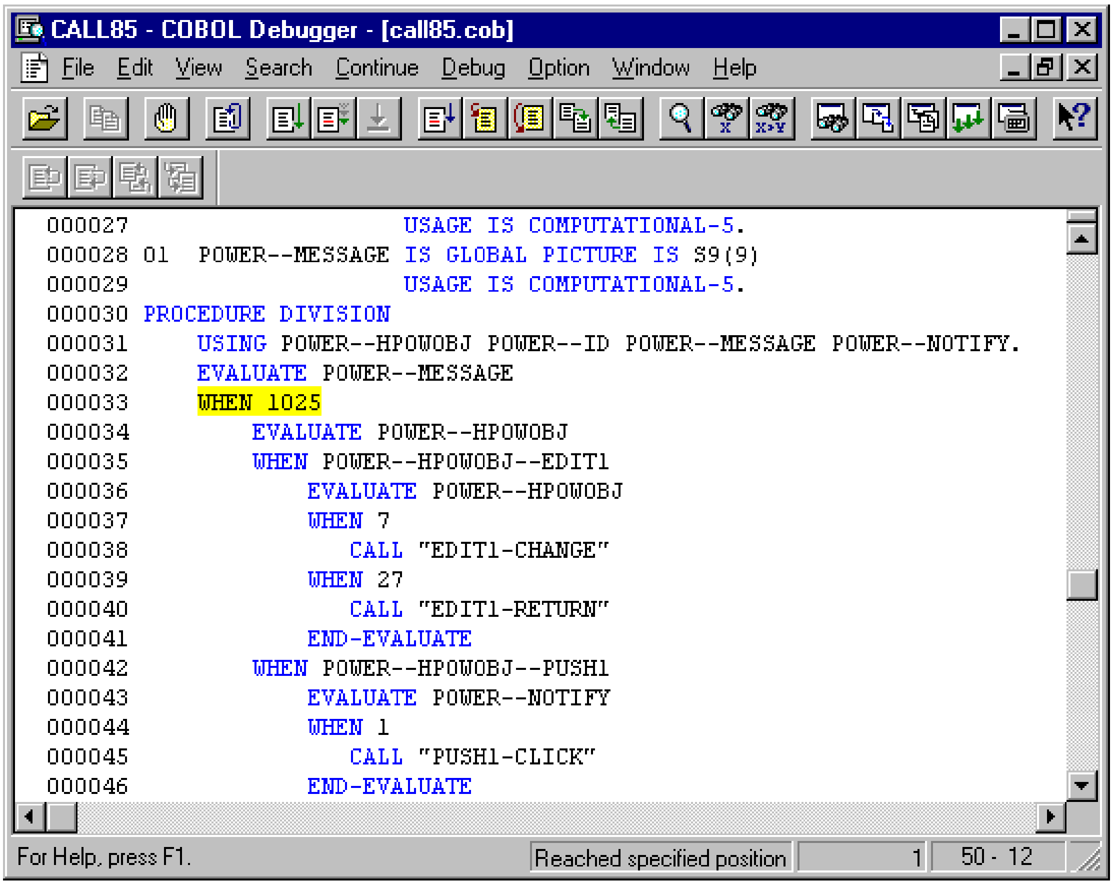
Before starting to debug, it is a good idea to specify all the environment variables you require in the initialization file (COBOL85.CBR). To do this, either edit the file, or use the Runtime Environment Setup Tool. Settings to consider include:

- File allocation mappings.
- COBOL sub-program name to DLL file name mappings.
- Other environment settings specific to your application requirements.

3.3 Starting Debugging Mixed COBOL Applications

Invoke the COBOL debugger, and start the main program of the application as described in Chapter 2. The screen below shows what you might see for a PowerCOBOL main program, with the source window maximized. Note that the code you first see for the PowerCOBOL program is not code that you wrote.

Figure 3.1 PowerCOBOL program source in the 32-bit COBOL debugger.



```
000027                    USAGE IS COMPUTATIONAL-5.
000028 01  POWER--MESSAGE IS GLOBAL PICTURE IS S9(9)
000029                    USAGE IS COMPUTATIONAL-5.
000030 PROCEDURE DIVISION
000031     USING POWER--HPOWOBJ POWER--ID POWER--MESSAGE POWER--NOTIFY.
000032     EVALUATE POWER--MESSAGE
000033     WHEN 1025
000034         EVALUATE POWER--HPOWOBJ
000035         WHEN POWER--HPOWOBJ--EDIT1
000036             EVALUATE POWER--HPOWOBJ
000037             WHEN 7
000038                CALL "EDIT1-CHANGE"
000039             WHEN 27
000040                CALL "EDIT1-RETURN"
000041             END-EVALUATE
000042         WHEN POWER--HPOWOBJ--PUSH1
000043             EVALUATE POWER--NOTIFY
000044             WHEN 1
000045                CALL "PUSH1-CLICK"
000046             END-EVALUATE
```

For Help, press F1. | Reached specified position | 1 | 50 - 12

You are now ready to start debugging. See the next section for debugging tips.

3.4 Tips for Debugging Mixed COBOL Applications

3.4.1 Expanded PowerCOBOL Code

The COBOL Debugger shows you code that PowerCOBOL normally hides. There are three types of expanded code you will see:

- The main event loop
- Internal sub-programs to handle events
- Expanded code that handles PowerCOBOL items, methods and attributes.

These are explained below.

3.4.2 The Main Event Loop

All Windows window-managing programs have a controlling event loop. This is because the way Windows works is to pass events (or messages) to programs and it expects the programs to act on these messages immediately. Examples of events or messages are "redisplay your window", " button 1 was clicked", "close your application". Each program receives messages and takes action on the messages received.

A PowerCOBOL sheet receives the messages in its main procedure and determines the type of message in the "EVALUATE POWER–MESSAGE" statement. The main procedure then calls internal sub-programs to handle the events.

When debugging within PowerCOBOL you do not see the main event loop, as PowerCOBOL only shows the code that you wrote.

3.4.3 Internal Sub-Programs to Handle Events

PowerCOBOL creates internal sub-programs around code that you write to handle events. This is not visible to you within PowerCOBOL. However, when using the COBOL Debugger, you see all the code for these internal programs. Internal programs start with the code:

```
IDENTIFICATION DIVISION
PROGRAM-ID.  "PROGRAM-NAME".
```

and end with the code:

```
END PROGRAM "PROGRAM-NAME".
```

"PROGRAM-NAME" usually has the structure:

```
item-event

e.g. "EDIT1-CHANGE", "EDIT1-RETURN", "PUSH1-CLICK".
```

The COBOL Debugger displays all the internal subprograms in a single source file. Thus the COBOL Debugger lets you browse, search and set breakpoints in the entire PowerCOBOL source code for your sheet.

3.4.4 Expanded Code for Items, Methods and Attributes

The COBOL Debugger displays expanded and changed versions of statements that contain references to items, methods and attributes.

For example:

The PowerCOBOL method call:

```
CALL CLOSESHEET OF CALL85.
```

appears as:

```
CALL "XPOWCSCLOSEMYSELF" USING BY VALUE CALL85.
```

in the COBOL Debugger.

The PowerCOBOL statement referencing an attribute of an item:

```
MOVE POW-TEXT OF EDIT1 TO ID-INPUT
```

appears as:

```
CALL "XPOWEDITGETTEXT" USING BY VALUE EDIT1 BY REFERENCE POW-0001
MOVE POW-0001 TO ID-INPUT
```

in the COBOL Debugger.

You handle the expanded statements like any other COBOL statements. You set breakpoints, and view and change data values as if the statements were your own.

Apparently Inactive Code

Debugging any event-based graphical system can appear strange at first if you normally work with procedural code. The debugger can become unresponsive and the application window at times does not refresh itself as you might expect. You find yourself clicking on windows, wondering why nothing is happening.

There are two basic reasons for this behavior:

- There are times when the debugger is waiting for an event to come from the application window. At these times only the "Break" button is enabled on the debugger toolbar.

- The debugger has stopped the running application (e.g., when a breakpoint has been encountered). There is nothing active to receive and process events from the application window. So clicking on the application window has no apparent effect.

Once you understand why the behavior exists, it is reasonably easy to cope with it.

If the debugger is not responding, look at its toolbar. If only the "Break" button is enabled the debugger is waiting for an event in the application window. You can either switch to the application window and take an appropriate action, or click the "Break" button that may abort the application.

If the user window is not responding, switch to the debugger. The debugger has halted execution for one reason or another. Check the reason, check your breakpoints and restart the execution using one of the Continue menu functions.

Sometimes you want to see the application window at the same time as viewing the code. You do this by sizing and positioning the application and debug windows appropriately.

Using Run to Next Program

Because you are debugging at least two programs (PowerCOBOL and COBOL), and often have many PowerCOBOL generated internal sub-programs, you may choose to use the Run to Next Program function. If you are at the top of the event loop on the EVALUATE POWER--MESSAGE statement, it may appear that nothing is happening. Every time you click on "Run to Next Program" you come back to the same point.

This happens because the PowerCOBOL sheet is receiving several messages from the Windows system. The event loop processes each message. The COBOL Debugger sees the event loop relinquishing control through the EXIT PROGRAM statement and then regaining control when the next message arrives. It therefore appears to the COBOL Debugger that a new program is being executed.

To get to the sub-program of interest you may need to click on "Run to Next Program" several times.

Keeping or Regaining Control

As with any debugging operation, the best way of keeping control is setting breakpoints at appropriate locations in the code.

If the code appears to be running and not hitting the breakpoints you have set, you can use the "Break" function. However, this can cause the application to abort so you have to restart the application.

SVD File Does Not Match Program to be Debugged

If you are experimenting with ways of building the mixed application code together you may encounter a message from the COBOL Debugger that says:

"Debugging information file FILENAME.svd does not match the program to be debugged. The debugging information is ignored."

This can happen when you compile the COBOL code in Project Manager and the rest of the system in PowerCOBOL (or vice versa). To correct this you may need to Build within PowerCOBOL or Rebuild within Project Manager. Rebuild in Project Manager forces a recompilation whereas Build does not.

Another possibility is that somehow one of the systems has lost the compiler "TEST" directive or Compile for Debug option.

Chapter 4 Debugging Visual Basic calling COBOL

This chapter covers the details of debugging Visual Basic applications calling COBOL. Details covered are:

- How to prepare programs for debugging
- How to start the dual debugging process
- How to stop the dual debugging process
- Do's, and Don'ts

4.1 Overview

NetCOBOL programs are designed to work well with Visual Basic. The main consideration in debugging these mixed language applications is in bringing up the two debugging environments. The COBOL subprograms are prepared exactly as if they were to be called from other COBOL programs.

Because the Visual Basic program will be calling COBOL, Visual Basic is brought up under the COBOL debugger. This ensures that calls from Visual Basic to COBOL can be intercepted by the COBOL debugger and the appropriate actions taken to let you see your COBOL source code.

When you are debugging mixed Visual Basic and COBOL applications you have two complex environments active. To ensure that they interact correctly it is important you follow the start-up and close-down steps documented in this chapter.

4.2 Preparing Programs for Debugging with Visual Basic

COBOL programs that are called from Visual Basic are prepared in exactly the same way as COBOL programs that are called from other COBOL programs. The only special consideration in writing the programs is to ensure that data passed through the Linkage Section must be compatible with Visual Basic data types.

Similarly preparing COBOL programs for debugging requires the same steps as if they were to be debugged in a totally COBOL environment.

4.2.1 Compiling for Debugging

Programs to be debugged must be compiled with the TEST directive.

4.2.2 Linking for Debugging

Programs to be debugged must be linked with the linker options:

```
/DEBUG
```

4.2.3 Making Files Accessible to Visual Basic

When the Visual Basic program makes a call to COBOL it has to be able to find the COBOL code and supporting library routines. At the time the call is made the system's current folder is determined by Visual Basic and is most likely the folder containing the Visual Basic start-up module.

There are therefore three options for ensuring the COBOL programs and supporting files can be found when Visual Basic makes its call:

- Put the COBOL files in a folder on the PATH. To update the path, change the PATH statement in the AUTOEXEC.BAT file.
- Make the code in the Visual Basic program specify a full path for the COBOL subprogram.
- Put the COBOL files in the folder that will be the current folder at the time the call is made. (Not recommended as you will have a mix of COBOL application and Visual Basic system files.)

4.2.4 COBOL Runtime Options

NetCOBOL tailors its behavior at runtime by checking the settings of a number of environment variables and runtime options. These variables can be set in a variety of ways, documented in the "NetCOBOL User's Guide".

Before starting to debug make sure that you have specified all the environment variables you require. These settings should be placed in the initialization file (COBOL85.CBR) either by editing, or by using the Runtime Environment Setup Tool.

Settings to consider include:

- File allocation mappings.
- COBOL sub-program name to DLL file name mappings.
- Other environment settings specific to your application requirements.

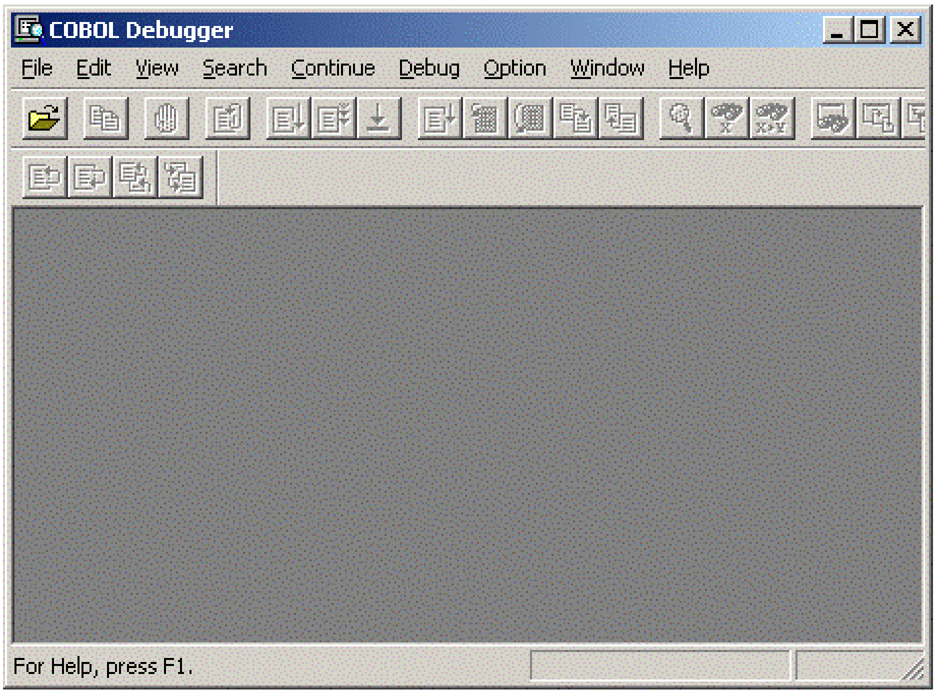
4.3 Starting Debugging with COBOL and Visual Basic

To debug applications in which Visual Basic programs call COBOL programs, the COBOL debugger is started first. You tell the debugger where the COBOL source and debugging information is stored then, instead of loading a COBOL program into the debugger, you specify Visual Basic as the application. Within Visual Basic you execute or debug the VB programs as normal and when Calls to COBOL are executed the COBOL debugger gains control so that you can debug the COBOL programs. This process is detailed in the following instructions.

Once you have the COBOL programs compiled, linked and stored in a suitable folder, start the COBOL debugger. It can be started from within Programming Staff or from the Windows desktop.

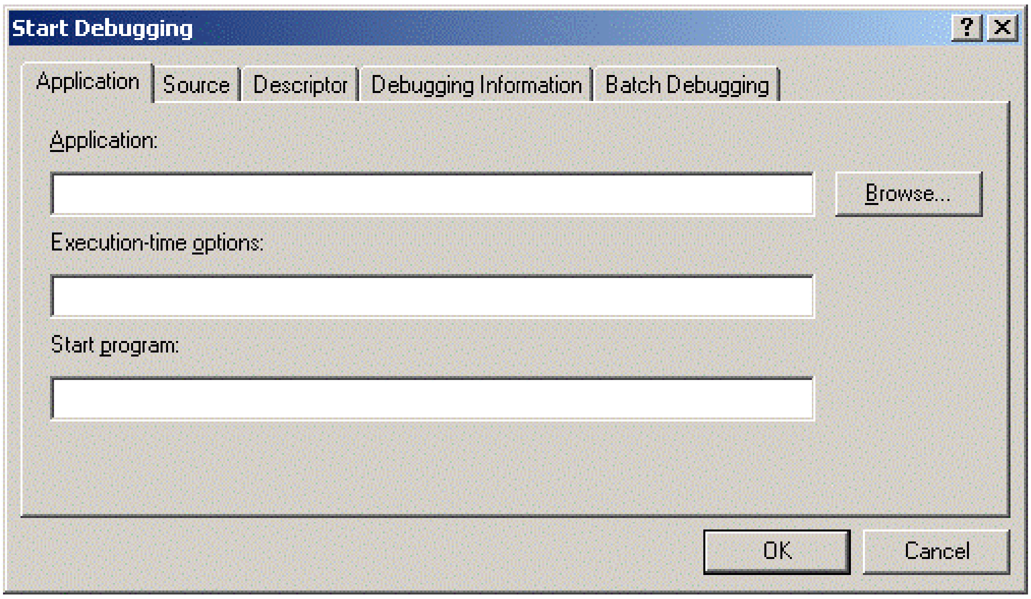
1. The debugger displays a blank debug window.

Figure 4.1 COBOL Debugger Main Window



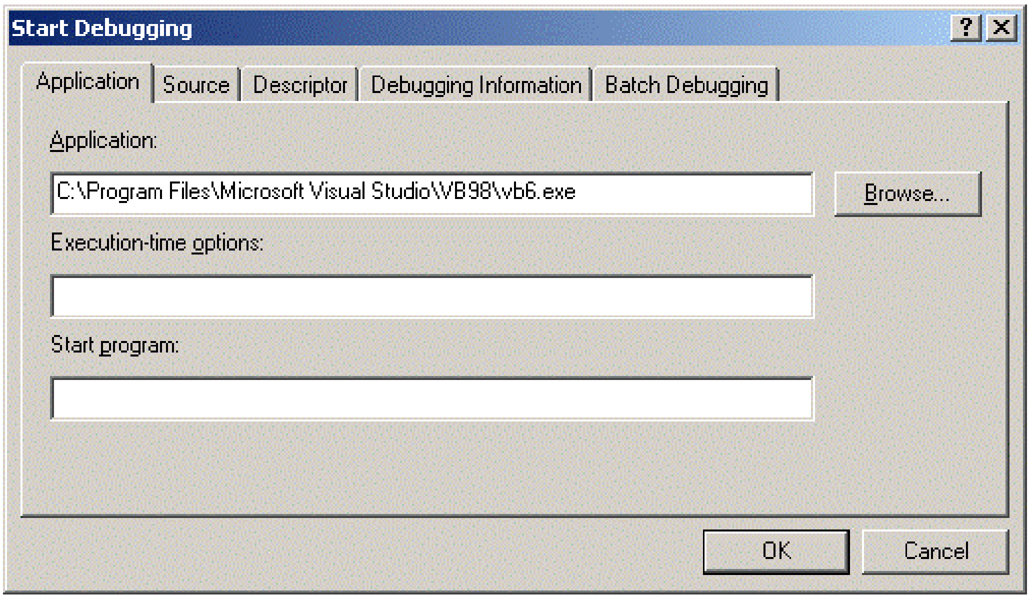
2. Select File, Start Debugging from the menu. The Start Debugging dialog box is displayed.

Figure 4.2 The Start Debugging Menu



3. Enter, or browse for, the location of the Visual Basic program.

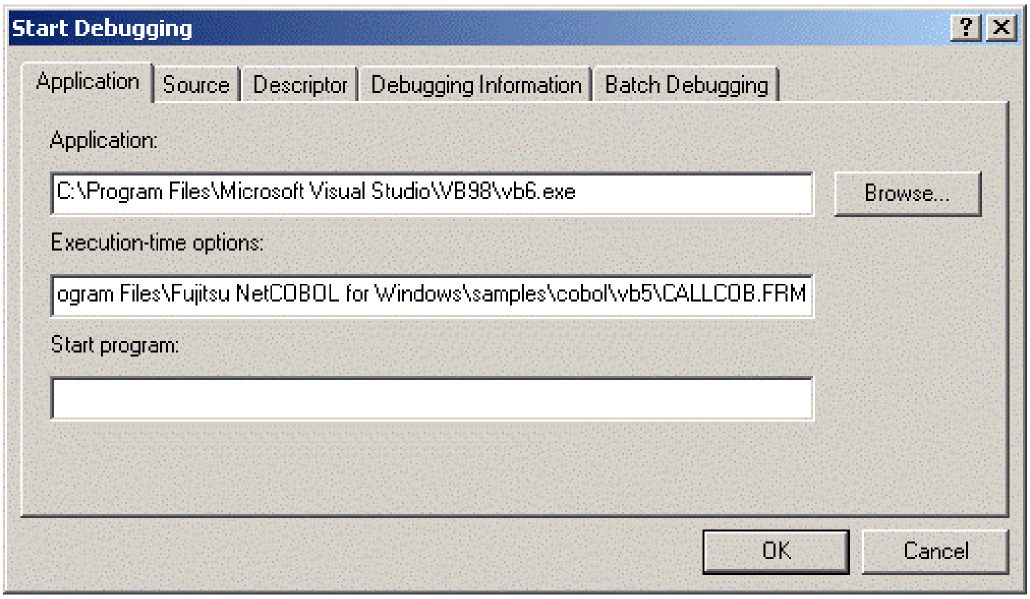
Figure 4.3 Application Field Filled In



Application: C:\Program Files\Microsoft Visual Studio\VB98\vb6.exe

4. Enter the name of the Visual Basic program you wish to start in the Execution-time-option edit box. Alternatively, you can leave this field blank and load the program after Visual Basic starts.

Figure 4.4 CallCOB.frm as Execution-time option



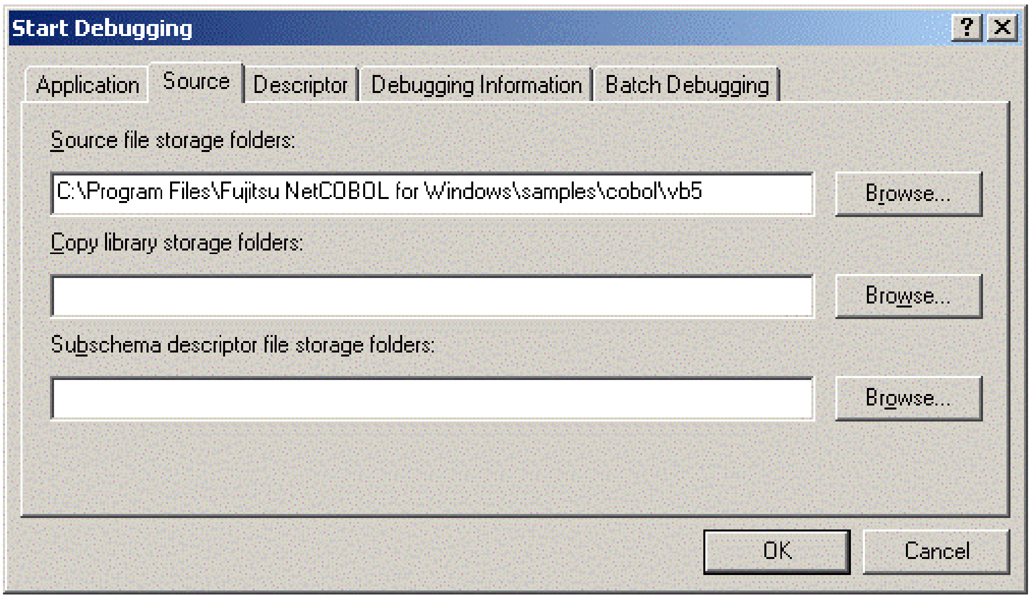
Application:
C:\Program Files\Microsoft Visual Studio\VB98\vb6.exe

Execution-time options:
ogram Files\Fujitsu NetCOBOL for Windows\samples\cobol\vb5\CALLCOB.FRM

Start program:

5. Click on the Source tab. Enter, or browse for, the name of the folder containing your COBOL source. If your programs use source libraries and subschemas, also enter these folder names.

Figure 4.5 Filling in Source File Storage Folders



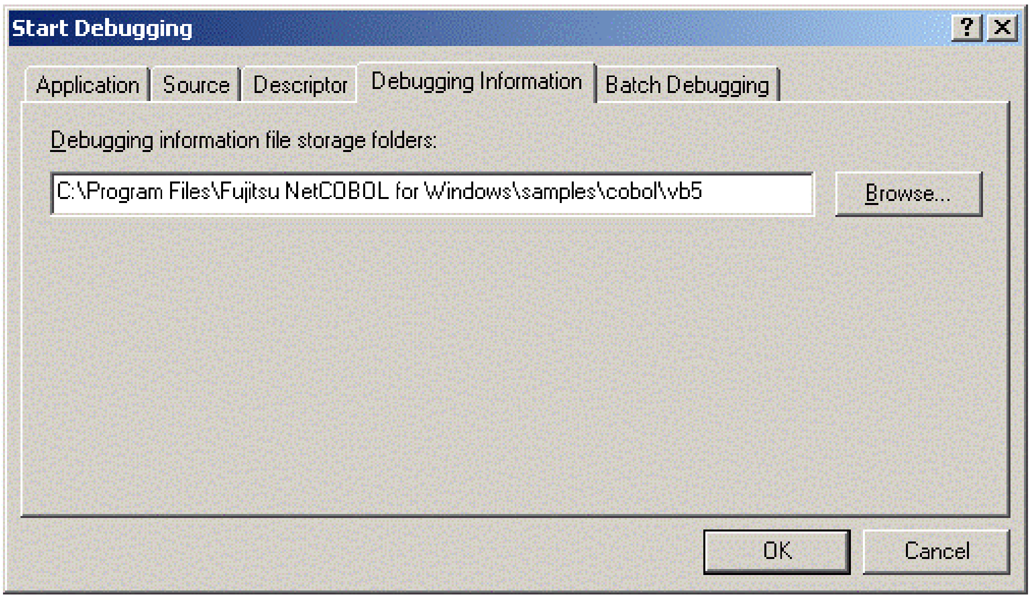
Source file storage folders:
C:\Program Files\Fujitsu NetCOBOL for Windows\samples\cobol\vb5

Copy library storage folders:

Subschema descriptor file storage folders:

6. Click on the Debugging Information tab. Enter, or browse for, the name of the folder containing the debugging information for the COBOL programs. The debugging information is stored in the folder specified in the TEST compiler option, or the folder containing the COBOL source if no folder is specified in the TEST option.

Figure 4.6 Debugging Information Entered

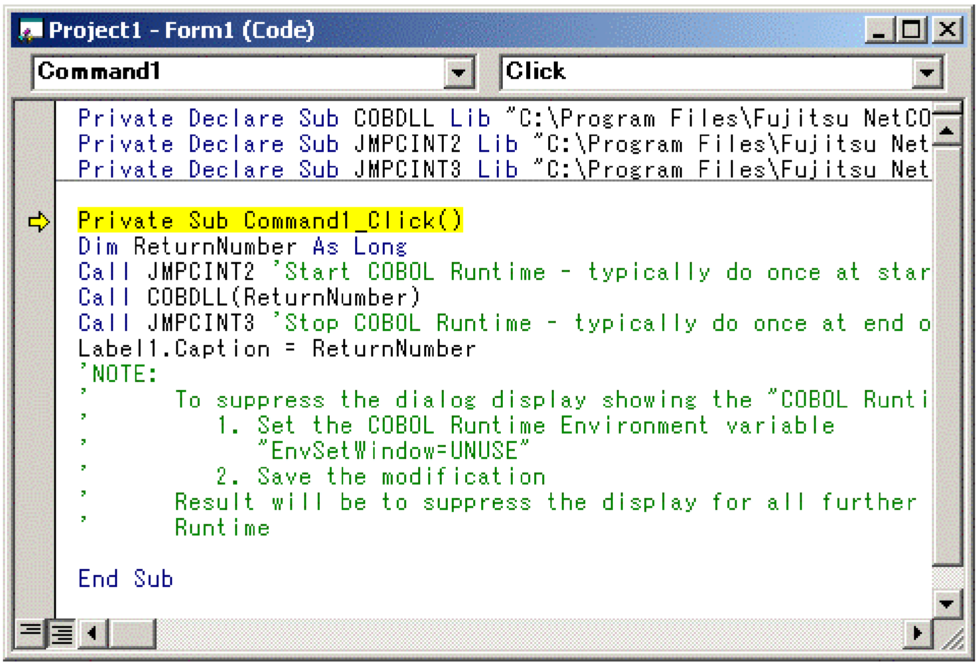


Debugging information file storage folders: C:\Program Files\Fujitsu NetCOBOL for Windows\samples\cobol\vb5

You are now ready to start debugging. Click on OK to invoke Visual Basic.

In Visual Basic start executing or debugging your Visual Basic program. The snapshot below shows a simple Visual Basic program that calls a COBOL program called COBDLL.

Figure 4.7 The Visual Basic Debugger



```
Private Declare Sub COBDLL Lib "C:\Program Files\Fujitsu NetCO
Private Declare Sub JMPCINT2 Lib "C:\Program Files\Fujitsu Net
Private Declare Sub JMPCINT3 Lib "C:\Program Files\Fujitsu Net

Private Sub Command1_Click()
Dim ReturnNumber As Long
Call JMPCINT2 'Start COBOL Runtime - typically do once at star
Call COBDLL(ReturnNumber)
Call JMPCINT3 'Stop COBOL Runtime - typically do once at end o
Label1.Caption = ReturnNumber
'NOTE:
'      To suppress the dialog display showing the "COBOL Runti
'         1. Set the COBOL Runtime Environment variable
'            "EnvSetWindow=UNUSE"
'         2. Save the modification
'      Result will be to suppress the display for all further
'      Runtime

End Sub
```

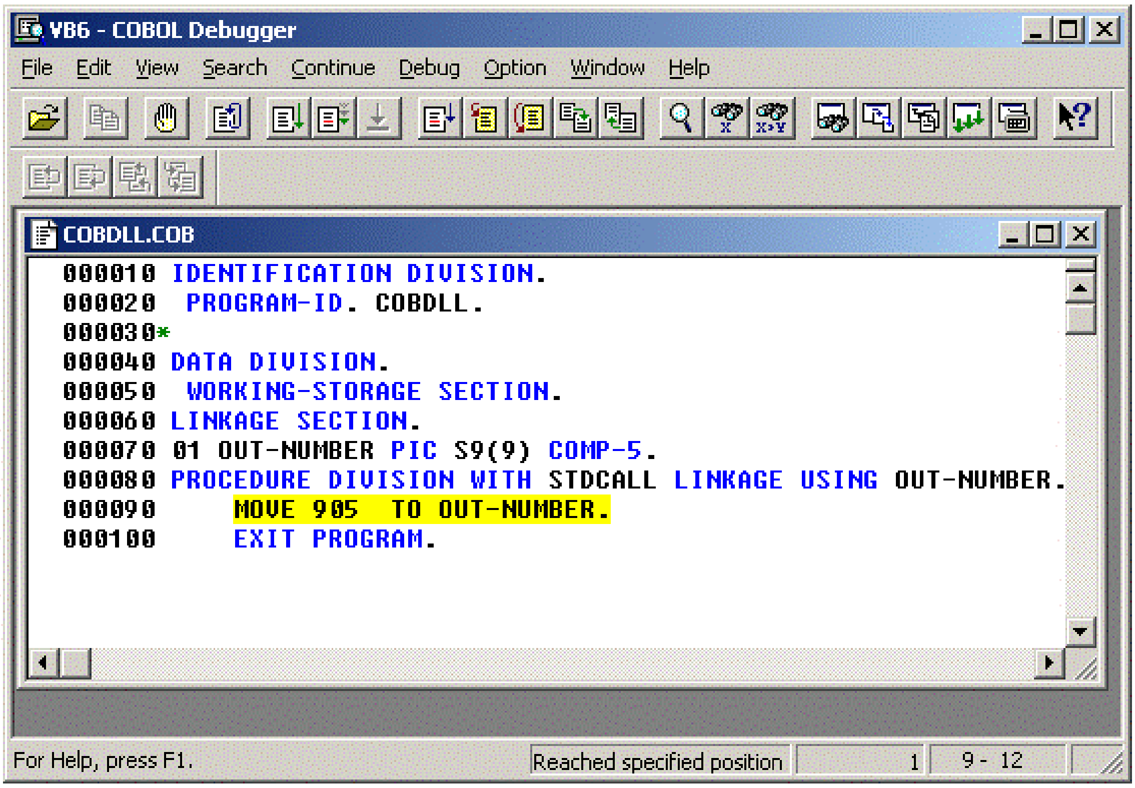
Step through the Call to JMPCINT2 which initializes the COBOL runtime system. Typically this is executed once at the beginning of the VB application.

Step into the Call to the COBOL program.

On the first Call, it will appear that nothing is happening. You need to switch to the COBOL debugger window (this is titled "VB6 - COBOL Debugger"). On subsequent Calls to COBOL the COBOL debugger window is displayed automatically.

The Called source is displayed.

Figure 4.8 The COBOL Debugger



```
000010 IDENTIFICATION DIVISION.
000020  PROGRAM-ID. COBDLL.
000030*
000040 DATA DIVISION.
000050  WORKING-STORAGE SECTION.
000060 LINKAGE SECTION.
000070 01 OUT-NUMBER PIC S9(9) COMP-5.
000080 PROCEDURE DIVISION WITH STDCALL LINKAGE USING OUT-NUMBER.
000090     MOVE 905  TO OUT-NUMBER.
000100     EXIT PROGRAM.
```

```
For Help, press F1.          Reached specified position      1   9 - 12
```

Note

Sometimes a tool tip from the Visual Basic debug toolbar may remain visible on top of the COBOL debugger window. It does not affect the execution of the COBOL code or debugger.

Debug the COBOL code as normal.

Note

a) The accelerator key for Step Into is F8 in both Visual Basic and the COBOL debugger.

b) Remember to set breakpoints in the COBOL program before a Go or Run command, as you may not be able to regain control in the COBOL source.

When you execute an EXIT PROGRAM statement in the top level COBOL program, control is returned to Visual Basic.

Continue debugging in Visual Basic and COBOL until you are ready to stop. Be sure to follow the instructions in the section "Stopping Debugging with COBOL and Visual Basic" when stopping debugging.

4.4 Stopping Debugging with COBOL and Visual Basic

It is important that the Visual Basic and COBOL debugging environments are closed down in the correct order. Failure to do so can result in one or both systems hanging.

Close down the debugging in the following order:

1. If you are not already there, return to the Visual Basic environment by executing an EXIT PROGRAM statement in the COBOL program.
2. Step through or execute a Call to JMPCINT3. This tells the COBOL runtime to tidy up and close down.
3. Stop debugging or executing in Visual Basic.
4. Close Visual Basic.
5. Either Close the COBOL debugger or start another debug session.

   To start another debug session use one of the following:

   - Select Continue, Re-debug.
   - Select File, Start Debugging
   - Select File, and a previously debugged program.

4.5 Do's and Don'ts in the Dual Debugging Environment

Do specify Application, Source and Debugging Information directories.

Control may be transferred from one debugging system to the other at points where the current folder has changed. To be sure the COBOL system can find the files it requires these directories must be entered in the Start Debugging dialog box.

Do set breakpoints in code before running.

You may find it difficult to break into the COBOL or Visual Basic code if you run the code without first setting breakpoints at suitable points.

Do close down in the proper order.

Failure to close down in the proper order can cause either or both debugging systems to hang.

Do NOT close down in an improper order!

Failure to close down in the proper order can cause either or both debugging systems to hang.

Chapter 5 NetCOBOL Debugging Functions

NetCOBOL debugging functions and a COBOL debugger are provided to help debug programs created with this product. This chapter provides instructions on using the NetCOBOL debugging functions.

For information on using the COBOL debugger, refer to "Chapter 2 Debugging in Windows System".

Outline of the debugging functions:

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

5.1 Outline of the Debugging Functions

Six types of debugging functions are available for COBOL:

- Checking the referencing of an incorrect area, data exceptions, and parameters (CHECK function)
- Tracing executed COBOL statements (TRACE 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).
- Using the object program listing to identify the statement that terminated abnormally (debugging using an object program listing)

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 5.1 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. **Purpose**	CHECK

Function Name	Outline	Compiler Option
	- 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 - To prevent different calling conventions 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. If the COBOL Error Report is also used, the destroyed locations can also be identified.	-
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	The following information is output for each object program. - Object relative offset - Object code in machine language - Procedure name and procedure number - Assembler instruction - Verb name and line number - Area name - Defined word written in the COBOL program **Purpose** - To identify the statement that caused the program to terminate abnormally	LIST PRINT SOURCE COPY MAP

Note

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

5.1.1 Statement Number

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

```
line-number[. verb-sequence-number-in-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.

verb-sequence-number-in-line-number

These are sequence numbers used to make each statement unique when multiple statements are entered at the same line number. Numbers are allocated in ascending order starting from 1 for the first statement and, 2, 3 ... subsequently.

5.2 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.

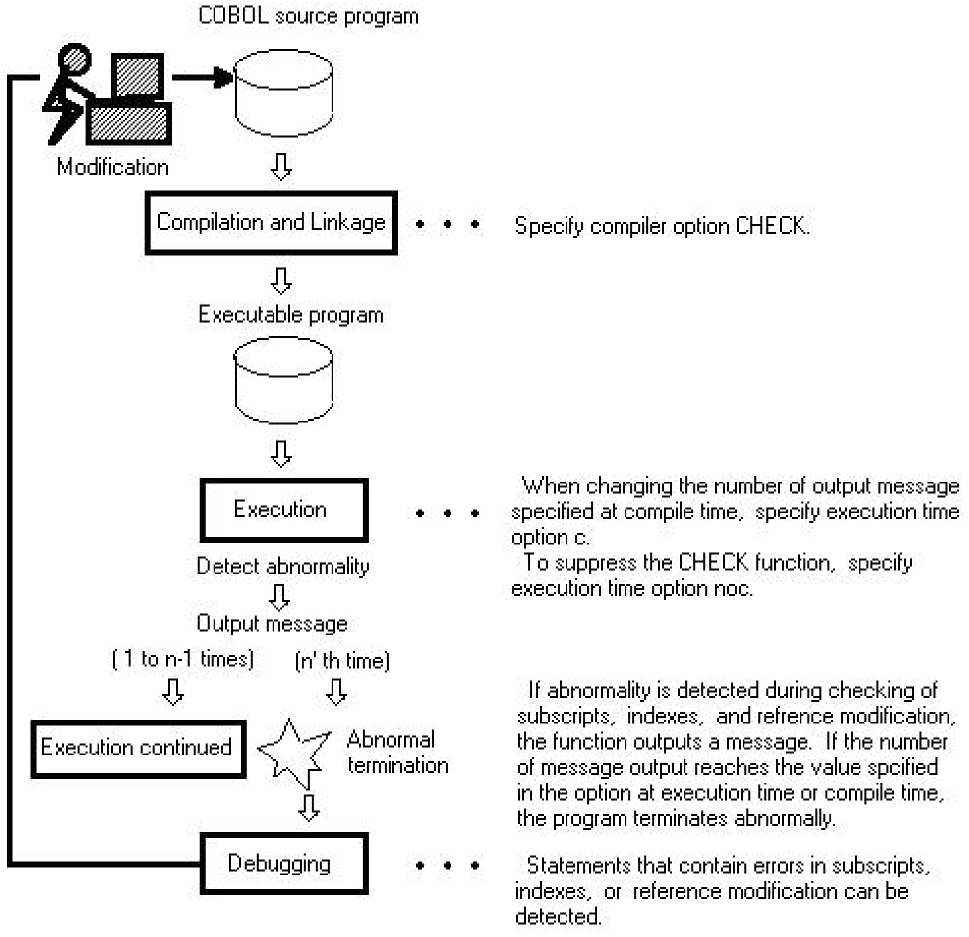
- Subscripts, indexes and reference modification outside their range
- Numeric data exceptions and zero divisor check
- Parameters for calling a method
- Program calling conventions
- Internal program call parameters
- External program call parameters

This section describes how to use the CHECK function.

5.2.1 Flow of Debugging

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

Figure 5.1 Flow of debugging with CHECK function


COBOL source program
Modification
Compilation and Linkage
Specify compiler option CHECK.
Executable program
Execution
When changing the number of output message specified at compile time, specify execution time option c.
To suppress the CHECK function, specify execution time option noc.
Detect abnormality
Output message
(1 to n-1 times)
(n' th time)
Execution continued
Abnormal termination
If abnormality is detected during checking of subscripts, indexes, and refrence modification, the function outputs a message. If the number of message output reaches the value spcified in the option at execution time or compile time, the program terminates abnormally.
Debugging
Statements that contain errors in subscripts, indexes, or reference modification can be detected.

5.2.2 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.

Checking parameters for calling a method

JMP08101-E/U

[PID:xxxxxxxx TID:xxxxxxxx] FAILURE IN USING (or RETURNING) PARAMETER OF THE 'method-name' METHOD. 'NUMBER' (or PARAMETER=parameter's sequence number). PGM=program-name LINE=statement-number

Remedy

Modify your program so that the method referenced in the message is called with valid parameters and execute it again.

Checking Subscripts and Indexes

JMP0820I-E/U

[PID:xxxxxxxx TID:xxxxxxxx] SUBSCRIPT/INDEX IS OUT OF RANGE. PGM=program-name. LINE=statement-number. OPD=data-name (dimension of data-name)

Remedy

Specify a correct value for the subscript or index indicated in the message, then re-execute.

Checking Reference Modification

JMP0821I-E/U

[PID:xxxxxxxx TID:xxxxxxxx] REFERENCE MODIFIER IS OUT OF RANGE. PGM=program-name. LINE=statement-number. OPD=data-name.

Remedy

Correct the program so that reference modification of the data item indicated in the message is performed within the specified range.

Checking a Target Word of the OCCURS DEPENDING ON Clause

JMP0822I-E/U

[PID:xxxxxxxx TID:xxxxxxxx] ODO OBJECT VALUE IS OUT OF RANGE. PGM=program-name. LINE=statement-number. OPD=data-name. ODO=name of target word of ODO clause.

Remedy

Specify a correct value for the object (in the OCCURS DEPENDING ON clause) indicated in the message, then re-execute.

Checking numeric data exceptions

JMP08281-E/U

[PID:xxxxxxxx TID:xxxxxxxx] INVALID VALUE SPECIFIED. PGM=program-name. LINE=statement-number. OPD=data-name

Remedy

Set a valid value in the operand referenced by the message and re-execute.

Checking zero-divisor

JMP08291-E/U

[PID:xxxxxxxx TID:xxxxxxxx] DIVIDED BY ZERO. PGM=program-name. LINE=statement-number. OPD=data-name

Remedy

Change the divisor in the operand referenced by the message to any value other than zero and re-execute.

Checking the program calling conventions

JMP0811I-E/U

[PID:xxxxxxxx TID:xxxxxxxx] FAILURE IN CALLING CONVENTIONS OR PARAMETERS OF THE 'called program name' PROGRAM. PGM=program-name. LINE=statement-number.

Remedy

Correct the programs so that the calling conventions and parameters match, then re-execute.

Internal program call parameter investigation

JMN3333I-S

THE NUMBER OF PARAMETERS SPECIFIED IN USING PHRASE OF CALL STATEMENT MUST BE THE SAME NUMBER OF PARAMETERS SPECIFIED IN USING PHRASE OF PROCEDURE DIVISION.

Remedy

Correct the program so that the number of parameters is the same.

JMN3334I-S

THE TYPE OF PARAMETER @2@ SPECIFIED IN USING PHRASE OR RETURNING PHRASE OF CALL STATEMENT MUST BE THE SAME TYPE OF PARAMETER @3@ SPECIFIED IN PROCEDURE DIVISION USING PHRASE OR RETURNING PHRASE OF PROGRAM @1@.

@1@: Program name

@2@: Identifier

@3@: Identifier

Remedy

Correct the program so that the class name, FACTORY, and ONLY that are specified in the USAGE OBJECT REFERENCE clause of the object specified in the parameter are the same.

JMN3335I-S

THE LENGTH OF PARAMETER @2@ SPECIFIED IN USING PHRASE OR RETURNING PHRASE OF CALL STATEMENT MUST BE THE SAME LENGTH OF PARAMETER @3@ SPECIFIED IN PROCEDURE DIVISION USING PHRASE OR RETURNING PHRASE OF PROGRAM @1@.

@1@: Program name

@2@: Identifier

@3@: Identifier

Remedy

Correct the program so that the parameter lengths are the same.

JMN3414I-S

RETURNING ITEM MUST BE SPECIFIED FOR CALL STATEMENT WHICH CALLS @1@. THERE IS RETURNING SPECIFICATION IN PROCEDURE DIVISION OF PROGRAM @1@.

@1@: Program name

Remedy

Correct the program so that the existence or non-existence of RETURNING phrase is matched.

JMN3508I-S

RETURNING ITEM MUST NOT BE SPECIFIED FOR CALL STATEMENT WHICH CALLS @1@. THERE IS NOT RETURNING SPECIFICATION IN PROCEDURE DIVISION OF PROGRAM @1@.

@1@: Program name

Remedy

Correct the program so that the existence or non-existence of RETURNING phrase is matched.

External program call parameter investigation

JMP0812I-E/U

[PID:xxxxxxxx TID:xxxxxxxx] FAILURE IN '$1' OF CALL STATEMENT. PGM=program-name. LINE=statement-number.

Remedy

Based on the content indicated by $1, perform operations presented in "Table 5.2 The contents of $1 of JMP0812I-E/U " then try again.

Table 5.2 The contents of $1 of JMP0812I-E/U

$1	Corrective action taken by the programmer
USING PARAMETER NUMBER	Match the number of USING phrase parameters
USING nTH PARAMETER (nTH = 1ST, 2ND, 3RD, 4TH...)	Match the size of nth USING phrase parameters
RETURNING PARAMETER	Match the size of RETURNING phrase parameters

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

- noc : All the CHECK function
- nocb : CHECK(BOUND)
- noci : CHECK(ICONF)
- nocl : CHECK(LINKAGE)
- nocn : CHECK(NUMERIC)
- nocp : CHECK(PRM)

Program execution is continued until the message count reaches the specified count. Refer to "Format of Runtime Options" in the "NetCOBOL User's Guide" for the detail.

5.2.3 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  d    table.
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=1200.1.
OPD=element-1
JMP0820I-E/U  [PID:xxxxxxxx TID:xxxxxxxx] SUBSCRIPT/INDEX IS OUT OF RANGE.  PGM=A. LINE=1400.1.
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=120.1.
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=70.1
```

Checking the program calling conventions

There are several calling conventions for Windows applications. The standard calling conventions and the specification method of the calling conventions depend on the development language.

NetCOBOL uses the CALL statement or the WITH phrase of the Procedure Division statement to determine which calling conventions are to be used when passing parameters. Refer to "Differences Among Calling conventions" in the "NetCOBOL User’s Guide".

If the calling conventions are different for the calling program and called program, an error will occur at linkage if the programs have a static-link structure or dynamic-link structure. For a dynamic program structure, however, an error will not occur at linkage. As a result, the execution-time stack is destroyed and the program terminates abnormally. In addition, if the calling conventions of the calling program are STDCALL, the program might terminate abnormally if the calling conventions are the same, but the number of parameters is different. Thus, the program might terminate abnormally for the same reason as if the calling conventions were different. Therefore, program calling conventions are an object for checking.

Program A

```
000000 @OPTIONS CHECK(LINKAGE)
000010 PROGRAM-ID. A.
             :
000030  01  PRM-01  PIC S9(9) COMP-5.
             :
000070     CALL "B" WITH C LINKAGE USING PRM-01.
             :
```

Program B(C functions)

```
#include <windows.h>
             :
int WINAPI B(long FAR* data1)   ...(*1)
{
             :
}
```

*1 For the following function declarations, the STDCALL calling conventions will be used.

```
       int WINAPI        function name()
       int CALLBACK      function name()
       int PASCAL        function name()
       int far pascal    function name()
       int _stdcall      function name()
```

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

```
JMP0811I-E/U [PID:xxxxxxxx TID:xxxxxxxx] FAILURE IN CALLING CONVENTIONS OR PARAMETERS OF THE 'B'
PROGRAM. PGM=A LINE=7.1
```

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:

```
[PID:xxxxxxxx TID:xxxxxxxx] FAILURE IN 'USING 1ST PARAMETER' OF CALL STATEMENT.  PGM=A. LINE=10.1.
```

5.2.4 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.

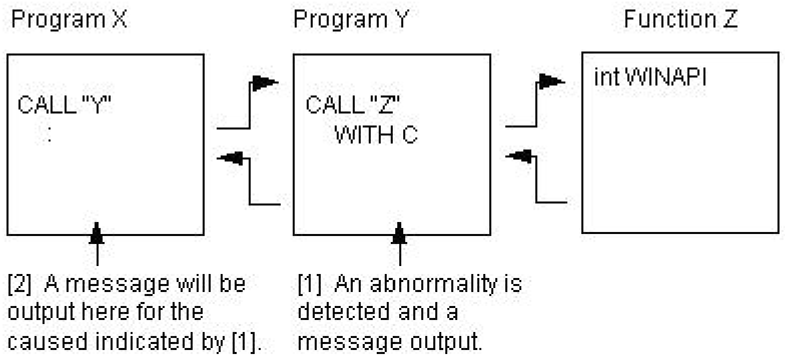
- The CHECK function performs processing other than the processing described in the COBOL program such as checking data. Therefore, the program size increases and execution speed deteriorates when the CHECK function is used.

- 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.

- For a CHECK (LINKAGE) check, the following phenomenon will occur if the output count has been specified and execution is continued after an abnormality was detected:
  If an abnormality was detected for a lower level call for a deep call hierarchy, a message will also be output for the upper level call as well as for the call for which the abnormality was detected. If the upper level call is normal, message output will be stopped only by correcting the lowest level call.


Program X
CALL "Y"
:
Program Y
CALL "Z"
WITH C
Function Z
int WINAPI
[2] A message will be output here for the caused indicated by [1].
[1] An abnormality is detected and a message output.

- CHECK(PRM) does not affect the program size or execution speed at the time of compilation.
- 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 NetCOBOL compiler V8.0L10 or later 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.
- CHECK(PRM) will check parameters for calls made using the COBOL and C calling conventions. The parameter check is not performed for the STDCALL calling convention.
  Refer to "Differences Among Calling conventions" in the "NetCOBOL User's Guide" for details of the calling conventions.
- 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 4-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.

5.3 Using the TRACE Function

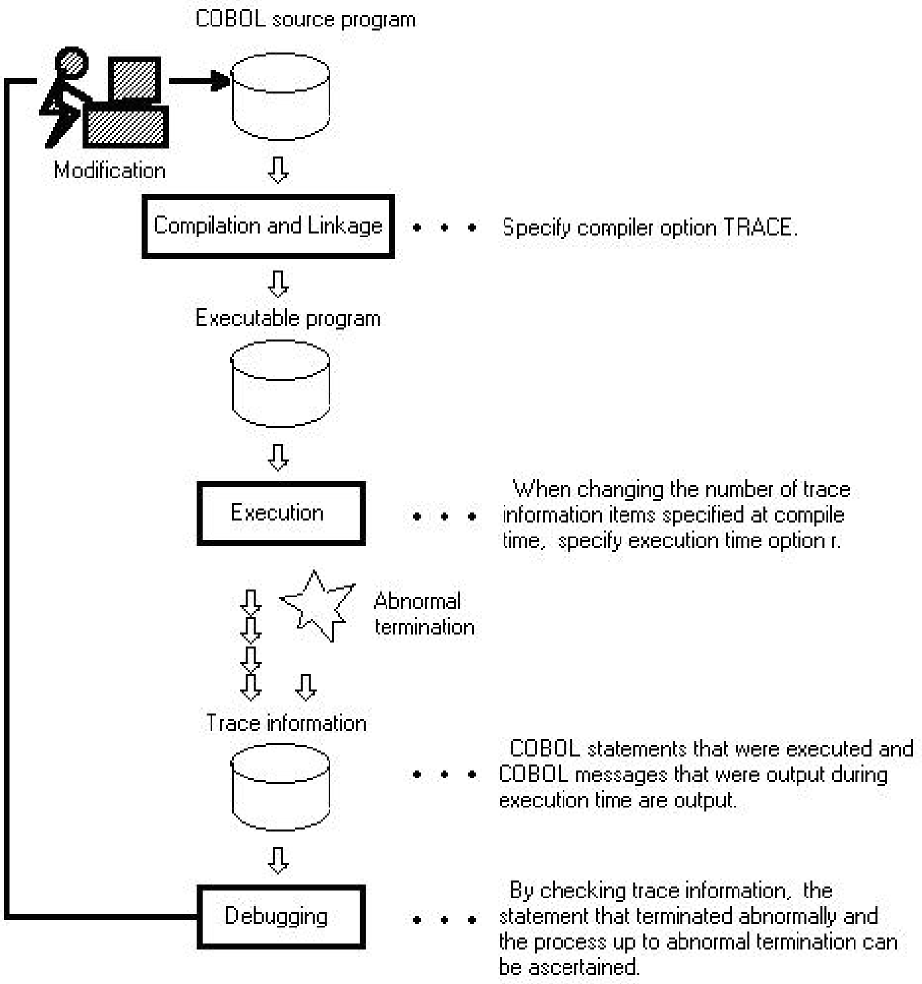
The TRACE function outputs trace information for the COBOL statements that have been executed up to program abnormal termination.

This section describes how to use the TRACE function.

5.3.1 Flow of Debugging

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

Figure 5.2 Flow of debugging with TRACE function


COBOL source program
Modification
Compilation and Linkage
Specify compiler option TRACE.
Executable program
Execution
When changing the number of trace information items specified at compile time, specify execution time option r.
Abnormal termination
Trace information
COBOL statements that were executed and COBOL messages that were output during execution time are output.
Debugging
By checking trace information, the statement that terminated abnormally and the process up to abnormal termination can be ascertained.

5.3.2 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 also be suppressed by specifying execution time option nor. Refer to "Format of Runtime Options" in the "NetCOBOL User's Guide" for the detail.

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 for 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 :

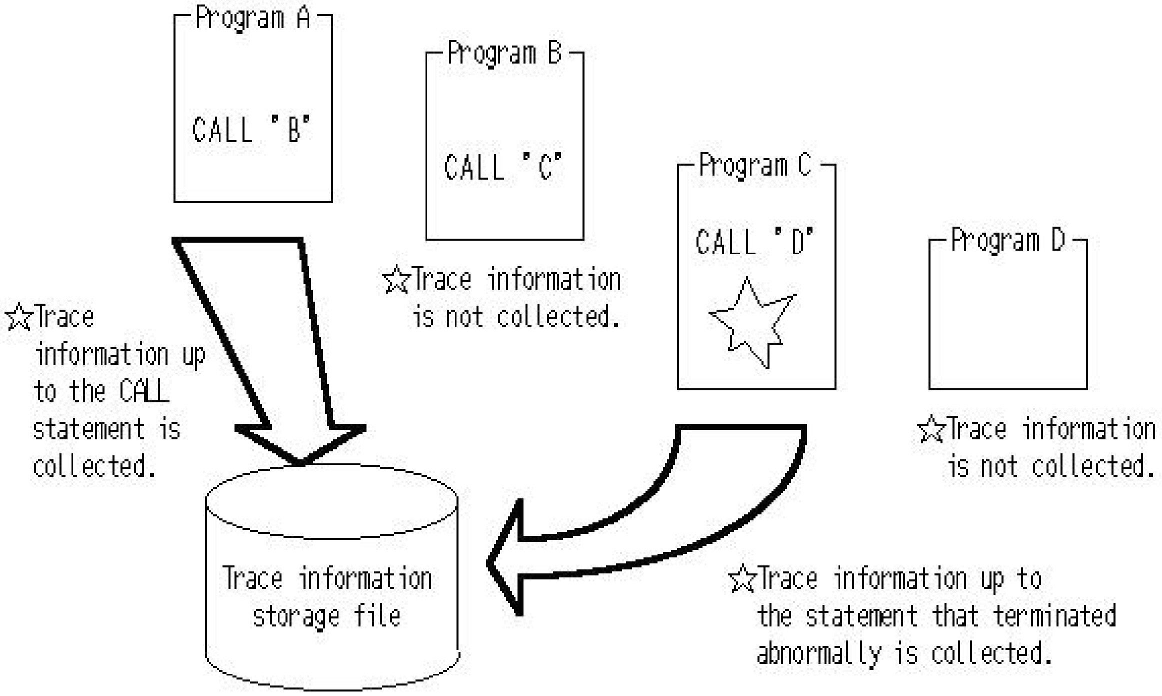
```
SAMPLE-00000EC4_20100112_104850.TRO
```

5.3.3 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 5.3 Collecting TRACE information



☆Trace information up to the CALL statement is collected.

☆Trace information is not collected.

☆Trace information is not collected.

☆Trace information up to the statement that terminated abnormally is collected.

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 Debug function of NetCOBOL Studio or the COBOL debugger.

- 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.

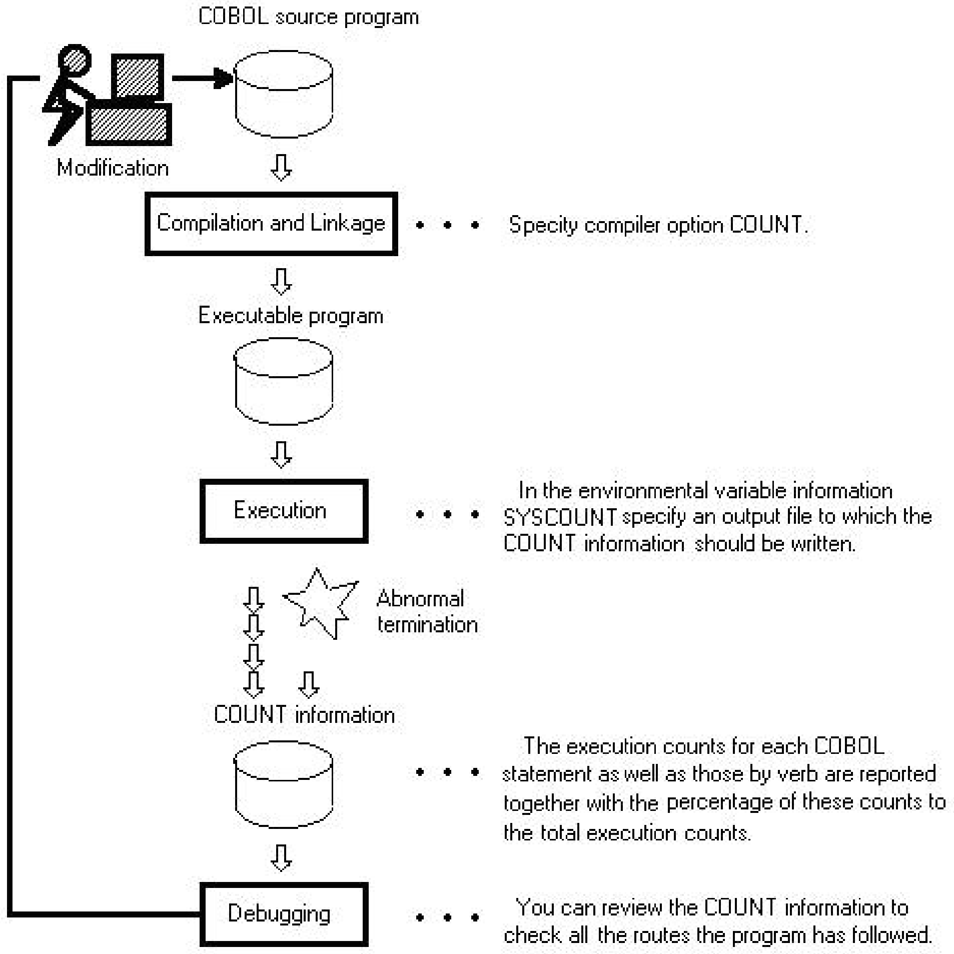
5.4 Using the COUNT function

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.

5.4.1 Flow of Debugging

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

Figure 5.4 Flow of debugging with COUNT function


COBOL source program
Modification
Compilation and Linkage
Specify compiler option COUNT.
Executable program
Execution
In the environmental variable information SYSCOUNT specify an output file to which the COUNT information should be written.
Abnormal termination
COUNT information
The execution counts for each COBOL statement as well as those by verb are reported together with the percentage of these counts to the total execution counts.
Debugging
You can review the COUNT information to check all the routes the program has followed.

5.4.2 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
PROGRAM/CLASS/PROTOTYPE METHOD EXECUTION COUNT
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.

5.4.3 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.

5.4.4 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.

5.5 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".

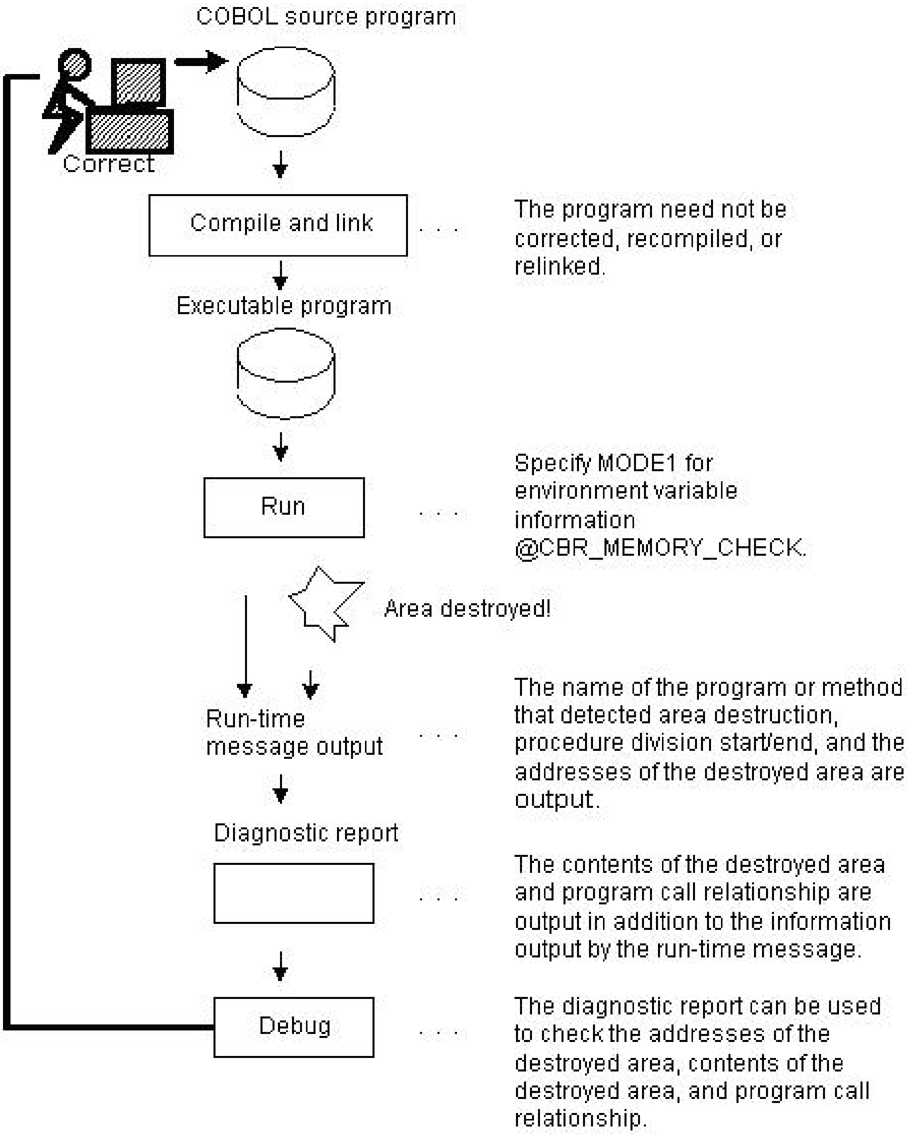
When using the memory check function, specify environment variable information @CBR_MEMORY_CHECK=MODE1.

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

5.5.1 Flow of Debugging

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

Figure 5.5 Flow of debugging with memory check function



COBOL source program
Correct
Compile and link
The program need not be corrected, recompiled, or relinked.
Executable program
Run
Specify MODE1 for environment variable information @CBR_MEMORY_CHECK.
Area destroyed!
Run-time message output
The name of the program or method that detected area destruction, procedure division start/end, and the addresses of the destroyed area are output.
Diagnostic report
The contents of the destroyed area and program call relationship are output in addition to the information output by the run-time message.
Debug
The diagnostic report can be used to check the addresses of the destroyed area, contents of the destroyed area, and program call relationship.

5.5.2 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.

5.5.3 Diagnostic report

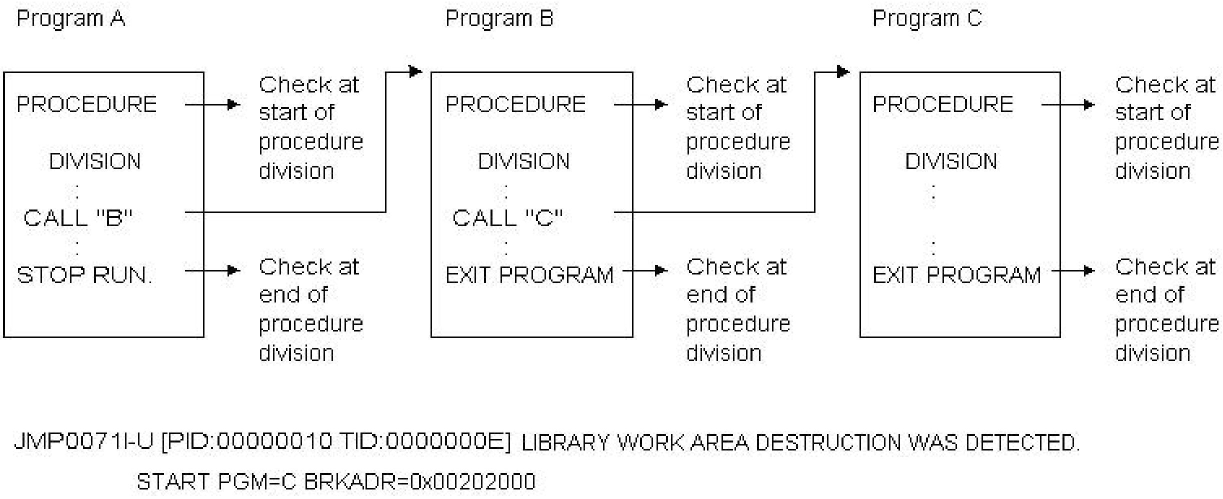
The following is an example of a diagnostic report output when the memory check function detects area destruction. The diagnostic report is output by the COBOL Error Report of the NetCOBOL debugging functions. Refer to "5.6 Using the COBOL Error Report" for details about the COBOL Error Report and how to read the output information of the diagnostic report.

```
NetCOBOL COBOL ERROR REPORT

<<Summary>>
The COBOL runtime message occurred:
Application       : D:\APL\EXDTM.EXE(PID=000000B2)
Exception Number  : JMP0071I-U [PID:000000B2 TID:00000085] LIBRARY WORK AREA DESTRUCTION WAS
DETECTED. START PGM=EXDTS BRKADR=0x00DC1198.
Generation Time   : MM/DD/YYYY(HH:MM:SS)
Generation Module : D:\APL\EXDTS.DLL
Time Stamp        : MM/DD/YYYY(HH:MM:SS)
File Size         : 26524bytes

<<Destroyed Area>>
Location : 00DC1198
Contents : Address  +0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +a +b +c +d +e +f
           00DC1198 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 AAAAAAAAAAAAAAAA
           00DC11A8 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 AAAAAAAAAAAAAAAA
           00DC11B8 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 AAAAAAAAAAAAAAAA
           00DC11C8 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 AAAAAAAAAAAAAAAA
           00DC11D8 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 AAAAAAAAAAAAAAAA
           00DC11D8 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 AAAAAAAAAAAAAAAA
           00DC11F8 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
           00DC1208 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
           00DC1218 11 00 11 00 00 01 08 00 54 4D 45 4D 00 00 00 00 ........TMEM....
           00DC1228 80 00 00 00 98 11 DC 00 A8 12 DC 00 46 00 00 00 ............F...
           00DC1238 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
           00DC1248 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
           00DC1258 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
           00DC1268 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
           00DC1278 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
           00DC1288 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................

<<Detail>>
Thread ID    : 00000085
Register     : EAX=0012E27C  EBX=1C03F3C8  ECX=00000000  EDX=00000000  ESI=0000005F
             : EDI=0013AAF0  EIP=77EED7A2  ESP=0012E278  EBP=0012E2CC  EFL=00000246
             : CS=001B  SS=0023  DS=0023  ES=0023  FS=0038  GS=0000
Stack Commit : 00004000 (Top:00130000, Base:0012C000)
Instruction  : Address  +0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +a +b +c +d +e +f
               77EED792 45 C0 00 00 00 00 8D 45 B0 50 FF 15 C0 D3 F0 77
       FAULT ->77EED7A2 5E 8B E5 5D C2 10 00 A1 18 64 F1 77 8B 4C 24 04

Module File : D:\APL\EXDTS.DLL
Section Relative Position : .text+000000FF
Export Relative Position : EXDTS+000000CB



Symbol Relative Position : EXDTS+000000FF
Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
External Program/Class : EXDTS
Source File : Exdts.cob
Source Line : IN ENTRY-CODE

<Call Stack>
[  1]--------------------------------------------------------------------------------

Omitted hereafter
```

5.5.4 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:



Program A
PROCEDURE
DIVISION
:
CALL "B"
:
STOP RUN.
Check at start of procedure division
Check at end of procedure division
Program B
PROCEDURE
DIVISION
:
CALL "C"
:
EXIT PROGRAM
Check at start of procedure division
Check at end of procedure division
Program C
PROCEDURE
DIVISION
:
:
EXIT PROGRAM
Check at start of procedure division
Check at end of procedure division

```
JMP0071I-U [PID:00000010 TID:0000000E] LIBRARY WORK AREA DESTRUCTION WAS DETECTED.
           START PGM=C BRKADR=0x00202000
```

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.

5.5.5 Identifying destroyed locations

The area destruction watch function of the COBOL Error Report is used to identify destroyed locations. To output the diagnostic report for identifying a destroyed location, set the leading address of the destroyed area into the @CBR_ATTACH_TOOL environment variable before starting the COBOL Error Report.

Specifying method

The following describes how to specify the destroyed addresses in the COBOL Error Report.

As an example, assume that the memory check function is enabled and the following message output:

```
JMP0071I-U [PID:00000010 TID:0000000E] LIBRARY WORK AREA DESTRUCTION WAS DETECTED.
           START PGM=A BRKADR=0x00202020
```

1. Before starting the COBOL application, specify environment variable information @CBR_ATTACH_TOOL, as follows. Refer to "5.6.3.1 Starting the COBOL Error Report for applications that generate application errors and U-level runtime messages".

   @CBR_MEMORY_CHECK need not be disabled.

   ```
   @CBR_ATTACH_T00L=SNAP -w 0x00202020
   ```

   For the destroyed area address to be specified after the -w option, specify the address of "BRKADR=destroyed-address" in the message reported by the memory check function.

2. Start the COBOL application. The diagnostic report that watches for area destruction will be output after the COBOL application ends. Refer to "5.6.4.3.4 Area destruction watch" for the format and how to read the output diagnostic report.

5.5.6 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). In addition, disable the area destruction watch function of the COBOL Error Report (environment variable information @CBR_ATTACH_TOOL).

5.6 Using the COBOL Error Report

This section begins by providing preliminary information about the COBOL Error Report and proceeds to explain how to run the function and how to use the report file generated by it to aid in troubleshooting.

5.6.1 COBOL Error Report overview

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

- Application errors and 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.

- No response

  The COBOL Error Report outputs information such as the program being executed, program calling relationship, and thread state so that the location that did not respond can be identified. The COBOL Error Report uses COBOL language-level information to output the information.

- Area destruction

  The COBOL Error Report watches for writing to specific areas. Each time the area is written to, the COBOL Error Report outputs the written contents and the location to the diagnostic report. This diagnostic report can then be used to easily identify the program that caused area destruction.

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.
- The COBOL Error Report can output the COBOL language-level information when the debugging information file made with COBOL compiler exists.
- The COBOL Error Report works in conjunction with the higher-level tool PowerCOBOL. On a system with PowerCOBOL installed, information about PowerCOBOL can be reported in a PowerCOBOL language format. For more information on linking with PowerCOBOL, refer to the "PowerCOBOL User's Guide".

5.6.2 Resources used by the COBOL Error Report

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

5.6.2.1 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

(Only those programs that run during the lifetime of the COBOL runtime environment, from opening to closing.)

Since the COBOL Error Report maintains user resource compatibility, you can use it without having to recompile and relink old resources.

5.6.2.2 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 5.3 Relationships between COBOL programs and output information".

Table 5.3 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	No	Yes	No	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 "5.6.4.2.1 For application errors, runtime messages, and no response".

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 (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 5.3 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 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 5.3 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 5.3 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 "PRINT (Whether compiler listing should be output and the output destination specification)" 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
(1) -> 00000000 31                   db      0x31
       00000001 08                   db      0x08
       00000002 53414D50444C4C32     dc      "SAMPDLL2"
       0000000A 08                   db      0x08
       0000000B 4E6574434F424F4C     dc      "NetCOBOL"
       00000013 07                   db      0x07
       00000014 XXXXXXXXXXXX         dc      "XXXXXX"
       0000001B XXXXXXXXXXXXXXXX     dc      "XXXXXXXX"
       00000023 XXXXXXXXXXXXXXXX     dc      "XXXXXXXX"
       0000002B 2B30303030           dc      "+0000"
       00000030 2031                 dc      " 1"
       00000032 0000                 dc      0x0000
       00000034                 PROLOGUEAD:
       00000034 XXXXXXXX             db      0xXXXXXXXX : PLB.1
(2) -> 00000038                 _SAMPDLL2:
       00000038 55                   push    ebp
       00000039 8BEC                 mov     ebp,esp
       0000003B 81ECB0000000         sub     esp,000000B0
       00000041 8BD7                 mov     edx,edi
       00000043 8BFD                 mov     edi,ebp
       00000045 81EF54000000         sub     edi,00000054
          :
```

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.

5.6.2.3 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 interactive debugger.

Please do not specify compiler option /Oy when you compile the C/C++ source programs. Information necessary for the investigation from <Call Stack> or <Stack Summary> of the diagnostic report is not obtained when compiler option /Oy is specified. Please note that compiler option /Oy might be enabled by specifying compiler option /Ox (full optimization), /O1 (optimization of the program size), and /O2 (optimization of the execution speed).

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

```
/DEBUG
```

Specify the linkage option /DEBUG to link object files of COBOL and non-COBOL programs. When these options are specified, the linker directs the information generated by the compiler in the object file to an executable file or dynamic link library file.

To link the object file of the COBOL Error Report, specify the linkage option /DEBUG.

The object program of the COBOL Error Report can be easily made by using the project management function. For more information, refer to "Creating a Debug Module" in the "NetCOBOL User's Guide".

When it is necessary to debug programs which link with the non-COBOL programs by using Visual C++, specify the linkage option /DEBUG. For details about other language products, refer to the manuals for those products.

Information

Given an object program listing and a symbol name relative offset, problems can be easily located. The specification of the linkage option /DEBUG is recommended for this purpose.

5.6.2.4 Location of the debugging information file (.SVD)

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

Store the debugging information 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 does not exist, the COBOL Error Report outputs the assembler-level information composed of export name, symbol name and offset. Refer to "5.6.2.2 Relationships between compiler and linkage options and output information" for output information on the COBOL Error Report.

5.6.3 Starting the COBOL Error Report

5.6.3.1 Starting the COBOL Error Report for applications that generate application errors and U-level runtime messages

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 debugger or the COBOL Error Report at abnormal termination)" in the "NetCOBOL User's Guide."

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
```

5.6.3.2 Starting the COBOL Error Report for applications that do not respond

To start the COBOL Error Report for applications that do not respond, start the COBOL Error Report manually. When starting the COBOL Error Report, the process ID of the application to be diagnosed must be specified in start parameter -p. Refer to "5.6.3.4 Start parameters".

To obtain the application process IDs, enter the following at the command prompt:

```
COBSNAP
```

When the command is run, a listing of the process IDs and applications will be displayed as shown below. The process IDs appear in hexadecimal. The application names are file names only.

```
PID      Application

    0  [System Process]
    4  System
  3F0  smss.exe
  430  csrss.exe
  448  winlogon.exe
  474  services.exe
  480  lsass.exe
  52C  testpgm.exe
           :
```

Search the list for the name of the application that does not respond to obtain its process ID.

The specification format for starting the COBOL Error Report for applications that do not respond is shown below.

Example

```
COBSNAP -p 0x52C
```

5.6.3.3 Starting the COBOL Error Report for applications that cause area destruction

To start the COBOL Error Report for an application that causes area destruction, specify starting of the COBOL Error Report in environment variable information @CBR_ATTACH_TOOL. The address of the area to be watched must be specified using the start parameter -w. . For the watch area address, specify the address of the destroyed area reported by the memory check function of the runtime system.

The specification format for starting the COBOL Error Report for applications that cause area destruction is shown below:

Example

```
@CBR_ATTACH_TOOL=SNAP -w 0xDC1198
```

For details about the format of environment variable @CBR_ATTACH_TOOL, refer to "@CBR_ATTACH_TOOL (Invoke debugger or COBOL Error Report from application)" in the "NetCOBOL User's Guide". For details about the check function, refer to "5.5 Using the Memory Check Function".

Note

If environment variable @CBR_JUSTINTIME_DEBUG has been set, delete the setting before starting the COBOL Error Report.

5.6.3.4 Start parameters

"Table 5.4 Start parameters" lists the start parameters of the COBOL Error Report. Where the start parameters are specified depends on the method used to start the COBOL Error Report.

a. Starting the COBOL Error Report for applications that generate application errors and U-level runtime messages with the start parameters in environment variable @CBR_JUSTINTIME_DEBUG.

b. Starting the COBOL Error Report for applications that do not respond, specifying the start parameters in the COBSNAP command.

c. Starting the COBOL Error Report for applications that cause area destruction, specifying the start parameters in environment variable @CBR_ATTACH_TOOL.

In "Table 5.4 Start parameters" a circle indicates that the listed start parameter is valid for the method, a, b, or c above.

Table 5.4 Start parameters

Specification format	a	b	c	Description
-d {YES | NO}	Yes	-	-	Specifies whether to output the dump. YES : Output the dump. NO : Do not output the dump. Omitting this start parameter defaults to YES.
-i {0 | 1 | 2}	Yes	Yes	-	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	Yes	-	-	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.

Specification format	a	b	c	Description
				If the specified folder does not exist and output is not possible, the dump file is output to the standard output destination folder. If this start parameter is omitted, the dump file is output to the standard output destination folder. Refer to "5.6.5.2 Dump output destination" for information concerning the standard output destination folder.
-r folder-name	Yes	Yes	Yes	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 "5.6.4.1 Diagnostic report output destination" for information concerning the standard output destination folder.
-l [computer-name]	Yes	-	-	Specifies that the occurrence of each application error or runtime message be written to an event log file. If computer-name is specified, the occurrence of each application error or runtime message is written to the event log file of the named computer. If computer-name is not specified, the occurrence of each application error or runtime message is written to the event log file of the computer on which the problem has occurred.
-t parameter-count	Yes	Yes	-	Specifies the number of parameters output to the stack summary. The number of parameters must be used from 1 to 16. Omitting this start parameter defaults to 8.
-s output-unit-count	Yes	Yes	-	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.
-p process-ID	-	Yes	-	Specifies the process ID of the application that does not respond. Specify the process ID as a hexadecimal value beginning with 0x.
-w address [,length]	-	-	Yes	Specifies the address and length of the area to be watched. Specify the address as a hexadecimal value beginning with 0x. Specify 4, 8, 12, or 16 as the length. Omitting the length defaults to 4.

* : 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 character string that follows the parameter name.
- 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 (").
- When the length is specified in start parameter -w, specify the address and length without inserting a space before or after the comma.

Information

If the start parameters -m and -l are 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.

5.6.4 Diagnostic Report

5.6.4.1 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 "5.6.3.4 Start parameters" 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 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 5.5 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 "5.6.3.4 Start parameters".

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.

5.6.4.2 Diagnostic report output information

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

5.6.4.2.1 For application errors, runtime messages, and no response

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:
or
Diagnosed an application with no response:
```

- 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 5.6 Exception codes and exception names". When a runtime message occurs, its body is generated. No information is generated for an application that does not respond.

- Generation time

  When an application error or runtime message occurs, the date and time when the error occurred is generated. For no response, the date and time when the COBOL Error Report was started is generated.

- Generation module

  When an application error or runtime message occurs, the name of the module in which the error occurred (absolute path name), its creation time, and file size are generated. No information is generated for an application that does not respond.

Detail

When an application error or runtime message occurs, the location at which the error occurred is generated. No information is generated for an application that does not respond.

- 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 module has COFF symbol information, 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, this information is not generated.

- Source file

  The name of the source file of the program that caused the error is generated.

- Source line

  The line number of the statement that caused the error is 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

STACK/HEAP information

The size of the stack and heap (hexadecimal) specified at executable file linkage time

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

For a parameter, the memory contents of the location (frame pointer + 8 bytes) where the parameter is stored on the stack are listed.

Stack dump

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

Thread information

When an application error or runtime message occurs, the items of information listed below are generated with regard to the threads other than the thread in which the error occurred. For an application that does not respond, these items of information are generated for each thread that has been created by the application.

- 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 5.6 Exception codes and exception names".

Table 5.6 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.

Code	Exception name Explanation
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 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 "5.2 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 5.7 Compiler options and output formats".

Table 5.7 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		
	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)
  ```

5.6.4.2.2 For area destruction watch

Summary

A summary of the diagnostic information

- Event detected

  A diagnostic report always begins with the following line:

  ```
  Watched the writing of an area:
  ```

- Application

  The name of the application (absolute path name) and process ID (hexadecimal)

- Starting time

  The date and time when the COBOL Error Report started

- Watch address

  The address (hexadecimal) of the watch area

- Watch size

  The size (decimal) of the watch area

Write information items

The locations in the watch area where writing occurred and the contents of the area after writing are listed in the order writing occurred. If writing to the watch area did not occur, information indicating this is generated in the diagnostic report.

- Counter

  Incremented each time information is output. These values can be used to identify the order of writing.

- Watch area

  The watch area contents in hexadecimal notation are generated.

- Write location

  The location of writing

  - Thread ID
  - Module file
  - Section relative position
  - Export relative position
  - Symbol relative position
  - Compilation information
  - Program name
  - Source file
  - Source line
  - Call stack

If an application error or runtime message occurs during an area destruction watch, the following information will be added to the diagnostic report:

Error information

Information related to the application error or runtime message

- Counter

  Values incremented each time information is output

- Error summary

  Detected event and error code

- Problem location

  Location where 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

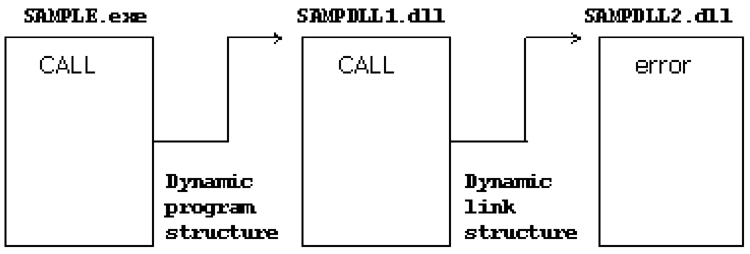
5.6.4.3 How to read diagnostic reports

This section explains how to troubleshoot using diagnostic reports generated by the COBOL Error Report, with reference to examples.

5.6.4.3.1 Application error

An example of a diagnostic report generated to report an application error is shown below.

The program used by the example is composed of the following program.



- When compiling, compiler option TEST is specified.
- When Linking, linkage options /DEBUG and /DEBUGTYPE:COFF are specified.
- The debugging information file exists in same folder as executable file and dynamic link library.

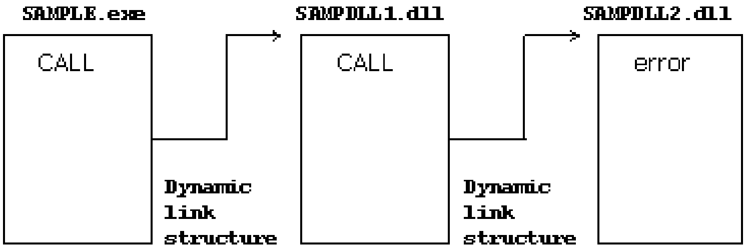
```
NetCOBOL COBOL ERROR REPORT

<<Summary>>
The application error occurred:
  Application        : D:\APL\SAMPLE.exe(PID=000000A7)
  Exception Number   : EXCEPTION_INT_DIVIDE_BY_ZERO(C0000094)
  Generation Time    : MM/DD/YYYY(HH:MM:SS)
  Generation Module  : D:\APL\SAMPDLL2.dll
  Time Stamp         : MM/DD/YYYY(HH:MM:SS)
  File Size          : 30720bytes

<<Detail>>
  Thread ID    : 0000005E
  Register     : EAX=00000000 EBX=7FFDF065 ECX=00000000 EDX=00000000 ESI=001421A6
               : EDI=00405108 EIP=03BB125D ESP=0012FCD8 EBP=0012FD98 EFL=00010256
               : CS=001B  SS=0023  DS=0023  ES=0023  FS=0038  GS=0000
  Stack Commit : 00004000 (Top:00130000, Base:0012C000)
  Instruction  : Address  +0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +a +b +c +d +e +f
                 03BB124D 03 0F BF 05 32 50 BB 03 99 0F BF 0D 2A 50 BB 03
         FAULT ->03BB125D F7 F9 0F BF C8 83 F9 00 7D 02 F7 D9 0F C9 C1 E9

  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

<Call Stack>
[ 1]--------------------------------------------------------------------
  Module File : D:\APL\SAMPDLL1.dll
  Section Relative Position : .text+0000026B
  Export Relative Position : SAMPDLL1+00000237
  Symbol Relative Position : SAMPDLL1+0000026B
  Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
  External Program/Class : SAMPDLL1
  Source File : SAMPDLL1.cob
  Source Line : 14
[ 2]--------------------------------------------------------------------
  Module File : D:\APL\SAMPLE.exe
  Section Relative Position : .text+0000047A
  Symbol Relative Position : SAMPLE+0000047A
  Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
  External Program/Class : SAMPLE
  Source File : SAMPLE.cob
  Source Line : 24
[ 3]--------------------------------------------------------------------
  Module File : D:\APL\SAMPLE.exe
  Section Relative Position : .text+0000000A
  Symbol Relative Position : SAMPLE+0000000A
[ 4]--------------------------------------------------------------------
  Module File : D:\APL\SAMPLE.exe
  Section Relative Position : .text+00000BEB
  Symbol Relative Position : _WinMainCRTStartup+0000014B
[ 5]--------------------------------------------------------------------
  Module File : C:\WINDOWS\System32\KERNEL32.dll
  Section Relative Position : .text+0001A623
  Export Relative Position : RegisterWaitForInputIdle+00000117
Omitted hereafter
```

1. Note <<Summary>>. Reports which application error has occurred and in which module.
   This example shows that a division by 0 exception has occurred in D:\APL\SAMPDLL2.DLL.
2. Then view <<Detail>>. Reports in which compilation unit the error has occurred.
   This example shows that an error has occurred on line 35 in the program SAMPDLL2.
3. Identify in which statement (instruction) the error occurred from the source file of the affected program or from the object program listing.
   This example assumes that the error has occurred in the COMPUTE statement on line 35.
4. Further, the calling path up to the error-affected program indicates the program calling relationship.
   In this example, the program SAMPDLL2 has been called from the program SAMPDLL1 in the module SAMPDLL1.DLL and SAMPDLL1 has been called from the program SAMPLE in the module SAMPLE.EXE.
5. Run the interactive debugger to collect detailed information about the error. Proceed with debugging by rebuilding the error-affected program and, if necessary, programs appearing in the calling path.

5.6.4.3.2 Runtime message

An example of a diagnostic report generated to report a runtime message is shown below.

The program used by the example is composed of the following program.



- When compiling, compiler option TEST is specified.
- When Linking, linkage options /DEBUG and /DEBUGTYPE:COFF are specified.
- The debugging information file exists in same folder as executable file and dynamic link library.

```
NetCOBOL COBOL ERROR REPORT

<<Summary>>
The COBOL runtime message occurred:
  Application       : D:\APL\SAMPLE.exe(PID=000000BB)
  Exception Number  : JMP0311I-U [PID:00000CB4 TID:0000034C] MISSING ALLOCATION. FILE=SYS001.
PGM=SAMPDLL2 LINE=31
  Generation Time   : MM/DD/YYYY(HH:MM:SS)
  Generation Module : D:\APL\SAMPDLL2.dll
  Time Stamp        : MM/DD/YYYY(HH:MM:SS)
  File Size         : 66336bytes

<<Detail>>
  Thread ID    : 0000034C
  Register     : EAX=0012E238 EBX=1C044B18 ECX=E9999999 EDX=00050001 ESI=00000000
               : EDI=00161EEC EIP=7C812A5B ESP=0012E234 EBP=0012E288 EFL=00000246
               : CS=001B  SS=0023  DS=0023  ES=0023  FD=0038  GS=0000
  Stack Commit : 00005000 (Top:00130000, Base:0012B000)
  Instruction  : Address  +0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +a +b +c +d +e +f
                 7C812A4B 8D 7D C4 F3 A5 5F 8D 45 B0 50 FF 15 08 15 80 7C
         FAULT ->7C812A5B 5E C9 C2 10 00 85 FF 0F 8E 36 93 FF FF 8B 55 FC

  Module File : D:\APL\SAMPDLL2.dll
  Section Relative Position : .text+0000029A
  Export Relative Position : SAMPDLL2+00000262
  Symbol Relative Position : SAMPDLL2+0000029A
  Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
  External Program/Class : SAMPDLL2
  Source File : SAMPDLL2.cob
  Source Line : 31

<Call Stack>
[ 1]----------------------------------------------------------------------
  Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BKATCH.dll
  Section Relative Position : .text+00002A1A
  Export Relative Position : NotifyExecErrorInfo+0000015E
[ 2]----------------------------------------------------------------------
  Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BIPRCT.dll
  Section Relative Position : .text+0000BEF8
  Export Relative Position : JMP1MESS+00000B58
[ 3]----------------------------------------------------------------------
  Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BIIO.dll
  Section Relative Position : .text+000226C7
  Export Relative Position : JMP5IOER+00000E97
[ 4]----------------------------------------------------------------------
  Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BIIO.dll
  Section Relative Position : .text+00002C71
  Export Relative Position : JMP5VSEQ+00002C71
[ 5]----------------------------------------------------------------------
  Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BIIO.dll
  Section Relative Position : .text+00000622
  Export Relative Position : JMP5VSEQ+00000622
[ 6]----------------------------------------------------------------------
  Module File : D:\APL\SAMPDLL2.dll
  Section Relative position : .text+00000298
  Export Relative position : JMP5VSEQ+00000298
[ 7]----------------------------------------------------------------------
  Module File: D:\APL\SAMPDLL2.dll
  Section Relative Position : .text+0000029E
  Export Relative Position : SAMPDLL2+00000266
  Symbol Relative Position : SAMPDLL2+0000029E
  Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
  External Program/Class : SAMPDLL2
  Source File : SAMPDLL2.cob
  Source Line : 31
[ 8]----------------------------------------------------------------------
  Module File: D:\APL\SAMPLE.exe
  Section Relative Position : .text+00000823
  Symbol Relative Position : SAMPLE+00000823
  Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
  External Program/Class : SAMPLE
  Source File : SAMPLE.cob
  Source Line : 33
[ 9]----------------------------------------------------------------------
  Module File : D:\APL\SAMPLE.exe
  Section Relative Position : .text+0000000A
  Export Relative Position : SAMPLE+0000000A
[10]----------------------------------------------------------------------
  Module File : D:\APL\SAMPLE.exe
  Section Relative Position : .text+00000B6A
  Symbol Relative Position : _WinMainCRTStartup+000000CE
[11]----------------------------------------------------------------------
  Module File : C:\Windows\System32\KERNEL32.dll
  Section Relative Position : .text+00015FD7
  Export Relative Position : RegisterWaitForInputIdle+00000049

<<System Information>>
  Computer Name   : MACHINE01
  User Name       : user01
  Windows Version : Microsoft Windows xx
  Version Number  : x.x.xxxx
  Service Pack    : Service Pack x

<<Command Line>>
  "D:\APL\SAMPLE.exe"

<<Environment Variable>>
  @WinCloseMsg=OFF
  @CnsWinSize=(80,24)
  @CBR_ENTRYFILE=ENTRY.DAT
  COMPUTERNAME=MACHINE01
  ComSpec=C:\Windows\system32\cmd.exe
  HOMEDRIVE=C:
  HOMEPATH=\users\default

  LOGONSERVER=\\WORK01
  LIB=C:\Program Files\Fujitsu NetCOBOL for Windows
  NUMBER_OF_PROCESSORS=1
  OS=Windows_xx
  Path=C:\Program Files\Fujitsu NetCOBOL for Windows;C:\Windows\system32;C:Windows;
  PROCESSOR_ARCHITECTURE=x86
  PROCESSOR_IDENTIFIER=x86 Family 15 Model 2 Stepping 9, GenuineIntel
  PROCESSOR_LEVEL=15
  PROCESSOR_REVISION=0209
  SystemDrive=C:
  SystemRoot=C:\Windows
  TEMP=C:\TEMP
  TMP=C:\TEMP
  USERDOMAIN=WIN-DOMAIN
  USERNAME=user01
  USERPROFILE=C:\Documents and Settings\user01
  windir=C:\Windows

<<Execution Environment Information>>

  Runtime System : Vxx.x.x PRODUCT
  Runtime Mode : ASCII, SINGLE THREAD
  Program Name : SAMPLE

  .CBR File    : D:\APL\COBOL85.CBR
    @WinCloseMsg=OFF
    @CnsWinSize=(80,24)
    [EOF]

  @CBR_ENTRYFILE : D:\APL\ENTRY.DAT
    [ENTRY]
    SAMPDLL1=SAMPDLL1.DLL
    SAMPDLL2=SAMPDLL2.DLL
    SAMPDLL3=SAMPDLL3.DLL
    [EOF]
Omitted hereafter
```

1. Note <<Summary>>. Reports which runtime message has occurred and in which module.
   This example shows that the runtime message JMP0311I-U has occurred in D:\APL\SAMPDLL2.DLL.

2. Then view <<Detail>>. It tells in which compilation unit the error has occurred.
   This example shows that an error has occurred on line 31 in the program SAMPDLL2.

3. Identify in which statement (instruction) the error has occurred from the source file of the affected program or from the object program listing.
   This example assumes that the error has occurred in the OPEN statement on line 31.
   Because the information in the initial file is reflected in the environment variables, the file identifier, logical destination definition

file, print information file, and so forth, can be identified from the <<Environment Variable>>. Entry information is not reflected in the environment variables. View the contents of the initial file and the entry information file included in the <<Execution Environment Information>> instead.
In this example, check the settings of the environment variables to identify the error of no file being assigned to SYSIN.

4. Run the interactive debugger as needed to collect detailed information about the error.

Note

The <Call Stack> indicated in the <<Detail>> in a runtime message differs from that in an application error. In the case of an application error, the calling path begins with the program that calls the error-affected program directly. The calling path for a runtime message, on the other hand, starts with the runtime system program. In the example, the error-affected program is SAMPDLL2, and the seventh and subsequent items of information in the <Call Stack> represent the calling relationship of the error-affected program.

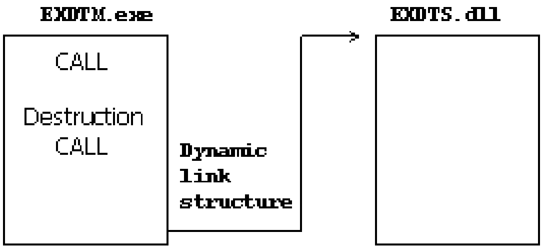
5.6.4.3.3 No response

1. Note <<Thread Information>>. It provides information on all threads in the application.
2. The compilation unit in which the application has paused for each thread can be seen.
3. Identify in which statement (instruction) the application has paused from the source file of the program or from the object program listing.
4. Locate roughly the position that did not respond from the source file or the object program listing.
5. Run the interactive debugger to collect detailed information.

5.6.4.3.4 Area destruction watch

The following is an example diagnostic report generated when watching for area destruction.

The program used in the example consists of the following programs:



- When compiling, compiler option TEST is specified.
- When Linking, linkage options /DEBUG and /DEBUGTYPE:COFF are specified.
- The debugging information file exists in same folder as executable file and dynamic link library.
- A statement of program EXDTM destroys the EXTERNAL data.

```
NetCOBOL COBOL ERROR REPORT

<<Summary>>
Watched the writing of an area:
Application   : D:\APL\EXDTM.EXE(PID=000000BE)
Start Time    : MM/DD/YYYY(HH:MM:SS)
Watch Address : 00DC1198
Watch Size    : 4bytes

<<1>>===============================================================================
Watch Area : +0 +1 +2 +3
             B8 00 DC 00
Thread ID : 00000070
Module File : C:\Windows\System32\ntdll.dll
```

```
Section Relative Position : .text+00003A44
Export Relative Position : RtlAllocateHeap+000003C2

<Call Stack>
[  1]---------------------------------------------------------------------------
Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BIPRCT.dll
Section Relative Position : .text+0002CB05
Export Relative Position : JMP1TMEM+00000295
[  2]---------------------------------------------------------------------------
Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BIPRCT.dll
Section Relative Position : .text+0002298D
Export Relative Position : JMP1EXDT+000005AD
[  3]---------------------------------------------------------------------------
Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BIPRCT.dll
Section Relative Position : .text+0002265A
Export Relative Position : JMP1EXDT+0000027A
[  4]---------------------------------------------------------------------------
Module File : D:\APL\EXDTM.EXE

Section Relative Position : .text+00000162
Symbol Relative Position : EXDTM+00000162
Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
External Program/Class : EXDTM
Source File : Exdtm.cob
Source Line : IN ENTRY-CODE
[  5]---------------------------------------------------------------------------
Module File : D:\APL\EXDTM.EXE
Section Relative Position : .text+0000000A
Symbol Relative Position : EXDTM+0000000A
[  6]---------------------------------------------------------------------------
Module File : D:\APL\EXDTM.EXE
Section Relative Position : .text+0000055C
Symbol Relative Position : _WinMainCRTStartup+000000CE
[  7]---------------------------------------------------------------------------
Module File : C:\Windows\System32\KERNEL32.dll
Section Relative Position : .text+0001AD15
Symbol Relative Position : GetProcessPriorityBoost+00000117

<<2>>===========================================================================
Watch Area : +0 +1 +2 +3
             00 00 00 00
Thread ID : 00000070
Module File : C:\Windows\System32\ntdll.dll
Section Relative Position : .text+00003C85
Export Relative Position : RtlAllocateHeap+00000603

<Call Stack>
[  1]---------------------------------------------------------------------------
Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BIPRCT.dll
SectionRelativePosition:.text+0002CB05
Export Relative Position : JMP1TMEM+00000295
[  2]---------------------------------------------------------------------------
Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BIPRCT.dll
Section Relative Position : .text+0002298D
Export Relative Position : JMP1EXDT+000005AD
[  3]---------------------------------------------------------------------------
Module File : c:\Program Files\Fujitsu NetCOBOL for Windows\F3BIPRCT.dll
Section Relative Position : .text+0002265A
Export Relative Position : JMP1EXDT+0000027A
[  4]---------------------------------------------------------------------------
Module File : D:\APL\EXDTS.DLL
Section Relative Position : .text+00000152
Export Relative Position : EXDTS+0000011E
```

```
Symbol Relative Position : EXDTS+00000152
Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
External Program/Class : EXDTS
Source File : Exdts.cob
Source Line : IN ENTRY-CODE


[  5]--------------------------------------------------------------------------
Module File : D:\APL\EXDTM.EXE
Section Relative Position : .text+00000238
Symbol Relative Position : EXDTM+00000238
Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
External Program/Class : EXDTM
Source File : Exdtm.cob
Source Line : 16
[  6]--------------------------------------------------------------------------
Module File : D:\APL\EXDTM.EXE
Section Relative Position : .text+0000000A
Symbol Relative Position : EXDTM+0000000A
[  7]--------------------------------------------------------------------------
Module File : D:\APL\EXDTM.EXE
Section Relative Position : .text+0000055C
Symbol Relative Position : _WinMainCRTStartup+000000CE
[  8]--------------------------------------------------------------------------
Module File : C:\Windows\System32\KERNEL32.dll
Section Relative Position : .text+0001AD15
Export Relative Position : IsProcessorFeaturePresent+00000117

<<3>>==========================================================================
Watch Area : +0 +1 +2 +3
             41 41 41 41
Thread ID : 00000070
Module File : D:\APL\EXDTM.EXE
Section Relative Position : .text+0000034E
Symbol Relative Position : EXDTM+0000034E
Compilation Information : ASCII, SINGLE THREAD, NOOPTIMIZE
External Program/Class : EXDTM
Source File : Exdtm.cob
Source Line : 19

<Call Stack>
[  1]--------------------------------------------------------------------------
Module File : D:\APL\EXDTM.EXE
Section Relative Position : .text+0000000A
Symbol Relative Position : EXDTM+0000000A
[  2]--------------------------------------------------------------------------
Module File : D:\APL\EXDTM.EXE
Section Relative Position : .text+0000055C
Symbol Relative Position : _WinMainCRTStartup+000000CE
[  3]--------------------------------------------------------------------------
Module File : C:\Windows\System32\KERNEL32.dll
Section Relative Position : .text+0001AD15
External Program/Class : IsProcessorFeaturePresent+00000117

<<4>>==========================================================================
The COBOL runtime message occurred:
Exception Number : JMP0071I-U [PID:000000B2 TID:00000085] LIBRARY WORK AREA DESTRUCTION WAS DETECTED.
START PGM=EXDTS BRKADR=0x00DC1198.
Thread ID : 00000070

Omitted hereafter
```

1. The watched memory areas are checked sequentially starting from the beginning.
   The contents written to the watch area and the write locations are given.
   Except for when the runtime system writes directly, the COBOL Error Report can generate watch area items for all write operations.
   As a result, watch area information is generated even for write operations using system functions invoked from the runtime system.
   In such cases, the callers of the system functions must be checked from the <Call Stack> to determine whether the system function was invoked from the runtime system or an application program.
   In this example, it is clear that the watch area contents <<1>> and <<2>> have been written using system functions invoked from the runtime system.

2. An invalid write can also be identified when runtime message JMP0071I-U occurs.
   In this example, checking the diagnostic report ("Diagnostic report" of "5.5 Using the Memory Check Function") when runtime message JMP0071I-U occurred shows that the statement indicated by the third watch area item corrupted the area.
   Normally, the watch area information generated immediately before the error information of runtime message JMP0071I-U indicates the program and instructions that corrupted the area.

5.6.5 Dump

5.6.5.1 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 my be 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.

5.6.5.2 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 "5.6.3.4 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 "5.6.3.4 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.

5.6.5.3 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.

5.6.6 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 interactive debugger, PowerCOBOL debugger, 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. To check for application errors that occur in such applications, use the interactive debugger.
- 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.

  - For COBOL programs:

    Items related to the description method for the source file in Chapter 2, "Notes"

  - For PowerCOBOL programs:

    Notes on how to use the library file in "PowerCOBOL User's Guide"

- If a non-COBOL program or system function that does not generate a stack frame is in the calling path of a program, the information items of a program that invokes such a non-COBOL program or system function will not be generated in the <Call Stack> or <Stack Summary> of the diagnostic report. For Visual C++, for example, this applies to a program compiled with the compiler option /Ox, /O1, /O2, or /Oy specified.

- If the stack is corrupted, calling path information in effect up to the moment of the corruption is covered in the diagnostic report along with information indicating that the stack is corrupted.

- After generating a diagnostic report about the application that does not respond, the COBOL Error Report aborts the process. Since the system could behave erratically after the abort, do not start the COBOL Error Report for a successfully running process or for a process that may affect the performance of the Windows system.

- When diagnosing application errors or runtime messages, the COBOL Error Report will not operate until a problem occurs. As a result, the execution speed of an application will not change unless a problem occurs. When watching for area destruction, however, the execution speed of an application will be reduced by 50 to 90 percent. The execution speed is reduced because the application is executed under the COBOL Error Report.

5.7 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 x86)

  This is a debug tool provided by Microsoft.

  Debugging Tools for Windows - native x86 is information published on the Microsoft home page.

- Windows Error Report

  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.)

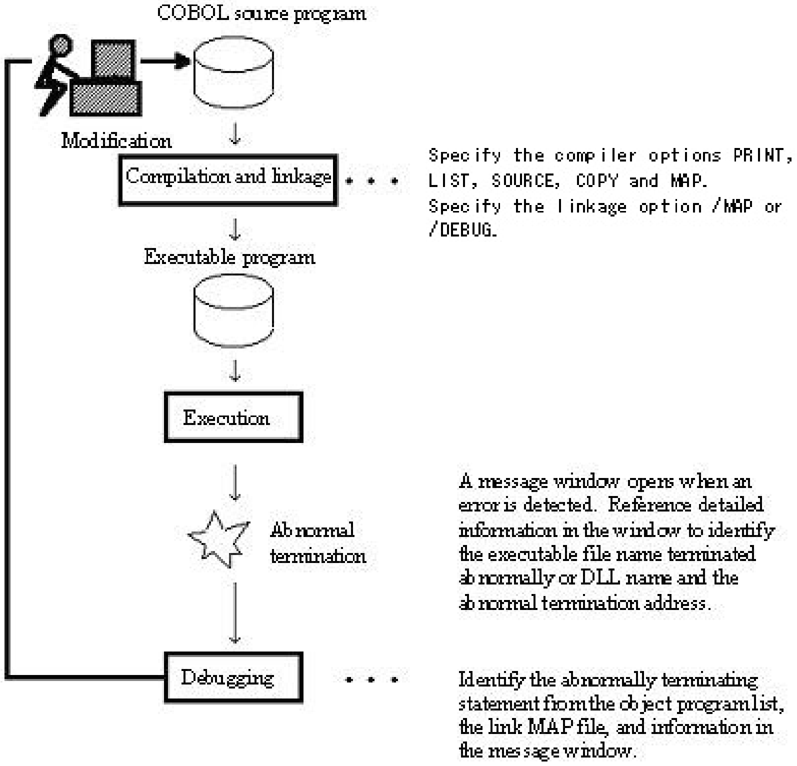
- Clash dump

  Crash dump made by WER (Windows Error Report) function.

5.7.1 Flow of Debugging

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

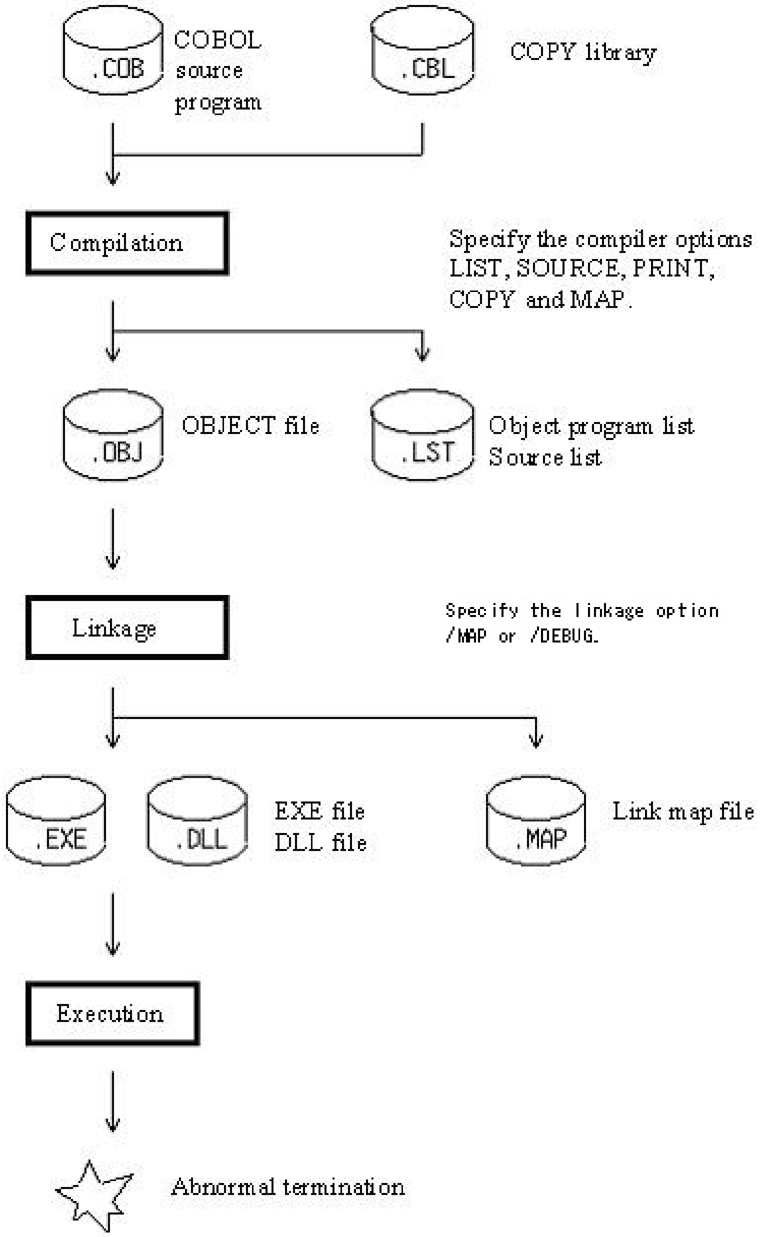
Figure 5.6 Flow of debugging using an Object Program Listing


COBOL source program
Modification
Compilation and linkage
Specify the compiler options PRINT, LIST, SOURCE, COPY and MAP. Specify the linkage option /MAP or /DEBUG.
Executable program
Execution
Abnormal termination
A message window opens when an error is detected. Reference detailed information in the window to identify the executable file name terminated abnormally or DLL name and the abnormal termination address.
Debugging
Identify the abnormally terminating statement from the object program list, the link MAP file, and information in the message window.

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

A file relationship diagram is shown below.

Figure 5.7 A file relationship diagram



Note

- 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 WinDbg 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 "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.

5.7.2 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.

5.7.3 Object Program Listing

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

Object program listing output format

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

```
BEGINNING OF NONDECLARATIVE PROCEDURES
                                                                     [9]
                                                                BBK=00004(01)
                                                                ............LX
                                                                .........PN.PX
   [1]      [2]                        [4]
0000017A 8D05A0000000         lea    eax,%GWA+000000A0
00000180 A39C000000           mov    %GWA+0000009C,eax
00000185 C7059800000000000000 mov    %GWA+00000098,00000000 : OTHAR.1  [6]
0000018F                 GLB.3  [3]
--- 12 ---            MOVE  [5]
0000018F 66A114000000         mov    ax,%COA+00000014 : +10     [8]
00000195 66A3DA000000         mov    %GWA+000000DA,ax : divisor [7]
0000019B A0DB000000           mov    al,%GWA+000000DB : divisor+1
000001A0 240F                 and    al,0F
000001A2 0C30                 or     al,30
000001A4 A2DB000000           mov    %GWA+000000DB,al : divisor+1
--- 13 ---            MOVE
000001A9 66A112000000         mov    ax,%C0A+00000012 : +00
000001AF 66A3DC000000         mov    %GWA+000000DC,ax : dividend
000001B5 A0DD000000           mov    al,%GWA+000000DD : dividend+1
000001BA 240F                 and    al,0F
000001BC 0C30                 or     al,30
000001BE A2DD000000           mov    %GWA+000000DD,al : dividend+1
--- 15 ---            COMPUTE
<REDUNDANT STORE>
<REDUNDANT STORE>
<REDUNDANT STORE>
<REDUNDANT STORE>
--- 17 ---            EXIT PROGRAM
000001C3 EB8D                 jmp    GLB.2
                                                                BBK=00005(00)
                                                                NEVER EXECUTED
                                                                .........PX

END OF A
```

- [1] Offset

  An object relative offset of a statement in machine language.

- [2] Object code in machine language

  The object code of the statement in machine language.

  Note

  With a forward-referencing branch instruction, the machine code area may have been altered.

- [3] Procedure name and procedure number

  Compiler-generated procedure name and procedure number.

- [4] Assembler instruction

  A statement in machine language represented in the Microsoft macro assembler language.

- [5] Verb name and line number

  A verb name and a line number given in the COBOL program.

- [6] Area name

  The name of the area used by the COBOL compiler.

- [7] Defined word written in the COBOL program

  The following defined words and expressions are displayed in the object program listing:

Table 5.8 Defined words displayed in the object program listing

Defined word	Expression in the object program listing
Defined word (alphanumeric)	Defined word (alphanumeric) Example. mov %GWA+00000108,AX :IDX

- [8] Constant written in the COBOL program

  The following constants and expressions are displayed in the object program listing:

Table 5.9 Constants and expressions displayed in the object program listing

Literal	Expression in the object program listing
Numeral	Numeral Example. sub esp,%COA+00000040 : +8
Character (alphanumeric)	Character (alphanumeric) Example. mov ax,%COA+00000012 : “ABCD”
Numeral (internal floating point) Numeral (external floating point) Boolean (internal) Boolean (external)	None displayed

- [9] Optimization information

  Optimization indicates the kind and location of an optimization operation. Refer to "OPTIMIZE (global optimization handling)" in the "NetCOBOL User’s Guide".

5.7.4 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

5.7.4.1 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  GWA+00000124                   FD OUTFILE       LSAM       BGW.000000
16 [GWA+00000020]+00000000       0 01 prt-rec    60 ALPHANUM   BVA.000003       SJIS
18  GWA+000001F8                 0 77 answer      8 EXT-DEC    BGW.000000
19  GWA+00000200                 0 77 divisor     4 EXT-DEC    BGW.000000
```

```
21  COA+00000060                0 01 CSTART      8 ALPHANUM   BCO.000000       SJIS
22  COA+00000068                0 01 CEND        8 ALPHANUM   BCO.000000       SJIS
23  COA+00000070                0 01 CRES        8 ALPHANUM   BCO.000000       SJIS
25 [GWA+00000018]+00000000      0 01 dividend    2 EXT-DEC    BVA.000001
[11]**SUB1**
48 [GWA+0000001C]+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 "5.7.2 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:

  - COA (.rodata)
  - GWA (.data)
  - GW2 (.bss)
  - EBP (stack)
  - HGW (heap)
  - HPA (heap)

  Where the abbreviations stand for:

  - COA - Constant Area
  - GWA - Global Working Area
  - GW2 - Global Working area 2
  - EBP - Extended Base Pointer register ("E" added when processors went from 16 to 32 bit)
  - HGW - Heap Global Working area
  - HPA - HeaP Area

  The methods for finding the base addresses of the various sections are as follows:

  - Find the base addresses of COA (.rodata), GWA (.data), and GW2 (.bss) by referencing the link map listing. For details how you do this, refer to "2) Retrieving base addresses of sections" in "5.7.5.3 Researching Data Values".
  - EBP is the processor's EBP register. Find the address in this register using the debugger.
  - HGW and HPA are stored in the stack. To find the base addresses, it is necessary to reference the program control information listing.

The base address of HGW is stored in BHG (Base for HGW).
The base address of HPA is stored in BOD (Base for Object Data).
Finding the base addresses for HGW and HPA is described in the following example:

Program control information listing

```
    ** STK **
       :
      * SGM *
     ........          SGM POINTERS AREA                   0
       :
EBP+FFFFFFB8            BOD                               4
EBP+FFFFFFBC            BHG                               4
```

The base address of HGW is stored in the location indicated by EBP+FFFFFFBC, and the base address of HPA is stored in the location indicated by EBP+FFFFFFB8. You figure the base addresses of HPA and HGW by finding the value in the EBP register and adding the respective numbers. (Note that the stack grows downwards in memory, and the EBP stores the starting address of the stack, so offsets from EBP are generally negative numbers - hence all the leading "F"s. To add these negative offsets, simply add the two hex numbers, including the "F"s, and ignore the final carry digit on the addition of the leftmost digits. However, as you'll see in "5.7.5.3 Researching Data Values", you can have the software do the addition for you.)

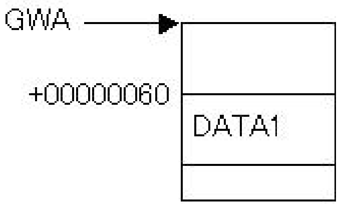
Relative address

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.

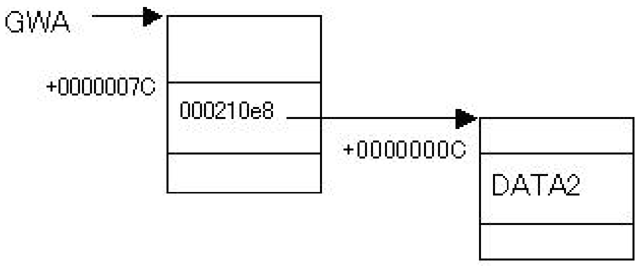
The method for referencing the data area depends on whether or not a pointer is involved:

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



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

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



   An address is stored at the location 0x7C from the GWA 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 "Table 5.10 Meanings of displayed data attribute abbreviations ".

Table 5.10 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
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
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 5.11 Meanings of displayed file types/access mode abbreviations ":

Table 5.11 Meanings of displayed file types/access mode abbreviations

Displayed Abbreviation	Meaning
SSAM	Sequential file, sequential access
LSAM	Line sequential file, sequential access

Displayed Abbreviation	Meaning
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 a 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

5.7.4.2 Program Control Information Listing

Format of Program Control Information Listing

```
     ADDR                  FIELD-NAME                     LENGTH
[1]
    ** GWA **
GWA+00000000          GCB FIXED AREA                     8
GWA+00000008          TL 1ST AREA                       16
     ........            MUTEX HANDLE AREA                 0
                        .
                        .
                        .

      * STL *
EBP+FFFFFFD8          TL 2ND AREA                         8
EBP+FFFFFFEC          LIA ADDRESS                        20

    ** LITERAL-AREA **
[2]
    ADDR              0 . . .  4 . . .  8 . . .  C . . .    0123456789ABCDEF
COA+00000040       10000000 01000000 08000000 04000000   ................
COA+00000050       40000000 5359534F 55542020            @...SYSOUT
```

- [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.

5.7.4.3 Section Size Listing

Format of Section Size Listing

```
    ** PROGRAM SIZE **
[1]
  .text SIZE        =       2409 BYTES
  .data SIZE        =        516 BYTES

     ** EXECUTION DATA SIZE **
[2]
   .bss SIZE        =          0 BYTES
   heap SIZE        =          0 BYTES
   stack SIZE       =        184 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
   .bss SIZE        =        272 BYTES
   heap SIZE        =          0 BYTES
METHOD NAME
   stack SIZE       =        384 BYTES           [3]
        :
```

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

5.7.5 Locating Errors

A simple example explains how to locate errors in an abnormally terminating program.

5.7.5.1 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 x86)

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:\ProgramData\Fujitsu\NetCOBOL\COBSNAP
\LISTDBG_1720_20140801-155635_cobsnap.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 7 Version 7601 (Service Pack 1) MP (2 procs) Free x86 compatible
Product: WinNt, suite: SingleUserTS
Machine Name:
Debug session time: Fri Aug  1 15:56:35.000 2014 (UTC + 9:00)
System Uptime: 0 days 4:35:31.089
Process Uptime: 0 days 0:00:01.000
......................................................
*** ERROR: Symbol file could not be found.  Defaulted to export symbols for ntdll.dll -

************* Symbol Loading Error Summary **************
Module name            Error
ntdll                  The system cannot find the file specified

You can troubleshoot most symbol related issues by turning on symbol loading diagnostics (!sym
noisy) and repeating the command that caused symbols to be loaded.
You should also verify that your symbol search path (.sympath) is correct.
This dump file has an exception of interest stored in it.
The stored exception information can be accessed via .ecxr.
(1720.1108): Integer divide-by-zero - code c0000094 (first/second chance not
available)                                                                        ... [1]
*** WARNING: Unable to verify checksum for LISTDBG.exe
*** ERROR: Symbol file could not be found.  Defaulted to export symbols for LISTDBG.exe -
eax=00000002 ebx=7ffdf000 ecx=00000000 edx=00000000 esi=00000000 edi=00406100
eip=00401516 esp=0012fd74 ebp=0012fe34 iopl=0         nv up ei ng nz na po cy
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00010283
LISTDBG!DIVPROC+0x20e:                                                            ... [3]
00401516 f7f9            idiv    eax,ecx                                          ... [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:"00401516", the "idiv eax,ecx" instruction.

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

   Use the r command to check the register contents.

   [r command output]

```
0:000> r
eax=00000002 ebx=7ffdf000 ecx=00000000 edx=00000000 esi=00000000 edi=00406100
eip=00401516 esp=0012fd74 ebp=0012fe34 iopl=0         nv up ei ng nz na po cy
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00010283
```

```
LISTDBG!DIVPROC+0x20e:
00401516 f7f9            idiv    eax,ecx
```

The above output indicates that "edx:eax=0000000000000002" was divided by "ecx=00000000" but, since ecx 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+0x20e".

   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 : 0x20e
```

   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
00400000 0040a000   LISTDBG  C (export symbols)       LISTDBG.exe
    Loaded symbol image file: LISTDBG.exe
    Image path: C:\work\tmp\tmp\LISTDBG.exe                            ... [4]
    Image name: LISTDBG.exe                                            ... [5]
    Timestamp:        Fri Aug 01 15:56:24 2014 (53DB3A18)
    CheckSum:         00000000
    ImageSize:        0000A000
    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+0x20e", obtain the position "0x20e" from the Object Program Listing (DIVPROC.LST) of the DIVPROC.cob that contains the symbol "DIVPROC".

   [Object Program Listing (DIVPROC.LST)]

```
BEGINNING OF DIVPROC
00000000 32                   db      0x32
00000001 07                   db      0x07
00000002 44495650524F43       dc      "DIVPROC"
00000009 08                   db      0x08
0000000A 4E6574434F424F4C     dc      "NetCOBOL"
00000012 07                   db      0x07
00000013 5631302E352E30       dc      "V10.5.0"
0000001A 3230313430383031     dc      "20140801"
00000022 3131343033393030     dc      "11403900"
0000002A 2B30303030           dc      "+0000"
0000002F 30313031             dc      "0101"
00000033 00                   db      0x00
00000034                 PROLOGUEAD:
00000034 XXXXXXXX             db      0xXXXXXXXX : PLB.1
00000038                 _DIVPROC:                                  ... [6]
00000038 55                   push    ebp
00000039 8BEC                 mov     ebp,esp
0000003B 81ECC0000000         sub     esp,000000C0
```

```
00000041 8BD7                 mov     edx,edi
00000043 8BFD                 mov     edi,ebp
00000045 81EF64000000         sub     edi,00000064
0000004B B90E000000           mov     ecx,0000000E
00000050 B800000000           mov     eax,00000000
00000055 FC                   cld
00000056 F3AB                 repe
00000058 8BFA                 mov     edi,edx
0000005A 897DEC               mov     ss:ebp-14,edi
0000005D 8975F0               mov     ss:ebp-10,esi
00000060 895DF4               mov     ss:ebp-0C,ebx
00000063 6800000000           push    00000000
00000068 C7859CFFFFFF00000000 mov     ss:ebp+FFFFFF9C,00000000
00000072 2EFF2534000000       jmp     cs:00000034
00000079 00000000000000       db      0x00000000000000
```

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).

Add the address number (offset) obtained above to the offset value from the symbol, "0x20e", to obtain the offset value within the list.

```
0x38+0x20e = 0x246
```

In the DIVPROC.cob Object Program Listing(DIVPROC.LST), search for address number "0x246 ".

[Object Program Listing(DIVPROC.LST)]

```
--- 14 --- MOVE
000001D0 B830300000 mov eax,00003030
000001D5 668945A0 mov ss:ebp-60,ax : answer
--- 15 --- COMPUTE ... [8]
000001D9 31D2 xor edx,edx
000001DB 8B3D18000000 mov edi,%GWA+00000018
000001E1 8A17 mov dl,ds:edi : dividend
000001E3 83E20F and edx,0F
000001E6 31C9 xor ecx,ecx
000001E8 8A4F01 mov cl,ds:edi+01 : dividend+1
000001EB 83E10F and ecx,0F
000001EE 8D1492 lea edx,ds:edx+edx*4
000001F1 8D1451 lea edx,ds:ecx+edx*2
000001F4 8A4F01 mov cl,ds:edi+01 : dividend+1
000001F7 80E1F0 and cl,F0
000001FA 80F950 cmp cl,50
000001FD 75XX jne GLB.4
000001FF F7DA neg edx
00000201 GLB.4
000001FE 02
00000201 31C0 xor eax,eax
00000203 8B3D18000000 mov edi,%GWA+00000018
00000209 8A4702 mov al,ds:edi+02 : divisor
```

```
0000020C 83E00F and eax,0F
0000020F 31C9 xor ecx,ecx
00000211 8A4F03 mov cl,ds:edi+03 : divisor+1
00000214 83E10F and ecx,0F
00000217 8D0480 lea eax,ds:eax+eax*4
0000021A 8D0441 lea eax,ds:ecx+eax*2
0000021D 8A4F03 mov cl,ds:edi+03 : divisor+1
00000220 80E1F0 and cl,F0
00000223 80F950 cmp cl,50
00000226 75XX jne GLB.5
00000228 F7D8 neg eax
0000022A GLB.5
00000227 02
0000022A 66A30A000000 mov %GWA+0000000A,ax : TRLP+0
00000230 66891512000000 mov %GWA+00000012,dx : TRLP+0
00000237 0FBF0512000000 movsx eax,%GWA+00000012 : TRLP+0
0000023E 99 cdq
0000023F 0FBF0D0A000000 movsx ecx,%GWA+0000000A : TRLP+0
00000246 F7F9 idiv ecx ... [7]
00000248 668945DA mov ss:ebp-26,ax : TRLS+0
0000024C 0FBF45DA movsx eax,ss:ebp-26 : TRLS+0
00000250 B102 mov cl,02
00000252 B500 mov ch,00
00000254 8D7DA0 lea edi,ss:ebp-60 : answer
00000257 E8XXXXXXXX call JMPZNCVZB_REG1
```

The instruction at address "00000246 " (the instruction at [7]) is "idiv ecx", 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 ([8]).

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" ([9]).

[**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.               ... [9]
        16    000160*
        17    000170     EXIT PROGRAM.
        18    000180 END PROGRAM DIVPROC.
```

5.7.5.2 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 x86)

The example used here is the same as in "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 "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:\ProgramData\Fujitsu\NetCOBOL\COBSNAP
\LISTDBG_1720_20140801-155635_cobsnap.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 7 Version 7601 (Service Pack 1) MP (2 procs) Free x86 compatible
Product: WinNt, suite: SingleUserTS
Machine Name:
Debug session time: Fri Aug  1 15:56:35.000 2014 (UTC + 9:00)
System Uptime: 0 days 4:35:31.089
Process Uptime: 0 days 0:00:01.000
......................................................
*** ERROR: Symbol file could not be found.  Defaulted to export symbols for ntdll.dll -

************* Symbol Loading Error Summary **************
Module name            Error
ntdll                  The system cannot find the file specified

You can troubleshoot most symbol related issues by turning on symbol loading diagnostics (!sym
noisy) and repeating the command that caused symbols to be loaded.
You should also verify that your symbol search path (.sympath) is correct.
This dump file has an exception of interest stored in it.
The stored exception information can be accessed via .ecxr.
(1720.1108): 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 -
eax=00000002 ebx=7ffdf000 ecx=00000000 edx=00000000 esi=00000000 edi=00406100
eip=00401516 esp=0012fd74 ebp=0012fe34 iopl=0         nv up ei ng nz na po cy
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00010283
LISTDBG!DIVPROC+0x20e:
00401516 f7f9            idiv    eax,ecx                                  ... [1]
```

This provides the abnormal end position of "00401516 " ([1]).

b. In order to identify the module held at the address "00401516 " at [1], use the lm command to output a module list.

[lm command output results]

```
0:000> lm
start    end        module name
002e0000 00324000   F3BIIO     (deferred)
00330000 00371000   F3BIFRM    (deferred)
00380000 003ca000   F3BIDBG    (deferred)
003d0000 003e5000   F3BIOLES   (deferred)
003f0000 003f5000   F3BIOVLD   (deferred)
00400000 0040a000   LISTDBG  C (export symbols)
LISTDBG.exe                                                               ... [2]
00420000 0045a000   F3BIOLER   (deferred)
00460000 004a2000   F3BISCRN   (deferred)
004b0000 00508000   F3BILPIO   (deferred)
00510000 0051e000   F3BISQL    (deferred)
00520000 00540000   F3BIPRIO   (deferred)
00540000 00551000   F3BISCLS   (deferred)
00560000 0056e000   F3BILANP   (deferred)
00570000 00588000   F3BIZCOM   (deferred)
005a0000 005ae000   F3BIAESV   (deferred)
005b0000 005dc000   F3BKATCH   (deferred)
005e0000 005f2000   F3BIEFNC   (deferred)
00600000 00636000   F3BIEXFH   (deferred)
00640000 00665000   F3BICICL   (deferred)
00670000 0067f000   F3BINDBC   (deferred)
006e0000 006f2000   F3BIFUNC   (deferred)
10000000 1006c000   F3BIPRCT   (deferred)
6c580000 6c6a2000   IMJP14K    (deferred)
6c6b0000 6c7c4000   IMJP14     (deferred)
71c90000 71ce1000   winspool   (deferred)
72170000 72177000   wsock32    (deferred)
72180000 7220e000   msvcp90    (deferred)
72410000 72494000   comctl32   (deferred)
72770000 72813000   msvcr90    (deferred)
74810000 74823000   dwmapi     (deferred)
74af0000 74b30000   uxtheme    (deferred)
750d0000 750d9000   version    (deferred)
75b40000 75bad000   sysfer     (deferred)
75bb0000 75bfc000   apphelp    (deferred)
75dc0000 75e0b000   KERNELBASE (deferred)
76000000 76057000   shlwapi    (deferred)
76060000 7606a000   lpk        (deferred)
76150000 76d9a000   shell32    (deferred)
76da0000 76e74000   kernel32   (deferred)
76e80000 76f4c000   msctf      (deferred)
76f50000 76ff2000   rpcrt4     (deferred)
77000000 77006000   nsi        (deferred)
```

```
77010000 770bc000   msvcrt     (deferred)
770c0000 7715d000   usp10      (deferred)
```

Since the "00401516 " at [1] is included in "00400000 0040a000 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 53db4524 (Fri Aug 01 16:43:32 2014)

 Preferred load address is 00400000                             ... [3]

Start         Length     Name                   Class
 0001:00000000 00003f1eH .text                   CODE
  ...
  Address         Publics by Value              Rva+Base     Lib:Object

 0001:00000000       $LISTDBG.CODE              00401000     LISTDBG.OBJ
 0001:00000000       _WinMain@16                00401000 f   LISTDBG.OBJ
 0001:000002d0       $DIVPROC.CODE              004012d0     DIVPROC.OBJ
 0001:00000308       _DIVPROC                   00401308 f   DIVPROC.OBJ    ... [4]
 0001:0000054a       _JMP1PLAN                  0040154a f   f3bicimp:F3BIPRCT.dll
...
```

Check whether the module loading address "400000" at [2] is the same as the address at [3], "Preferred load address is “00400000".

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

  Compare the address "00401516" 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]" 0001:00000308       _DIVPROC                   00401308 f   DIVPROC.OBJ
  ```

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

  ```
  0x00401516 - 0x00401308 = 0x20e
  ```

  The above results give the following information:

  ```
  Module            : "LISTDBG.exe"
  Symbol            : "DIVPROC"
  Offset from Symbol: 0x20e
  ```

- 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.

  ```
  0x00401516 - 0x00400000 = 0x1516
  ```

  Then obtain the relative offsets of the symbol of each.

  ```
  main      0x00401000 - 0x00400000 = 0x1000
  LISTDBG   0x00401000 - 0x00400000 = 0x1000
  DIVPROC   0x00401308 - 0x00400000 = 0x1308   ... [5]
  JMP1PLAN  0x0040154a - 0x00400000 = 0x154a
        :
  ```

  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  0x00401308 - 0x00400000 = 0x1308”
```

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

```
0x1516 - 0x1308 = 0x20e
```

The above results give the following information:

```
Module            : "LISTDBG.exe"
Symbol            : "DIVPROC"
Offset from Symbol: 0x20e
```

Subsequent tasks are the same as in "Locating Errors (Program Database File)".

5.7.5.3 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 x86)

Note

- The only data that can be referenced at abnormal termination is the data used in the program or method that terminated abnormally.
- Additionally, if the compile option OPTIMIZE is specified, the optimization process may mean that execution results have not been stored in a particular area and statements may have been moved or deleted. For this reason, examining data areas may not be reliable.

1) Retrieving base addresses of sections

You can find the base address of each section by using the link map listing and the debugger. The following describes where you can find each section.

COA (.rodata)

Located in the link map listing at the address in the Rva+Base column on the line where the “Publics by Value” column is ‘$program-name.LIT’. [1] in the sample link map listing below.

GWA (.data)

Located in the link map listing at the address in the Rva+Base column on the line where the “Publics by Value” column is ‘$program-name.DATA’. [2] in the sample link map listing below.

GW2 (.bss)

Located in the link map listing at the address in the Rva+Base column on the line where the “Publics by Value” column is ‘$program-name.BSS’. [3] in the sample link map listing below.

EBP (stack)

Represents the EBP register. Find the address in this register using the debugger.

HGW (heap)

The base address of HGW is stored in the BHG pointer. Reference the program control information listing to find the location of the BHG pointer, then use the debugger to obtain the address in the BHG pointer - this is the base address of HGW. [4] in the sample program control information listing below.

HPA (heap)

The base address of HPA is stored in the BOD pointer. Reference the program control information listing to find the location of the BOD pointer, then use the debugger to obtain the address in the BOD pointer - this is the base address of HPA. [5] in the sample program control information listing below.

Sample link map listing, for a program called “A”:

```
Start         Length     Name                   Class v
0001:00000000 000043a2H .text                   CODE
          :
0003:00000030 00002580H .data                   DATA
0003:000025b0 0000052cH .bss                    DATA
0004:00000000 0000025cH .rodata                 DATA
         :
  Address         Publics by Value              Rva+Base     Lib:Object
         :
 0001:00000000       $A.CODE                    00401000     A.OBJ
 0001:00000000       _main                      00401000 f   A.OBJ
         :
0003:00000030       $A.DATA               [2]  00406030     A.OBJ
         :
0004:00000000       $A.BSS                [3]  00409f00     A.OBJ
         :
0005:00000000       $A.LIT                [1]  0040a000     A.OBJ
         :
```

The BHG and BOD pointers are found in the SGM POINTERS AREA in the program control information listing as illustrated in the following sample:

```
    ** STK **
      * SCB *
EBP+FFFFFF40          SCB FIXED AREA                  92
     ........          TL 1ST AREA                      0
      * SGM *
EBP+FFFFFF98          SGM POINTERS AREA                8
     ........             VPA                           0
     ........             PSA                           0
     ........             BVA                           0
EBP+FFFFFF98       [5]   BOD                           4
EBP+FFFFFF9C       [4]   BHG                           4.
         :
```

2) Retrieving the data address

You obtain information on the data address from the data map listing. For details on data map listing format, see the sections “Format of Data Map Listing” and “Data Map Listing Description” in "5.7.4.1 Data Map Listing".

Note

Data map listing addresses and offsets are written in hexadecimal, Big Endian, format. Addresses stored in memory are written in Little Endian format, but the debugger expects addresses to be entered in Big Endian format. Therefore the byte order of addresses read from memory must be reversed before being used, E.g. an address stored in 4 bytes of memory will appear as F8 C4 35 00, but the address is 00 35 C4 F8 and this is the number to use when adding offsets or entering into the debugger’s address entry field.

Here is a sample data map listing.

```
LINE  ADDR    OFFSET REC-OFFSET LVL NAME   LENGTH ATTRIBUTE BASE      DIM
**LISTDBG1**
  6  GWA+000000E8               0 01 answer       2 EXT-DEC   BGW.000000
  7  GWA+000000EA               0 01 divisor      2 EXT-DEC   BGW.000000
  9 [GWA+00000020]+00000000   0 01 dividend     2 EXT-DEC   BVA.000001
10 [HGW+00000024]+00000000   0 01 dynamic-area 2 EXT-DEC   BVA.000002
```

The location of the data is found in the ADDR and OFFSET columns (entries of the form “XXX+number” or “[XXX +number-1]+number-2”). The length of the stored data is given in the LENGTH column. In the above example:

Data Item	Data Stored at	Data Area Length
answer	Stored at the address produced by adding 000000E8 to the GWA base address.	2 bytes
divisor	Stored at the address produced by adding 000000EA to the GWA base address	2 bytes
dividend	The square brackets indicate that the (four-byte) base address of the data is stored at the location produced by adding 00000020 to the GWA base address. The data is stored at the location produced by adding the offset (in this case, 0000000) to this address.	2 bytes
dynamic-area	The square brackets indicate that the (four-byte) base address of the data is stored at the location produced by adding 00000024 to the HGW base address. The data is stored at the location produced by adding the offset (in this case, 00000000) to this address.	2 bytes

3) Examining data values

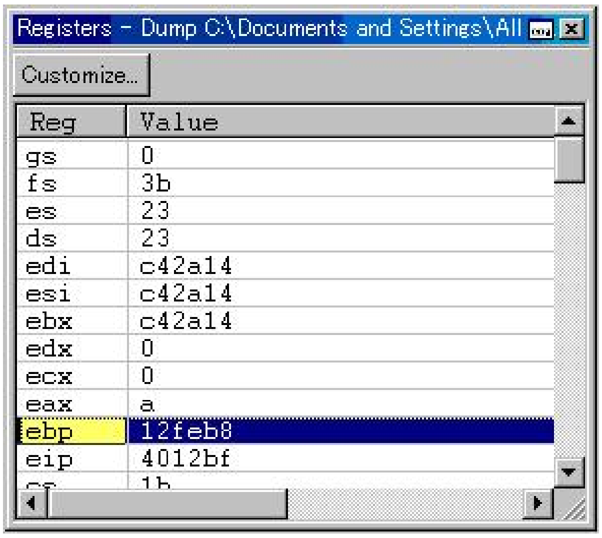
Having derived the address(es) of the data in step 2 above, you can now use the debugger to examine the contents.

(Remember the note on reading addresses from memory given under step 3!)

1. Start the Debugging Tools for Windows.

2. From the File menu, select the Open Crash Dump command to open the Crash dump.

3. To examine the registers, from the View menu, select the Registers command. The Registers window is displayed. This snapshot shows the EBP register and value highlighted:



Registers - Dump C:\Documents and Settings\All

Customize...

Reg	Value
gs	0
fs	3b
es	23
ds	23
edi	c42a14
esi	c42a14
ebx	c42a14
edx	0
ecx	0
eax	a
ebp	12feb8
eip	4012bf
cs	1b

4. To examine memory, from the View menu, select the Memory command and enter the address to be referenced in the “Virtual” entry field. The following examples show how addresses are entered and data values examined.

Example

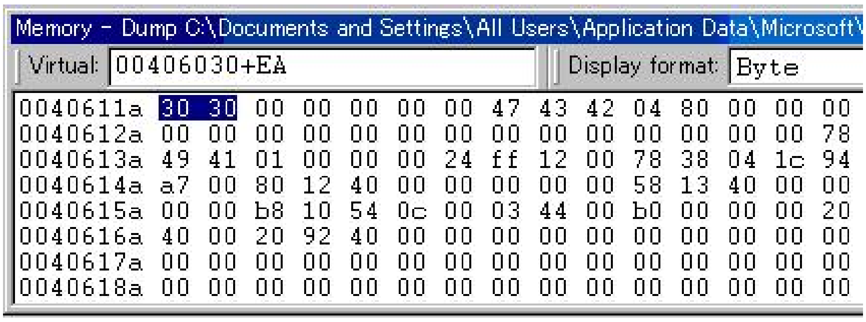
Example 1: Examining the "divisor" data item

The information of "divisor" in our example data map listing is as follows:

```
7  GWA+000000EA            0 01 divisor          2 EXT-DEC    BGW.000000
```

The link map file shows the GWA base address to be 00406030.

We can let the debugger add the offset (0xEA) to the base address for us by entering “00406030+EA” in the address bar:



Memory - Dump C:\Documents and Settings\All Users\Application Data\Microsoft\

Virtual: 00406030+EA

Display format: Byte

```
0040611a 30 30 00 00 00 00 00 47 43 42 04 80 00 00 00
0040612a 00 00 00 00 00 00 00 00 00 00 00 00 00 00 78
0040613a 49 41 01 00 00 00 24 ff 12 00 78 38 04 1c 94
0040614a a7 00 80 12 40 00 00 00 00 00 58 13 40 00 00
0040615a 00 00 b8 10 54 0c 00 03 44 00 b0 00 00 00 20
0040616a 40 00 20 92 40 00 00 00 00 00 00 00 00 00 00
0040617a 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0040618a 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

The debugger positions you at the resulting address. The above snapshot shows the 2 byte value of “divisor” to be 0x3030 (we added the highlighting by selecting the two bytes - the debugger doesn’t “know” that the data item at this offset is 2 bytes long - and similarly in the following examples).

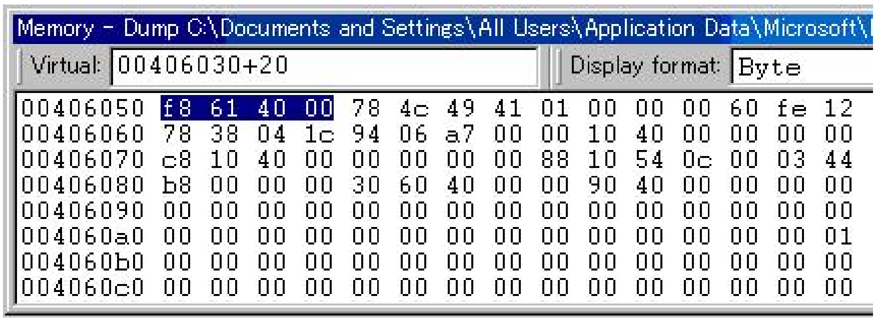
Example 2: Examining the "dividend" data item

The information of "dividend" in our sample data map listing is as follows:

```
9 [GWA+00000020]+00000000    0 01 dividend       2 EXT-DEC   BVA.000001
```

In an indirect reference such as this, the actual address of the data item is stored at the location indicated by [GWA+00000020].

As in example 1, the GWA base address is 00406030, so we enter 00406030+20 in the address bar:



Memory - Dump C:\Documents and Settings\All Users\Application Data\Microsoft\

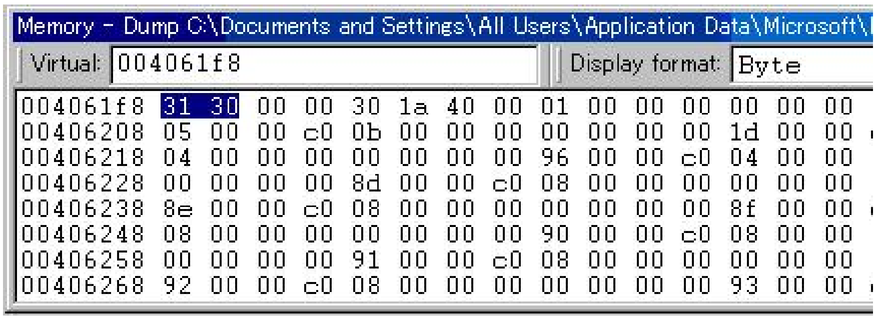
Virtual: 00406030+20

Display format: Byte

```
00406050 f8 61 40 00 78 4c 49 41 01 00 00 00 60 fe 12
00406060 78 38 04 1c 94 06 a7 00 00 10 40 00 00 00 00
00406070 c8 10 40 00 00 00 00 00 88 10 54 0c 00 03 44
00406080 b8 00 00 00 30 60 40 00 00 90 40 00 00 00 00
00406090 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
004060a0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 01
004060b0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
004060c0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

The four bytes at this address (highlighted) make up the address of the “dividend” data item. However, remember that addresses stored in memory are in reverse byte order, To derive the address in the Big Endian format used for entering the data we must reverse the order of the bytes: 004061f8.

The “dividend" data content is stored at 004061f8+00000000. So we enter the address 004061f8 in the address bar. (+0000000 is omitted.)



Memory - Dump C:\Documents and Settings\All Users\Application Data\Microsoft\

Virtual: 004061f8

Display format: Byte

```
004061f8 31 30 00 00 30 1a 40 00 01 00 00 00 00 00 00
00406208 05 00 00 c0 0b 00 00 00 00 00 00 00 1d 00 00
00406218 04 00 00 00 00 00 00 00 96 00 00 c0 04 00 00
00406228 00 00 00 00 8d 00 00 c0 08 00 00 00 00 00 00
00406238 8e 00 00 c0 08 00 00 00 00 00 00 00 8f 00 00
00406248 08 00 00 00 00 00 00 00 90 00 00 c0 08 00 00
00406258 00 00 00 00 91 00 00 c0 08 00 00 00 00 00 00
00406268 92 00 00 c0 08 00 00 00 00 00 00 00 93 00 00
```

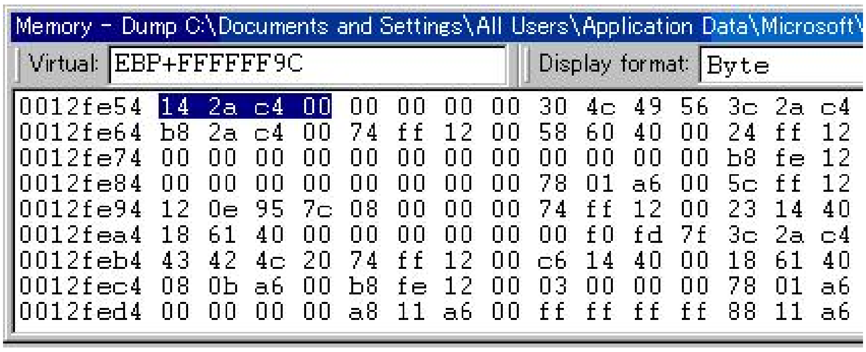
This shows the data content of the “dividend” data item to be 0x3130.

Example 3: Examining the "dynamic-area" data item

The information of "dynamic-area" in our sample data map listing is:

```
10 [HGW+00000024]+00000000   0 01 dynamic-area     2 EXT-DEC   BVA.000002
```

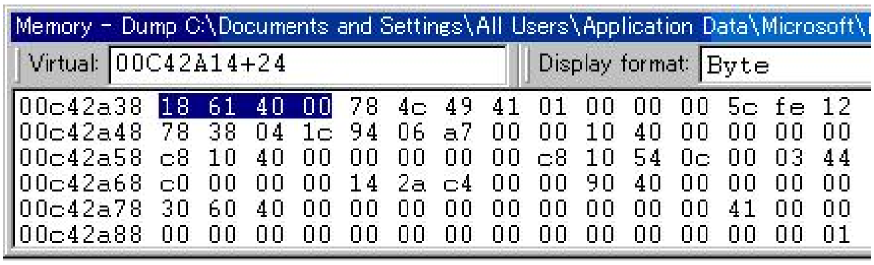
Because the HGW base address is stored in the BHG pointer we must first find that value. From the program control information listing we find that BHG is at the address EBP+FFFFFF9C. So, we first enter EBP+FFFFFF9C in the address bar (the debugger accepts register names as part of the address expressions):



```
Memory - Dump C:\Documents and Settings\All Users\Application Data\Microsoft\
Virtual: EBP+FFFFFF9C                Display format: Byte
0012fe54 14 2a c4 00 00 00 00 00 30 4c 49 56 3c 2a c4
0012fe64 b8 2a c4 00 74 ff 12 00 58 60 40 00 24 ff 12
0012fe74 00 00 00 00 00 00 00 00 00 00 00 00 b8 fe 12
0012fe84 00 00 00 00 00 00 00 00 78 01 a6 00 5c ff 12
0012fe94 12 0e 95 7c 08 00 00 00 74 ff 12 00 23 14 40
0012fea4 18 61 40 00 00 00 00 00 00 f0 fd 7f 3c 2a c4
0012feb4 43 42 4c 20 74 ff 12 00 c6 14 40 00 18 61 40
0012fec4 08 0b a6 00 b8 fe 12 00 03 00 00 00 78 01 a6
0012fed4 00 00 00 00 a8 11 a6 00 ff ff ff ff 88 11 a6
```

This shows that the HGW base address is 00c42a14.

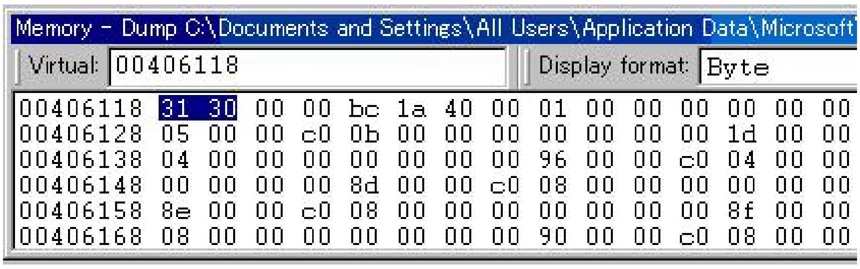
Next, we look up the actual address stored at [HGW+00000024]. We therefore enter 00c42a14+24 in the address bar:



```
Memory - Dump C:\Documents and Settings\All Users\Application Data\Microsoft\
Virtual: 00C42A14+24                 Display format: Byte
00c42a38 18 61 40 00 78 4c 49 41 01 00 00 00 5c fe 12
00c42a48 78 38 04 1c 94 06 a7 00 00 10 40 00 00 00 00
00c42a58 c8 10 40 00 00 00 00 00 c8 10 54 0c 00 03 44
00c42a68 c0 00 00 00 14 2a c4 00 00 90 40 00 00 00 00
00c42a78 30 60 40 00 00 00 00 00 00 00 00 00 41 00 00
00c42a88 00 00 00 00 00 00 00 00 00 00 00 00 00 00 01
```

So the (base) address for the “dynamic-area” item is 00406118.

The content of “dynamic-area” is stored at 00406118+00000000. We enter 00406118 in the address bar. (+0000000 is omitted.)



```
Memory - Dump C:\Documents and Settings\All Users\Application Data\Microsoft
Virtual: 00406118                    Display format: Byte
00406118 31 30 00 00 bc 1a 40 00 01 00 00 00 00 00 00
00406128 05 00 00 c0 0b 00 00 00 00 00 00 1d 00 00
00406138 04 00 00 00 00 00 00 00 96 00 00 c0 04 00 00
00406148 00 00 00 00 8d 00 00 c0 08 00 00 00 00 00 00
00406158 8e 00 00 c0 08 00 00 00 00 00 00 8f 00 00
00406168 08 00 00 00 00 00 00 00 90 00 00 c0 08 00 00
```

This shows the data content of “dynamic-area” to be 0x3130.

Similarly, in the case of an address based on HPA such as: [HPA+xxxxxxxx]+yyyyyyyy,

we start with the BOD pointer to obtain the HPA base address and go on to examine the variable area.

Appendix A Debugger Command Lists

This appendix lists the debugger commands. For details on the command specification format, refer to Help.

Table A.1 Debugger Commands

Command Name	Function
ALTERTHREAD	Change the thread status.
ASSIGNDATA	Allocate a data file.
AUTORUN	Debugs automatically.
BREAK	Sets a breakpoint.
CALLS	Displays the calling path.
CLOSEDATA	Close a data file.
CONTINUE	Resumes execution.
COUNT	Sets a passage count point.
CURRENTTHREAD	Change the implicit thread.
DATACHK	Monitors satisfaction of a conditional expression.
DELCOUNT	Cancels a passage count point.
DELDCHK	Cancels monitoring satisfaction of a conditional expression.
DELDTR	Cancels monitoring changes in data item contents.
DELETE	Cancels a breakpoint.
DELMON	Cancels monitoring for changes in a data item.
DTRACE	Monitors change in data item contents. (No interruption at change)
ENV	Sets up and changes the debug environment.
LINKAGE	Acquires a data area in the linkage section.
LIST	References data area contents.
MONITOR	Monitors changes in data item contents. (Interruption at change)
OPENDATA	Open a data file.
READDATA	Read from a data file.
RERUN	Re-debug.
RUNTO	Executes with a breakpoint specification.
SCOPE	Changes program qualification.
SET	Changes data area contents.
SKIP	Changes the current execution position.
STATUS	Displays debug status.
QUIT	Ends debugging
THREADLIST	Displays thread status.
WHERE	Displays the current execution position.
WRITEDATA	Write into a data file.

Index