

DevPartner[®] Advanced Error Detection Techniques

Release 9.0.0



Technical support is available from our Technical Support Hotline or via our FrontLine Support Web site.

Technical Support Hotline:
1-800-538-7822

FrontLine Support Web Site:
<http://frontline.compuware.com>

This document and the product referenced in it are subject to the following legends:

Access is limited to authorized users. Use of this product is subject to the terms and conditions of the user's License Agreement with Compuware Corporation.

© 2008 Compuware Corporation. All rights reserved. Unpublished - rights reserved under the Copyright Laws of the United States.

U.S. GOVERNMENT RIGHTS

Use, duplication, or disclosure by the U.S. Government is subject to restrictions as set forth in Compuware Corporation license agreement and as provided in DFARS 227.7202-1(a) and 227.7202-3(a) (1995), DFARS 252.227-7013(c)(1)(ii)(OCT 1988), FAR 12.212(a) (1995), FAR 52.227-19, or FAR 52.227-14 (ALT III), as applicable. Compuware Corporation.

This product contains confidential information and trade secrets of Compuware Corporation. Use, disclosure, or reproduction is prohibited without the prior express written permission of Compuware Corporation.

DevPartner[®] Studio, BoundsChecker, FinalCheck and ActiveCheck are trademarks or registered trademarks of Compuware Corporation.

Acrobat[®] Reader copyright © 1987-2008 Adobe Systems Incorporated. All rights reserved. Adobe, Acrobat, and Acrobat Reader are trademarks of Adobe Systems Incorporated.

All other company or product names are trademarks of their respective owners.

US Patent Nos.: 5,987,249, 6,332,213, 6,186,677, 6,314,558, and 6,016,466

September 19, 2008

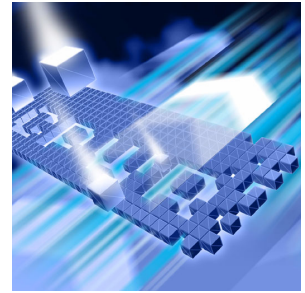


Table of Contents

Preface

Who Should Read This Manual	vii
What This Manual Covers	viii
Conventions Used In This Manual	ix
Customer Assistance	ix
For Non-technical Issues	ix
For Technical Issues	ix

Chapter 1

Workflow and Configuration Settings

DevPartner Error Detection Workflow	1
Benefits of the DevPartner Error Detection Workflow	2
Saving Error Detection Configurations	2
Using Error Detection from the Command Line	3
Instrumenting Native C/C++ Code with nmvcbuild	4
Customizing the DevPartner Error Detection Settings	6
General	7
Data Collection	7
API Call Reporting	7
Call Validation	8
COM Call Reporting	8
COM Object Tracking	9
Deadlock Analysis	9
Memory Tracking	9
.NET Call Reporting	10
.NET Analysis	11
Resource Tracking	11
Modules and Files	12
Fonts and Colors	12
Configuration File Management	12

Chapter 2

Checking and Analyzing Programs

Error Detection Tasks	15
Finding Leaks	15
Finding Pointer and Memory Errors	16
Finding Memory Corruption	16
Analyzing Transitions to Legacy Code in .NET Applications	17
Validating Win32 API Calls	18
Searching for Application Deadlocks	18
Expanded Uses for DevPartner Error Detection	19
Understanding Complex Applications	19
Reverse Engineering	22
Stress Testing	24

Chapter 3

Analyzing Complex Applications

About Complex Applications	27
Wait for Process	28
Analyzing Limited Parts of Your Program	30
Using Modules and Files Settings	32
Deciding What to Monitor	33
How Does an Application Start Up?	34
Analyzing Services	35
Requirements and Guidelines	35
Analyzing a Service	35
Timing Problems and dwWait	36
Alternate Method: Separating Control Logic from the Worker Thread	36
Custom Code to Turn the DevPartner Error Detection Log On and Off	36
Common Service-related Issues	37
Analyzing ActiveX Controls Using the Test Container	38
Common Test Container Issues	39
Analyzing Applications That Use COM	39
Common COM Issues	41
Analyzing ISAPI Filters Under IIS 5.0	42
Common ISAPI Filter Issues	43
Analyzing ISAPI Filters under IIS 6.0	44
IIS 5.0 Isolation Mode	44
IIS 6.0 Default Configuration	45
Common IIS 6.0 ISAPI Filter Issues	46
Frequently Asked Questions	47

Chapter 4

Working with User-Written Allocators

Introduction	49
Gathering Necessary Information	50
Finding the Names of User-Written Allocators	50
Special Assumptions Made By User-Written Allocators about Memory	52
Creating Entries in UserAllocators.dat	53
Modules	54
Allocator Records	55
Deallocator Records	59
QuerySize Records	63
Reallocator Records	66
Ignore Records	69
Coding UserAllocator Hook Requests	72
Code Requirements for UserAllocators	72
Allocator Function Hooks	72
Deallocator Function Hooks	73
Reallocator Function Hooks	74
Debugging UserAllocator Hooks	75
NoDisplay	75
Debug	75
How to Diagnose Errors in UserAllocators.dat	76
Token Parsing Errors	76
Semantic Errors	77
If Your Application becomes Unstable after Changing UserAllocators.dat ...	77

Chapter 5

Deadlock Analysis

Background: Single and Multi-threaded Applications	79
Threads	80
Critical Sections	80
Deadlock - A Basic Definition	81
Techniques for Avoiding Deadlocks	82
Potential Deadlocks	83
The Dining Philosophers	83
Monitoring Synchronization Objects	84
Other Synchronization Objects	85
Additional Information	87
MSDN References	87
Other References	87

Appendix A

Troubleshooting Error Detection

Troubleshooting	89
-----------------------	----

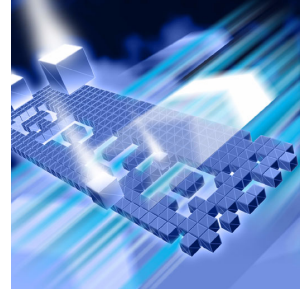
Appendix B

Important Error Detection Files

Files and Their Purpose	99
-------------------------------	----

Index

Preface



- ◆ Who Should Read This Manual
- ◆ What This Manual Covers
- ◆ Conventions Used In This Manual
- ◆ Customer Assistance

This manual describes concepts and procedures to help you understand the use of your Compuware® DevPartner Error Detection software.

Who Should Read This Manual

This manual is intended for new DevPartner Error Detection users and for users of previous versions of DevPartner Error Detection who want an overview of new functions and interface changes.

New users should read the error detection chapter in Understanding DevPartner Studio to get an overview of DevPartner Error Detection concepts and then use this document to learn how to use DevPartner Error Detection most effectively.

Users of previous versions of DevPartner studio should read the Release Notes to see how DevPartner Error Detection differs from BoundsChecker, the error detection tool included with previous versions.

This manual assumes that you are familiar with the Windows interface and with software development concepts.

What This Manual Covers

This manual contains the following chapters and appendixes:

- ◆ **Chapter 1, *Workflow and Configuration Settings***, explains how to configure DevPartner Error Detection to solve various problems, ranging from simple API call validation to problems encountered in complex COM applications.
- ◆ **Chapter 2, *Checking and Analyzing Programs***, describes error detection tasks you can perform with DevPartner Error Detection and other tasks, beyond error detection.
- ◆ **Chapter 3, *Analyzing Complex Applications***, provides information to help you use DevPartner Error Detection more effectively when checking complex applications.
- ◆ **Chapter 4, *Working with User-Written Allocators***, explains how to customize the `UserAllocators.dat` file so you can analyze your own memory allocators.
- ◆ **Chapter 5, *Deadlock Analysis***, explains deadlocks, potential deadlocks, and synchronization objects. It also lists Web addresses and books that provide more information on these topics.
- ◆ **Appendix A, *Troubleshooting Error Detection***, provides answers to some of the most common issues in a problem/solution format.
- ◆ **Appendix B, *Important Error Detection Files***, provides a list of the important files associated with DevPartner Error Detection, and describes each file's purpose.

You will also find an index at the back of this manual.

Note: This manual contains information for all of the Visual Studio versions of DevPartner Studio. Notes throughout the text identify features that are available only for a specific release of Visual Studio.

Conventions Used In This Manual

This book uses the following conventions to present information.

- ◆ Screen commands and menu names appear in **bold typeface**. For example:
Choose **Item Browser** from the **Tools** menu.
- ◆ Computer commands and file names appear in `monospace typeface`. For example:
The *Understanding DevPartner Error Detection* manual (`bc_vc.pdf`) describes...
- ◆ Variables within computer commands and file names (for which you must supply values appropriate for your installation) appear in *italic monospace type*. For example:
Enter `http://servername/cgi-win/itemview.dll` in the **Destination** field...

Customer Assistance

The following provides information on how to access customer assistance for non-technical, as well as technical issues.

For Non-technical Issues

Customer Service is available to answer any questions you might have regarding upgrades and other order fulfillment needs. Customer Service is available from 8:00 am to 6:00 pm EST, Monday through Friday.

North America: 800 538 7822

International: +1 313 227 5444

International customers, check Compuware Worldwide Offices for the local phone number at <http://www.compuware.com/corporate/offices>.

For Technical Issues

Technical Support can assist you with all your technical problems, from installation to troubleshooting.

Before contacting technical support please read the relevant sections of the product documentation and the ReadMe files.

You can contact Technical Support by:

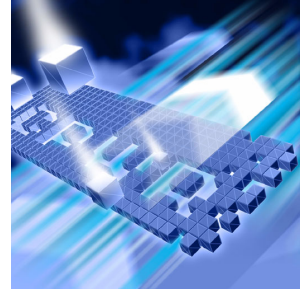
E-Mail	Include your as many details as possible. Send all information to DevPartnerSupport@compuware.com
World Wide Web	Submit issues and access our support knowledge base at http://frontline.compuware.com
Telephone	Telephone support is available as a paid* Priority Support Service from 8:00 am to 6:00 pm EST, Monday through Friday. Have product version and license information ready. In the U.S. and Canada, call: 800 538 7822 International customers, call: +1 313 227 5444 * Technical Support handles installation and setup issues free of charge.

Before contacting Technical Support, please obtain and record the following information:

- ◆ Product name (or edition), version, or service pack
- ◆ Product license information
- ◆ System configuration: operating system, network configuration, amount of RAM, environment variables, and paths
- ◆ Name and version of your compiler and linker and the options you used in compiling and linking
- ◆ Problem details: settings, error messages, stack dumps, and the contents of any diagnostic windows
- ◆ If the problem is repeatable, the details of how to create the problem

Chapter 1

Workflow and Configuration Settings



- ◆ DevPartner Error Detection Workflow
- ◆ Customizing the DevPartner Error Detection Settings

DevPartner Error Detection can identify many different types of problems. The default DevPartner Error Detection settings have been chosen to find the most common errors with the minimum impact on performance.

By changing the settings, you can fine-tune DevPartner Error Detection to search for specific types of problems. Understanding the error detection settings will enable you to use DevPartner Error Detection to its fullest.

This chapter describes how to configure DevPartner Error Detection to solve various problems, ranging from simple API call validation to problems encountered in complex COM applications.

Note: Error Detection creates data files for each target application. You must ensure that you have write access to the directory containing the target executable before starting Error Detection.

DevPartner Error Detection Workflow

DevPartner Error Detection follows a program workflow that is more extensive than the workflow of earlier DevPartner Error Detection versions. This mechanism enables you to control the amount of data collected and reported.

Here are the four steps of the DevPartner Error Detection workflow:

- 1 Configure DevPartner Error Detection to collect the desired data
 - a Select the types of data you want to collect
 - b Define the portions of your application to be monitored
 - c Select the **Suppressions** and **Filters** you want to apply
- 2 Run your application
 - a As the program runs, review errors presented in the **Program Error Detected** dialog box
 - b Suppress errors that are not valid
 - c View the log and create filters if necessary
 - d Review memory and resource usage
- 3 View the data (after program termination)
 - a Filter out events you do not want to see in the log
 - b Create new suppressions to be applied to future runs of your application
- 4 If desired, save your settings, suppressions, and filters for future use

Benefits of the DevPartner Error Detection Workflow

The DevPartner Error Detection workflow enables you to:

- ◆ Select the type and amount of data to be collected
- ◆ Select the portions of the application to be monitored
- ◆ Suppress errors that report known issues, are handled by conditional code, or have been generated in third-party code
- ◆ Create filters to hide extraneous information in the log
- ◆ Save different configurations so that settings, suppressions and filters can be reused

DevPartner Error Detection provides defaults for each step in the workflow process. This means you can use DevPartner Error Detection with default settings, or you can change the settings to customize the way that DevPartner Error Detection analyzes your application.

Saving Error Detection Configurations

You can save an error detection configuration - a specific combination of settings (standalone versions) or options (Visual Studio) - to use again.

For example, you might create a configuration for memory and resource leaks, another for COM leaks and a third to do detailed lint type analysis. You can further refine settings and define configurations that look only at particular sections of a large application.

Using Error Detection from the Command Line

Use the following command syntax to check a program with `BC.exe` (the executable) from the command prompt. Brackets `[]` indicate that a command is optional.

```
BC.exe [/?]
BC.exe sessionlog.DPbc1
BC.exe [/B sessionlog.DPbc1] [/C configfile.DPbcc] [/M] [/NOLOGO]
[X[S|D] xmlfile.xml] [/OUT errorfile.txt] [/S] [/W workingdir]
target.exe [target args]
```

Table 1-1. Command Line Options

Option	Description
<code>/?</code>	Display usage information
<code>sessionlog.DPbc1</code>	Open an existing session log
<code>/B sessionlog.DPbc1</code>	Run in batch mode and save the session log to a log file <code>sessionlog.DPbc1</code>
<code>/C configfile.DPbcc</code>	Use the <code>configfile.DPbcc</code> options
<code>/M</code>	Start <code>BC.exe</code> and minimize when running
<code>/NOLOGO</code>	Do not show the splash screen when loading <code>BC.exe</code>
<code>/X xmlfile.xml</code>	<p>Generate XML output and save to the specified file.</p> <ul style="list-style-type: none"> When you specify an executable, Error Detection runs a session on the executable and then generates XML output from the results. When you specify a session log file only (<code>sessionlog.DPbc1</code>), Error Detection converts the specified session log to XML and saves the output. <p>Note: When you specify an executable, you must still specify an corresponding session log file using the <code>/B</code> switch.</p>

Table 1-1. Command Line Options (Continued)

Option	Description
<code>/XS xmlfile.xml</code>	The <code>/X</code> flag used with the <code>S</code> modifier instructs Error Detection to only save Summary data to the xml file. Information about the running of the Error Detection session (Session data) is always exported.
<code>/XD xmlfile.xml</code>	The <code>/X</code> flag used with the <code>D</code> modifier instructs Error Detection to only save Details data to the xml file. Information about the running of the Error Detection session (Session data) is always exported.
<code>/OUT errorfile.txt</code>	Output any error messages to a text file named <code>errorfile.txt</code> — this file will only contain error messages generated while trying to execute Error Detection, not the list of error and leaks discovered by Error Detection
<code>/S</code>	Run in silent mode — do not open the Program Error Detected dialog box on errors
<code>/W workingdirectory</code>	Set the target's working directory
<code>target.exe [target args]</code>	The executable to launch and its arguments

Note: You must specify the full directory path to your program executable if it is not located on the current path (the environment variable listing the directories that the system searches in order to find an executable).

You can specify multiple command options for one program. For example:

```
BC.exe /B test.dpbcl /S /M c:\testdir\test.exe
```

Instrumenting Native C/C++ Code with nmvcbuild

If you plan to build your project from the command line, and want to instrument it for Error Detection, you need to use `nmvcbuild.exe` instead of the Microsoft `vcbuild.exe` compiler. The `vcbuild` compiler does not provide any way to replace the default compiler and linker, so there is no way to perform DevPartner native C/C++ instrumentation.

`nmvcbuild.exe` is a command line utility, designed specifically for DevPartner, that allows it to perform native C/C++ instrumentation for `vcbuild`. It functions as a wrapper for `vcbuild` that watches for `cl.exe` and `link.exe` being started, and replaces them with `nmcl.exe` and `nmlink.exe`.

The `nmvcbuild` utility accepts the same command line parameters as `vcbuild` and `nmcl`. You can view the parameters for `vcbuild` and `nmcl` by entering `vcbuild ?` and `nmcl ?` at the command line. You can also embed any required parameters in the environment variable `nmcl`, and then you only need to pass the `vcbuild` parameters when you call `nmvcbuild`. For example, the following entry would set `nmcl` parameters in the environmental variable:

```
set nmcl=/NMignore:StdAfx.cpp
```

For more information, refer to `nmcl` Options in the online help.

Prerequisites

In order to run `nmvcbuild.exe` you must have:

- ◆ DevPartner Studio installed on your system.
- ◆ A system environment set up to run the Visual Studio tools.
- ◆ `vcbuild.exe` and `nmvcbuild.exe` in your path setting. By default `nmvcbuild.exe` is installed in the following location:

```
\program files\common files\compuware\nmshared
```

Note: For installs on 64-bit versions of Windows, the file is located at:

```
\Program Files (x86)\Common Files\Compuware\NMShared
```

Example

To build the debug configuration of the sample project with Error Detection instrumentation:

```
nmvcbuild /nmbcon sample.vcproj debug
```

Customizing the DevPartner Error Detection Settings

The DevPartner Error Detection settings provide the following types of customization:

- ◆ Restrict the types of information collected (e.g. memory and resource leaks)
- ◆ Further refine the types of information collected in each major category of analysis (for example, look only for resource leaks generated by graphics calls)
- ◆ Determine how much additional information such as call stacks, parameter data, return values, etc. is recorded along with the event or error
- ◆ Control the look and feel of the DevPartner Error Detection user interface. This includes changing fonts, colors, highlighting, or whether the **Program Error Detected** dialog box is displayed
- ◆ Save and restore DevPartner Error Detection settings created previously

By customizing the DevPartner Error Detection settings, you control how much data is collected and which portions of the application are monitored.

The DevPartner Error Detection settings are divided into these groups:

- ◆ General
- ◆ Data Collection
- ◆ API Call Reporting
- ◆ Call Validation
- ◆ COM Call Reporting
- ◆ COM Object Tracking
- ◆ Deadlock Analysis
- ◆ Memory Tracking
- ◆ .NET Analysis
- ◆ .NET Call Reporting
- ◆ Resource Tracking
- ◆ Modules and Files
- ◆ Fonts and Colors
- ◆ Configuration File Management

General

Use the check boxes under **General** settings to control following:

- ◆ Event logging

Note: Turning off event logging “silences” Error Detection. Error Detection will not report anything until event logging is turned on again.

- ◆ The **Program Error Detected** dialog box - to display on each error or not
- ◆ Whether or not to display a prompt to save program results when closing Error Detection or starting another session
- ◆ Whether or not to display the **Memory Resource Viewer** dialog box when the target application exits or not
- ◆ The directories to search for source and symbol files
- ◆ The working directory (available only when you use DevPartner Error Detection in standalone mode)
- ◆ Specify command line arguments (available only when you use DevPartner Error Detection in standalone mode)

Data Collection

Use the **Data Collection** settings to control the following features.

- ◆ The depth of various call stacks
- ◆ The amount of data to be stored for non-scalar parameters (for example, structures, classes, and pointers) and return values

If you are working with computers that have limited memory, or if you are analyzing large complex applications, you may want to restrict the size of the **Maximum call stack depth on allocation** to reduce memory requirements.

API Call Reporting

Use **API Call Reporting** settings to control the type of Windows API calls to be logged if **Enable API call reporting** has been selected. You can also control the logging of Windows messages.

To reduce log file sizes, selectively enable API calls for particular Windows module (for example, select GDI32 to log graphics calls).

Call Validation

Use **Call Validation** settings to control whether DevPartner Error Detection validates Windows API parameter and return values. By default, DevPartner Error Detection does not validate parameters.

If you are also tracking memory usage, you can select **Enable memory block checking**. When you select this option, DevPartner Error Detection performs more detailed parameter analysis using the knowledge gathered from the memory tracking system. Enabling this feature will detect more errors but will affect performance.

DevPartner Error Detection includes settings that enable you to restrict the types of validations performed on the Windows APIs. These settings enable you to de-select categories of errors that can generate spurious errors. Examples include flag checks, range checks, and enumeration checks. Explore these options if you want the detailed analysis of handles and pointers but are not interested in other types of validation.

DevPartner Error Detection enables you to select which Windows APIs to check. The default is to check all Windows APIs. If you are interested in a limited set of API calls, select only those modules. This can reduce the number of errors detected and improve performance.

COM Call Reporting

Use **COM Call Reporting** settings to control the COM interfaces that should be logged if **Enable COM method call reporting on objects that are implemented in the selected modules** has been selected.

By default, if **Enable COM method call reporting on objects that are implemented in the selected modules** is selected, DevPartner Error Detection will report on all known COM interfaces. For improved performance, select only the COM interfaces you need to check. Use the tree view that appears under **COM Call Reporting**. Decreasing the number of COM interfaces checked decreases the size of the log file and improves performance.

You can also select **Report COM method calls on objects implemented outside of the listed modules**.

COM Object Tracking

DevPartner Error Detection can monitor COM usage within an application and will report on any code that is leaking interfaces. If an interface leak is detected, DevPartner Error Detection will provide a COM use-count graph showing every `AddRef` and `Release` within the application. The graphs can be used to quickly spot missing `AddRef` or `Release` calls based on your knowledge of the application.

By default, DevPartner Error Detection does not enable COM object tracking. Select **Enable COM object tracking** to activate this feature. When COM object tracking is active, you can select **All COM classes** or you can select individual classes from the list provided.

Deadlock Analysis

Use **Deadlock Analysis** to monitor multi-threaded applications for deadlocks. This includes the following types of analysis:

- ◆ Monitoring and reporting of deadlocks as they occur in the application
- ◆ Monitoring the usage patterns of the synchronization objects within your application for potential deadlocks
- ◆ Monitor your application for synchronization object errors

Memory Tracking

Use **Memory Tracking** settings to control the type of memory leak detection performed on the application. **Memory Tracking** is enabled by default. If you do not want to perform memory leak detection, clear **Enable memory tracking**.

The **Memory Tracking** settings have been preset to generate acceptable results for most applications. The **Enable FinalCheck**, **Guard bytes**, **Fill on allocation** and **Poison on free** settings are of special note.

Enable FinalCheck

Selecting **Enable FinalCheck** has no effect unless your application is instrumented with FinalCheck. FinalCheck is on by default when you select **Instrumenting for Error Detection**. To enable instrumentation without having FinalCheck run, you can disable FinalCheck in the **Memory Tracking** pane of the **Error Detection Settings**.

The recommended usage is to leave **Enable FinalCheck** selected and to clear it only when you want to perform a less-detailed ActiveCheck analysis on an application that is already instrumented.

Guard Bytes

Guard bytes are used to detect memory overruns in ActiveCheck analysis. If you encounter heap corruption and DevPartner Error Detection does not detect the problem, consider increasing the **Count** setting to a larger value. Refer to the online documentation for tips on using these settings to track down heap errors that are hard to find.

Fill on allocation and Poison on free

Fill on allocation sets memory to a known state when it is allocated. **Poison on free** sets memory to a known state when it is deallocated.

The byte patterns used have been carefully selected to cause an application to generate errors if these byte patterns are accidentally used during program execution. Refer to the online documentation for additional information on these settings.

UserAllocators.dat

If you write your own memory allocation logic or override global operator `new`, see [Chapter 4, “Working with User-Written Allocators”](#) and review the documentation (in the form of comments) in the following file:

```
C:\Program Files\Compuware\DevPartner Studio\BoundsChecker  
Data\UserAllocators.dat
```

Note: For installs on 64-bit versions of Windows, the file is located at:
 \Program Files (x86)\Compuware\DevPartner
 Studio\BoundsChecker\Data\UserAllocators.dat

.NET Call Reporting

Use **.NET Call Reporting** settings to control .NET assemblies that should be logged if **Enable .NET method call reporting** has been selected.

By combining .NET and COM call reporting, you can see both sides of COM Interop.

The .NET User Assemblies and .NET System Assemblies are displayed on separate branches of a tree view control.

Performance Tip: .NET Call Reporting can generate a large amount of data, and cause system slowdowns. Enable .NET Call Reporting only when necessary to debug and understand the framework, and even then select only the assemblies you need to check. Limiting the number of assemblies selected in the **All types** tree view decreases the size of the log file and improves performance.

.NET Analysis

DevPartner Error Detection supports mixed native and managed applications. If you are working in mixed environments, you can select **Enable .NET runtime analysis**. DevPartner Error Detection supports the following types of .NET analysis:

- ◆ Monitoring of unhandled exceptions being passed from native to managed code
- ◆ Analysis of .NET Finalizers
- ◆ Managed to native code interoperability
- ◆ Monitoring of garbage collection events

.NET Interoperability

The DevPartner Error Detection .NET Interoperability feature monitors the number of times an application transitions from managed to native code. Use this information to analyze usage patterns and target native code that could benefit from being rewritten in managed code. For best results, use this feature with the **Interop reporting threshold** parameter to specify your own lower limit for acceptable usage.

Resource Tracking

Use **Resource Tracking** settings to control the type of resource leak detection performed on the application. **Resource Tracking** is selected by default. If you do not want to perform resource leak detection, clear the **Enable resource tracking** check-box.

When resource tracking is selected, you can search for all resource leaks or limit the search to particular resources associated with specific libraries in the Windows API.

The resources have been grouped by library and within each library by the API call used to deallocate the resource. For example, if you have recently written a lot of code to manipulate the registry, you might want to de-select all libraries except ADVAPI32, then select only RegCloseKey.

Modules and Files

Use the **Modules and Files** settings to:

- ◆ Identify executables and libraries within your application that should be monitored or ignored
- ◆ Refine the list of executables and libraries to be monitored or ignored down to the source file level if symbols are available
- ◆ Identify a list of **System directories** that should be ignored by the DevPartner Error Detection analyzers

Use the **Modules and Files** settings to control the portions of your application that are monitored by DevPartner Error Detection. For example, you might consider using **Modules and Files** settings when writing large applications or applications such as ISAPI filters.

Note: Disabling all the modules in the **Modules and Files** settings will not prevent reporting of some error types. Error Detection always reports memory overruns within any module, and other types of events originating from the `MFCxxx.dll` libraries.

For more information, see [“Using Modules and Files Settings”](#) on page 32.

Fonts and Colors

Use the **Fonts and Colors** settings to change the font, color and emphasis of each item in the DevPartner Error Detection user interface.

Configuration File Management

Use **Configuration File Management** to create multiple settings files for each project. [Figure 1-1](#) on page 13 shows the Configuration File Management options available. You can then use these settings files throughout the software development cycle to perform various types of analysis. Consider these examples of settings files you might create:

- ◆ Use **Call Validation** and **Modules and Files** to select only your components; use these settings daily as you add new code to your application
- ◆ Use settings under **Memory Tracking** and **Resource Tracking** as you complete new components, or make non-trivial changes to existing components

- ◆ Create a settings file to be used in batch mode over the weekend to analyze the results of major milestones. You might also want to instrument the build with FinalCheck to obtain the most detailed information when you analyze the reports.
- ◆ Create a settings file with various sets of modules selected but all analysis features disabled. You can then load this settings file and select the options you want during an interactive session. This may be especially useful when you need to manage complex modules and files settings.

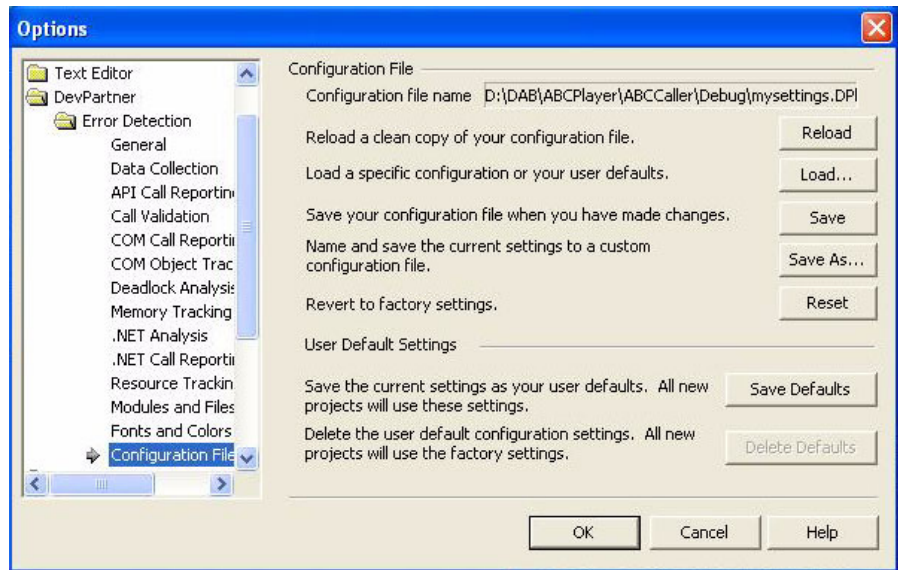


Figure 1-1. Configuration File Management Settings

Configuration File Functions

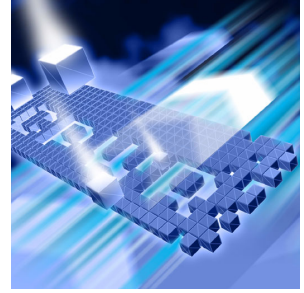
The Configuration File Management page has the following functions available:

- ◆ **Configuration file name:** The full path and name of the configuration file.
- ◆ **Reload:** Loads the current configuration file again, discarding any changes. This returns you to the last saved version of the current configuration file.
- ◆ **Load:** Opens the **Load From** dialog box. Select **Internal User Defaults** to load your user default settings. If you select **Configuration File**, the **Load Configuration File** dialog opens. Use this to select a different configuration file to load.

- ◆ **Save:** Saves all active changes in the currently loaded configuration file.
- ◆ **Save As:** Opens the **Save Configuration File** dialog box. Use this to save the current configuration settings under a different file name.
- ◆ **Reset:** Resets all the program property settings to the default factory settings.
- ◆ **Save Defaults:** Save the current settings as your user defaults. All new projects will use these settings.
- ◆ **Delete Defaults:** Delete the user default configuration settings and revert to factory settings. All new projects will use the factory settings.

Chapter 2

Checking and Analyzing Programs



- ◆ Error Detection Tasks
- ◆ Expanded Uses for DevPartner Error Detection

This chapter describes some of the error detection tasks you can perform with DevPartner Error Detection. It also describes other tasks that you can perform with DevPartner Error Detection.

Error Detection Tasks

DevPartner Error Detection typically includes tasks such as:

- ◆ Finding memory, resource and interface leaks
- ◆ Looking for pointer and memory errors
- ◆ Searching for memory corruption
- ◆ Analyzing the use of legacy code in .NET applications
- ◆ Validating Win32 API calls
- ◆ Searching for application deadlocks

Finding Leaks

DevPartner Error Detection excels at finding memory, resource and interface leaks. By default, DevPartner Error Detection searches for memory and resource leaks but not interface leaks. To search for interface leaks, select **Enable COM object tracking** in the **COM Object Tracking** settings.

DevPartner Error Detection provides two methods of detecting memory leaks, `ActiveCheck` and `FinalCheck`. `ActiveCheck` will search for memory leaks in any Windows application. Leaks will be reported when your application shuts down. `FinalCheck` will comprehensively report memory leaks at run-time as they occur in your application. Examples include when a local variable goes out of scope or when the last pointer to a block of memory is re-assigned, as well as dangling pointer usage and other hard to find errors.

Finding Pointer and Memory Errors

DevPartner Error Detection can search for pointer and memory errors using both `ActiveCheck` and `FinalCheck` technology. In `ActiveCheck` mode, DevPartner Error Detection will monitor pointers passed to Windows calls for errors. Alter the settings for **Call Validation** and **Memory Tracking** to configure the amount of checking done by DevPartner Error Detection.

If you re-compile your program using `FinalCheck`, DevPartner Error Detection will check every pointer reference in your program for correct usage. `FinalCheck` provides very detailed analysis of your program and will locate hard-to-find problems such as uninitialized variables, dangling pointers, unrelated pointer comparisons, array index errors, and so on.

Finding Memory Corruption

DevPartner Error Detection helps you find memory corruption problems caused by the following types of problems:

- ◆ Overrun allocated buffers
- ◆ Continued access to memory after it has been deallocated
- ◆ Deallocating a resource multiple times (e.g. double delete)

DevPartner Error Detection can detect many of these errors in `ActiveCheck` mode but provides the most detailed analysis with `FinalCheck`.

If you encounter memory overrun errors and you are restricted to using only `ActiveCheck`, see the online documentation which contains more information about **Check heap blocks at runtime** in the **Memory Tracking** settings.

Analyzing Transitions to Legacy Code in .NET Applications

DevPartner Error Detection provides the following types of analysis that can help you make the transition from native application to managed application programming:

- ◆ Complete analysis of the native portions of Windows applications
- ◆ Analysis of the transition layer between native and managed sections of applications that use mixed code
- ◆ Analysis of finalizers in managed applications

These types of analysis enable you to monitor:

- ◆ Unhandled exceptions being thrown from native applications and passed to managed code
- ◆ Garbage collector activity that might cause performance problems
- ◆ COM interoperability between managed and native code
- ◆ P/Invoke calls being made from managed code to native windows libraries
- ◆ The frequency of calls across the managed to native boundary

You can use this information to plan and monitor the process of migrating an application.

Migrating from Native to Mixed or Managed Code

The migration process involves the following steps:

- 1 Analyze COM usage for your native application to determine which objects are being used.
- 2 Rewrite a section of the application in managed code using P/Invoke and COM to call native portions of the application.
- 3 Under **.NET Analysis**, select **Enable .NET analysis** and **PInvoke interop monitoring** to analyze the transitions between the newly written code and the existing native code.
- 4 Make any necessary changes.
- 5 Under **.NET Analysis**, select **COM Interop monitoring** and **PInvoke interop monitoring** to monitor the number of calls made between managed and native code. Use the performance data to help make decisions on these additional changes:

- a Determine which additional COM objects should be ported to managed code.
- b Determine if new methods should be added to reduce the number of calls between managed and native code. For example, you might add a method to request data records 10-20 items at a time instead of one at a time.
- c Determine if calls to native APIs (such as the Windows API) are being made efficiently.

You can also check for unhandled exceptions being thrown across the native-to-managed boundary. To do this, select **Exception monitoring** under **.NET Analysis**. Applications written in native code use exceptions to notify a caller that a call or method failed. As sections of your application are re-written in managed code, monitor the use of exceptions to catch exceptions before they transition to managed code.

Validating Win32 API Calls

DevPartner Error Detection recognizes thousands of Windows calls. This capability allows DevPartner Error Detection to validate pointers, flags, enumerations, handles, and return codes. Select **Enable call validation** to confirm that your applications are using Windows calls properly.

You can configure the following **Call Validation** features:

- ◆ Choose what types of Windows calls to monitor
- ◆ Selectively disable various types of validation such as flag, range, and enumeration checking

With these features, you can configure DevPartner Error Detection to validate important parameters such as handles and pointers and to report fewer errors that do not pertain to the task at hand.

Searching for Application Deadlocks

DevPartner Error Detection can identify code that will cause deadlocks in your application. Select **Enable deadlock analysis** to locate deadlocks. Additional controls enable you to fine-tune deadlock analysis.

Expanded Uses for DevPartner Error Detection

Beyond error detection tasks, DevPartner Error Detection can be used as:

- ◆ An aid to understand complex applications
- ◆ A reverse engineering tool
- ◆ A tool for stress testing an application

Understanding Complex Applications

DevPartner Error Detection contains several tools that help you better understand large, complex programs. Consider these three scenarios:

- ◆ A new developer joins an existing team and needs to understand how the various DLLs interact.
- ◆ A consultant has been brought onto a project to solve a problem (such as crashes, memory leaks, and so on) and needs to understand where to concentrate the most resources given a tight engineering schedule.
- ◆ A developer starts using a third-party library and wants to understand why the library is leaking Windows resources. In many cases, the problem is not with the library but in the way that the library is being used.

The following DevPartner Error Detection features can be used to address these scenarios.

COM Object Tracking

Many applications use COM objects that were provided by in-house developers, third-party vendors, or Microsoft. If these COM objects are not used correctly, interface leaks will occur. Interface leaks result in memory and resource leaks — objects allocated from the heap are not released properly, and in turn any memory allocated by those objects is not released properly.

The **COM Object Tracking** enables you to view leaked COM objects. This information can help you determine where the missing `Release` call should be made corresponding to an `AddRef` in your application.

Deadlock Analyzer

Many legacy applications, written before the common use of dual processors, may behave unpredictably when run on more current high-performance computer systems. For example, applications can become deadlocked when they use synchronization objects improperly.

Deadlock analysis under DevPartner Error Detection can identify code that may lead to deadlocks. Note that this analysis can also identify *potential* deadlocks. A potential deadlock is a deadlock waiting to happen when an undesirable set of conditions develop as an application runs. With DevPartner Error Detection, you can identify these potential deadlocks before they occur in a production environment.

Modules and Files

Complex applications are often developed across multiple organizations and include libraries purchased from outside vendors. By default, DevPartner Error Detection will report errors in any non-system DLL. Use the **Modules and Files** settings to restrict DevPartner Error Detection error reporting and call reporting to specific sections of your application. The result is a more meaningful error report that can be used to solve complex problems.

Note: Disabling all the modules in the **Modules and Files** settings will not prevent reporting of some error types. Error Detection always reports memory overruns within any module, and other types of events originating from the `MFCxxxx.dll` libraries.

The Modules Tab

The DevPartner Error Detection **Modules** tab (see [Figure 2-1](#) on page 21) and associated details pane provide a view into your program. This view shows what DLLs are being loaded as the program runs. By carefully reviewing this report, you can answer the following questions and make better-informed decisions when you have to make trade-offs:

- ◆ Is this module instrumented, and how?
- ◆ Is a particular DLL really needed?
- ◆ Is it worth calling only one method in a DLL to incur the cost of n additional DLLs being loaded into the process?
- ◆ Why is my DLL being loaded at the non-preferred load address?
- ◆ Why are multiple versions of the same DLL being loaded into memory?

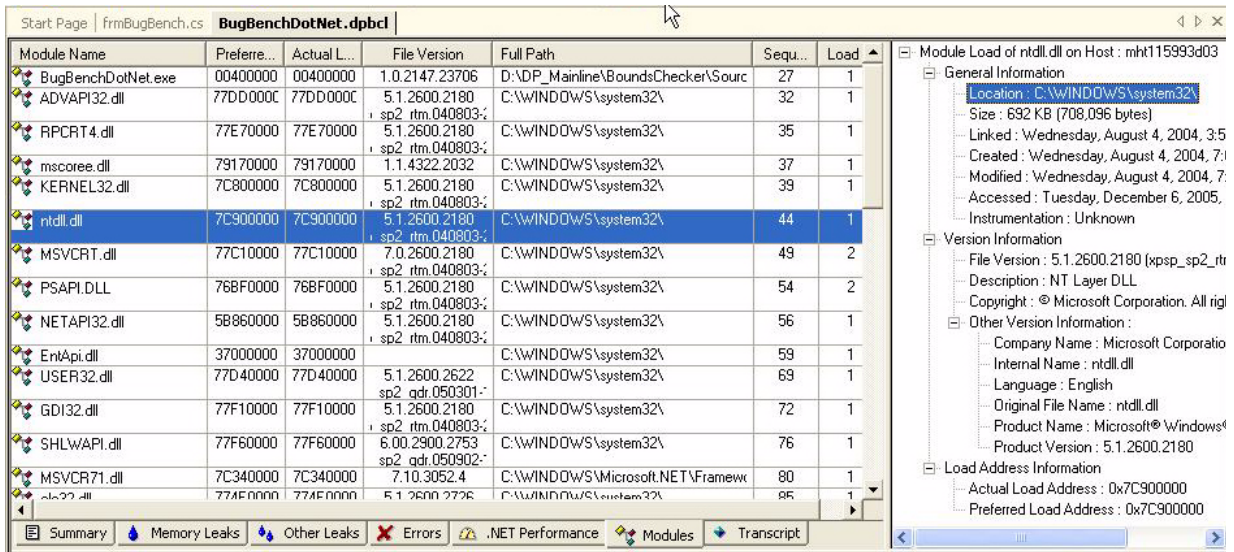


Figure 2-1. Modules Tab and Details Pane

Viewing and Sorting in the Results Pane

DevPartner Error Detection provides a wide variety of ways to view the data collected on your application. Initially, DevPartner Error Detection shows the **Summary** tab, a high-level report, in the **Results** pane. You can review the **Summary** tab and then double-click an entry to view more information.

This capability to navigate through multiple layers of information provides many different views of the data. For example:

- ◆ A technical lead might review the data looking for trends such as more or fewer memory leaks over time
- ◆ A developer might be interested in correcting memory overrun errors, dangling pointers, and so on.

This multi-level view enables you to identify the most relevant data and access a more detailed view in one of the tabs (**Memory Leaks**, **Other Leaks**, **Errors**, **.NET Performance**, or **Modules**) in the **Results** pane. When viewing data in one of the tabs, you can click column headers to further sort data by size, number of occurrences, location, and so on.

Reverse Engineering

DevPartner Error Detection can be used to analyze Windows applications. By creating a configuration with settings like those described in this section, you can use DevPartner Error Detection to monitor and report on the operations being performed by a Windows application.

Data Collection

Increase the **Call parameter encoding depth** parameter to generate more detailed API parameter information. Increasing the encoding depth will slow processing and increase the size of the log file.

API Call Reporting

Select **Enable API call reporting** to log API call and return values. The amount of detail DevPartner Error Detection gathers on parameters and classes passed as parameters is determined by the **Call parameter encoding depth** value under the **Data Collection** settings.

Select **Collect window messages** to record all window messages sent to the application. Selecting this option provides a view of how the application responds to various window events such as mouse clicks, repaint events, etc.

Note: Selecting either of these options will increase the size of the log file and will slow DevPartner Error Detection performance.

To minimize the overhead of API call reporting, select only system DLLs most relevant to the current task.

COM Call Reporting

Select **Enable COM method call reporting** on objects that are implemented in the selected modules to enable collection of COM method calls.

To keep the COM Call Reporting information manageable, select only the most relevant interfaces and clear the **All components** check box.

.NET Call Reporting

Select **Enable .NET Method Call Reporting** to enable collection of .NET method calls. To keep .NET call reporting manageable, select only .NET user assemblies (default setting).

.NET Analysis

When writing mixed native and managed code applications, use the **.NET Analysis** features to:

- ◆ Monitor unhandled exceptions being thrown from native code into managed code
- ◆ Monitor calls (P/Invoke or COM method calls) being made from managed code to native code
- ◆ Select **Exception monitoring** to monitor exceptions.

To monitor calls from managed code to native code, select either **COM Interop monitoring** or **PInvoke monitoring**, then select an appropriate **Interop reporting threshold** value. When monitoring calls from managed to native code, select a sufficiently high reporting threshold value and use the **Modules and Files** settings to reduce unwanted information.

Function Groups to Turn Off for Reverse Engineering

DevPartner Error Detection provides tools to monitor many types of leaks and errors in Windows applications. However, during reverse engineering sessions it may be desirable to turn off the DevPartner Error Detection error and leak detection logic. Follow these steps to disable these features in the **Program Settings** dialog box (in DevPartner Error Detection standalone) or the **Options** dialog box (in the Visual Studio IDE):

- 1 Under **Call Validation**, clear **Enable call validation**.
- 2 Under **COM Object Tracking**, clear **Enable COM object tracking**.
- 3 Under **Memory Tracking**, clear **Enable memory tracking**.
- 4 Under **Resource Tracking**, clear **Enable resource tracking**.
- 5 Under **Deadlock Analysis**, clear **Enable deadlock analysis**.

These features are intended to identify bugs in the code you are examining. By turning off these features, you can concentrate on information that may help you understand how the code in a component or API works.

Modules and Files

By default, DevPartner Error Detection will report on all portions of your application except those parts listed in the **System Directories** exclusion list.

Tip: Remember to select these features after you have finished your reverse engineering session.

When doing reverse engineering, you may want to monitor a few DLLs that would normally be excluded. By monitoring a DLL, you can trace into that DLL to see how it operates.

For example, to understand how a particular common control uses WIN32 API calls, you might explicitly include COMCTL32.DLL then enable **API Call Reporting**.

To monitor system DLLs explicitly, click **Add module** and add the desired DLLs.

Configuration File Management

You can use **Configuration File Management** to create and save settings designed for special tasks in your development cycle.

For example:

- ◆ Memory, Resource and COM leak detection
- ◆ Memory and Validation only
- ◆ Reverse engineering
- ◆ Any of the above, but with restricted sets of DLLs using custom **Modules and Files** settings.

To prevent DevPartner Error Detection from monitoring business-critical portions of your application (such as password checking), you can selectively disable DevPartner Error Detection logging by making calls to the DevPartner Error Detection callable interface at runtime. Please refer to the comments on event reporting in the following file for details:

```
C:\Program Files\Compuware\DevPartner Studio\BoundsChecker\ErptApi\NmApiLib.h
```

Note: For installs on 64-bit versions of Windows, the file is located at:

```
\Program Files (x86)\Compuware\DevPartner Studio\BoundsChecker\ErptApi\NmApiLib.h
```

Stress Testing

A side effect of running DevPartner Error Detection is that it forces an application to deal with many unexpected situations that might only occur under heavy load situations.

Handling Non-zero Uninitialized Data

Many applications are written with the incorrect assumption that local variables and memory returned from dynamic memory allocation routines is initialized to some value. DevPartner Error Detection writes a

known fill pattern over various types of memory when it is allocated to search for uninitialized data access. Examples include local variables, and memory allocated by `new`, `malloc`, `HeapAlloc` or `LocalAlloc`.

If your application has been written assuming that uninitialized memory will be zero, your program may crash or behave unpredictably when run under DevPartner Error Detection. If this occurs, instrument your application with `FinalCheck` and check it again with DevPartner Error Detection to locate the errors.

Note: If you have written your own memory allocation routine that does not follow these rules, add an entry for your routine in the `UserAllocators.dat` file. See [Chapter 4, “Working with User-Written Allocators”](#) for more information.

Pool Poisoning on Free

DevPartner Error Detection writes a known pattern on dynamically allocated memory after it has been deallocated. By doing so, applications that attempt to reference deallocated structures will generate errors. In many cases, dangling pointer errors can be very difficult to diagnose and repair. Instrument your application with `FinalCheck` and check it again with DevPartner Error Detection to locate the errors.

Note: If you have written your own memory allocation routine that does not follow these rules, add an entry for your routine in the `UserAllocators.dat` file. See [Chapter 4, “Working with User-Written Allocators”](#) for more information.

Working in a Heavy CPU-Bound Environment

Many developers write applications on extremely fast and lightly-loaded systems. When the application is moved to a production environment, the program fails randomly. Tracking down timing and performance-related issues can be difficult and time-consuming.

DevPartner Error Detection monitors all aspects of program flow and places your application under a heavy CPU and memory workload. At the same time, DevPartner Error Detection can monitor calls to Windows functions for signs of failure; errors are reported in the **Program Error Detected** dialog box.

Detecting Problems with Multi-threaded Code

Many applications are written to make use of multiprocessor application servers. Unless a multi-threaded application is carefully designed, deadlock and resource deprivation issues can occur when the program is put under stressful conditions.

Running a multi-threaded application under DevPartner Error Detection will cause the performance of various threads to deteriorate and may cause the program to display timing-related problems. Many such problems would normally occur in production situations when the program is under stress. By using DevPartner Error Detection, you may be able to find problems in the development process and correct them before going into production.

Run your application under DevPartner Error Detection with Deadlock Analysis enabled to check for deadlock, potential deadlock, and other synchronization bugs.

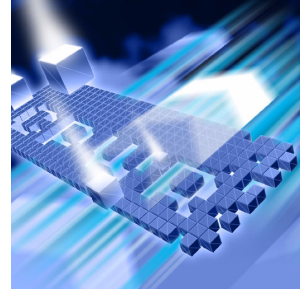
Detecting Memory and Pointer Reuse Errors

As applications have become more complex, the amount of memory and the number of pointers used in applications has increased dramatically. To deal with this problem, software developers use tools such as DevPartner Error Detection to search for memory and resource leaks. However, finding and plugging leaks is only one part of the task. Once memory has been deallocated, all outstanding pointers to the block should be declared as “dangling.” Attempts to reference dangling pointers should generate an error. The FinalCheck feature in DevPartner Error Detection has been designed to find and report on dangling pointers.

Undetected dangling pointers cause programs to reference blocks that have been deallocated or deallocated and reused by some other part of the system. A program run in a simple debugging environment may not show signs of failure. However, this same program could randomly crash, corrupt data or produce unexpected results when moved into a production environment.

Chapter 3

Analyzing Complex Applications



- ◆ About Complex Applications
- ◆ Wait for Process
- ◆ Analyzing Limited Parts of Your Program
- ◆ Deciding What to Monitor
- ◆ Analyzing Services
- ◆ Analyzing ActiveX Controls Using the Test Container
- ◆ Analyzing Applications That Use COM
- ◆ Analyzing ISAPI Filters Under IIS 5.0
- ◆ Analyzing ISAPI Filters under IIS 6.0
- ◆ Frequently Asked Questions

This chapter provides information to help you use DevPartner Error Detection more effectively when checking complex applications.

About Complex Applications

When you debug typical Windows applications, the default DevPartner Error Detection settings gather enough data to help you solve most common programming problems.

When you debug a complex application, you can benefit by customizing the Error Detection settings.

Complex applications can be divided into two groups:

- ◆ Large applications that contain many complex components
- ◆ Non-traditional applications such as Windows NT services, ActiveX components, MTS or COM components, ISAPI filters, and so on

Large Applications

Large Windows application are exceptional only because their size makes them difficult to monitor. Using DevPartner Error Detection, you can analyze a large application in logical, manageable sections, rather than trying to analyze the entire application at once. For example, if you are writing one DLL for a large application, you might:

- ◆ Exclude sections of the application from analysis
- ◆ Monitor only specific sections of the application
- ◆ Monitor only specific transactions within the application

Non-traditional Applications

Non-traditional applications may require different error detection strategies because of complex startup or configuration issues. You can configure DevPartner Error Detection to perform the special debugging or analysis operations required to monitor these types of applications.

DevPartner Error Detection Capabilities and Complex Applications

These Error Detection capabilities can help you analyze complex applications:

- ◆ Ability to Wait for Process
- ◆ Ability to restrict the modules and files monitored by your application
- ◆ Ability to enable or disable the Error Detection log at run-time

Wait for Process

Instead of running your program under Error Detection, you can have Error Detection initialize itself for your application and wait for it to start. You can then start your application manually, or using another means (such as the Service Control Manager). You can use this option to debug services such as IIS.

Note: When using Wait for Process, the full path name of the application that will be launched must exactly match the full path name of the application that Error Detection is looking for.

Note: This option replaces the use of Image File Execution Options in previous releases of BoundsChecker and DevPartner Error Detection.

This option is only available when you are using the DevPartner Error Detection standalone application (BC.EXE), and is not available when using Error Detection integrated into Visual Studio.

To debug an application or service using Error Detection in an “Initialize and Wait” manner:

- 1 Open the image you want to test inside the Error Detection application (BC.EXE).
- 2 Configure Error Detection to watch for the errors that interest you.
- 3 Select **Wait for Process** from the **Program** menu.
Error Detection initializes itself and displays a dialog box allowing you to cancel the session if desired.

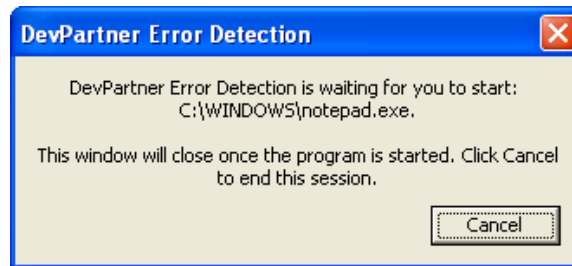


Figure 3-1. Wait for Process Dialog Box

- 4 Start your application as you normally would.
If you normally start your application via the Service Control Manager, then start it that way. Error Detection closes the dialog when your application starts.
- 5 Exercise your application, and then cause it to exit.

Analyzing Limited Parts of Your Program

You can point DevPartner Error Detection at a limited problem area within a large or complex application and ignore the rest of the application. DevPartner Error Detection provides four mechanisms to help you analyze limited parts of your program:

- ◆ Use **Modules and Files** to exclude sections of your program from analysis.
- ◆ Use **Suppressions and Filters** to prevent undesirable information from either being logged or displayed.
- ◆ Use the **Program > Log Events** menu item or the Log Events toolbar button to toggle Error Detection logging.
- ◆ Add conditional code into your application to call `StartEvtReporting` and `StopEvtReporting`.

Note: `StartEvtReporting` and `StopEvtReporting` are DevPartner Error Detection functions that you can call from inside your application to control the writing of data into the DevPartner Error Detection log. If DevPartner Error Detection is not active, these calls return immediately.

Modules and Files

If you are working with large applications, you can use the **Modules and Files** settings to prevent sections of the application from being analyzed. This can reduce analysis time and decrease the number of unwanted error messages. These are some of the sections you can exclude:

- ◆ Unwanted DLLs, including third-party DLLs
- ◆ Individual source files from a DLL or EXE
- ◆ Entire DLL directory trees
- ◆ Exclude errors if source code is unavailable

Note: Disabling all the modules in the **Modules and Files** settings will not prevent reporting of some error types. Error Detection always reports memory overruns within any module, and other types of events originating from the `MFCxxx.dll` libraries.

See [“Using Modules and Files Settings”](#) on page 32.

Suppression and Filtering

There are two ways to hide the errors and events that DevPartner Error Detection reports.

- ◆ **Suppression** prevents a specified type of error or event from being entered into the Error Detection log. To show a suppressed error, you need to remove the suppression instruction and re-run your application under DevPartner Error Detection.
- ◆ **Filtering** hides an error or event that has already been entered into the log. You can hide or display filtered errors.

Selective Event Logging

To monitor a small section of a large application, use the **Log Events** menu or tool bar button to turn the Error Detection log on and off. This technique can be especially useful when you select the following settings:

- ◆ API or COM call logging
- ◆ Call validation.

If you use selective event logging with any of the leak detection features (for example, memory tracking, resource tracking or COM interface tracking) be aware that many leaks are only detected at the end of the program. If logging is off when your program terminates, many of the leaks you are trying to find will not be reported.

When trying to detect leaks, use **Modules and Files** or **Suppression** to exclude unwanted information.

Conditional Code

You can modify your program to make calls into the DevPartner Error Detection data collection engine to enable or disable Error Detection logging. The following sample code shows how to disable Error Detection logging around unwanted areas:

```
// Requires library [installation directory]
\ErptApi\NMApiLib.lib
// Include file is located in [installation directory]\ErptApi
#include "nmapilib.h"
... [Code that can be monitored]
StopEvtReporting()
... [Code that should not be monitored]
StartEvtReporting()
... [Code that can be monitored]
```

You can also use the `StartEvtReporting` or `StopEvtReporting` API calls to prevent DevPartner Error Detection from logging business-critical sections of an application. Examples might include password validation or encryption routines. If DevPartner Error Detection is not active, the API calls return immediately.



Using Modules and Files Settings

To determine what to exclude from your application, follow these steps:

- 1 Open your executable in DevPartner Error Detection.
- 2 Disable all data collection.
 - ◇ In DevPartner Error Detection standalone:
Select **Program > Settings > Error Detection**
 - ◇ In Visual Studio:
Select **DevPartner > Options**

In the Options or Settings dialog box, clear the settings for **API Call Reporting, Call Validation, COM Call Reporting, COM Object Tracking, Deadlock Analysis, Memory Tracking and Resource Tracking**.
- 3 Run your program in DevPartner Error Detection.
Error detection records all DLLs used by your application. Exercise the program in a way that causes all its DLLs to be loaded, then exit your application.
- 4 Open the DevPartner Error Detection **Settings** or **Options** dialog box and select data collection settings.
- 5 Select **Modules and Files** in the **Settings** or **Options** dialog box. DevPartner Error Detection automatically lists all executables and DLLs used by your application except for files located in the system directories.
- 6 Review the list of modules and files. Clear any listed DLLs that do not pertain to the task at hand. From this reduced list of DLLs, expand each DLL and select the source files to monitor.
- 7 To exclude all DLLs in a specific directory, click **System directories** and add the directory to the list of excluded directories. If there is a particular file you want to include from a system directory, click **Add module** to add it to the list of monitored DLLs. Clicking on the folder icon will toggle it from a single folder to multiple folders. [Table 3-1](#) explains the icon meanings.

Table 3-1. Meaning of Folder Icons in this Dialog

Icon	Description
	The selected directory is excluded from testing (unless the specific dll is also listed in the Modules dialog).
	The selected directory and all sub-directories are excluded from testing.

- 8 To exclude leaks and errors in portions of your program without source code, select **Show leaks and errors only if source code is available**.
- 9 After you create a logical subset of your application, use **Configuration File Management** to save your settings.

Table 3-2 provides a list of ways to use the **Modules and Files**: settings.

Table 3-2. Using the Modules and Files Settings

When debugging...	Configure Error Detection to exclude...
An ActiveX control	All modules other than the DLL containing your ActiveX control including the ActiveX test container executable
A Windows NT service	Any modules that are not directly associated with the section of the service you are debugging
An ISAPI filter	All executables and DLLs in IIS or W3WP except your ISAPI filter
A complex application	The sections of the application that do not apply to the problem you are trying to solve
An out of process COM object	Any modules that are not directly associated with your DLL, such as DLLHOST.exe or MTX.exe

Note: If you exclude everything but your code, you might not see memory or resource leaks that are indirectly caused by your section of the application.

Deciding What to Monitor

When dealing with a complex application it is important to know which sections of an application to monitor. Deciding what to monitor and what to ignore will affect your success when tracking down leaks and errors.

Tip: If you plan to create multiple settings files you can name one of the settings files **Base Configuration**. You can then use the **Base Configuration** settings as a starting point to create other settings files.

To decide what to monitor, consider these questions about your application:

- ◆ How does your application start up?
 - ◇ Do you start it directly?
 - ◇ Do you start it by running another program?
 - ◇ Do you launch it from the control panel?
 - ◇ Is your application launched indirectly?
- ◆ How many modules and files are in your application?
 - ◇ Do you own all the modules in your application (other than system modules)?
 - ◇ Do you have source for all of your modules?
- ◆ Are you interested in the entire application or only a part?
 - ◇ Do you care about errors in modules you don't control?
 - ◇ Is your application transactional? If so, do you want to watch the entire application or just a few transactions?
 - ◇ Does your application make use of resources passed to it from code you do not control?

Once you have answered these questions you can configure DevPartner Error Detection to monitor your application.

As you decide what to monitor, remember that other parts of the program may provide resources to your application. Be aware that if you narrow the focus too much, you may miss resources being passed between your selected analysis subset and the rest of your application.

For example, if you are writing an ActiveX control and running it under the test container, you want to know what happens in your DLL. However, if you call your object incorrectly, resource and interface leaks may occur. If you monitor only your control, you will find your errors but you will not find errors caused by incorrect usage of your control.

How Does an Application Start Up?

If you are working with a console or Windows application, you can configure Error Detection to monitor your application by selecting **File > Open**. DevPartner Error Detection will open your application and analyze any DLLs that are directly linked to it.

If you are working with a non-traditional application, it falls into one of two categories:

- ◆ It is started directly through a control program
- ◆ It is started indirectly based on a system action

The first type of application includes ActiveX controls or DLLs that are invoked by some test application. For example, if you have written an ActiveX control, you can analyze it using the Test Container application (TSTCON32.EXE) provided with Visual Studio.

If your application is invoked indirectly by a system action, you can use the Error Detection **Wait for Process** option to wait for the application to start (see “[Wait for Process](#)” on page 28). Examples of this include:

- ◆ Windows NT services
- ◆ Out-of-process COM servers

Many specialized applications, such as services and COM servers, are time critical. If your application is time critical, disable the time out logic when using DevPartner Error Detection for best results.

Analyzing Services

DevPartner Error Detection can monitor Windows NT services. When monitoring services consider the following:

- ◆ Is your service started at boot time or on demand?
- ◆ Does your service require a particular security context?
- ◆ Can your service be run interactively?
- ◆ Can you run your service without being a service?
- ◆ Does your service have timing issues?

DevPartner Error Detection can analyze services that can be started after the system is up and running. For best results, you should be able to manually start or stop your service throughout the debugging process.

Requirements and Guidelines

In order to monitor a service, DevPartner Error Detection requires that the account being used to run it have Administrative privileges. You might have additional problems if your application has tight timing requirements.

Analyzing a Service

Follow these steps to analyze your service with DevPartner Error Detection:

- 1 Stop your service.
- 2 Build the Debug configuration of your service with symbols and no optimization (optionally with FinalCheck).
- 3 Open your service's image with Error Detection and update the settings appropriately for this session.
- 4 Select **Wait for Process** from the **Program** menu.
Error Detection initializes itself and displays a dialog box allowing you to cancel the session if desired.
- 5 Start your service as you normally would.
If you normally start your service via the Service Control Manager, then start it that way. Error Detection closes the dialog when your application starts.

Timing Problems and dwWait

If your service fails to start up, or starts up and almost immediately terminates, you may need to alter the `dwWait` parameter in the `ServiceStatus` block passed to `SetServiceStatus`. If the value specified in your service is too small, the Windows NT **Service Control Manager** will terminate your service. When using DevPartner Error Detection, set `dwWait` to a large value such as 4 million.

Note: After you finish using DevPartner Error Detection, restore the normal value for `dwWait`.

Alternate Method: Separating Control Logic from the Worker Thread

If you have written your service in a modular way, you may be able to separate the service control logic from the worker thread. One technique is to wrap a simple console application around the worker thread logic. This way, you can use DevPartner Error Detection to check your service worker thread as if it were a Windows console program.

Custom Code to Turn the DevPartner Error Detection Log On and Off

When dealing with a service that is not interactive, you can write custom code to turn DevPartner Error Detection logging on and off while the service is running. Write custom code to respond to control codes you pass from the `dwControl` parameter to `ControlService`.

You can make calls to the start and stop event reporting APIs in your service control logic. See [“Conditional Code”](#) on page 31.

Common Service-related Issues

My service starts and immediately hangs.

Make sure you are running your service with Administrative privileges. If you cannot get Administrative privileges, try the alternate method discussed above.

My service starts and almost immediately terminates.

The most likely cause is that the Windows NT Service Control Manager terminated your service. Increase the value of `dwWait` in your service's initialization logic and re-run your service.

Also, you should verify that DevPartner Error Detection has a valid working directory. Specify the working directory via the **General** settings, under **Settings** in the **Program** menu.

If the problem persists, consider modifying your service using the alternate method discussed above.

My service runs for a while then terminates unexpectedly.

Your service may be responding too slowly to a control message requesting your service state. Increase the time out value in `dwWait` when responding to service state requests.

Also, DevPartner Error Detection may have poisoned memory in your application, causing the crash. Disable the **Memory Tracking** feature in the Error Detection settings. If this eliminates the crash, instrument your service with `FinalCheck`, then re-run your application looking for uninitialized memory references, buffer overruns, and dangling pointers.

If the problem persists, consider modifying your service using the alternate method discussed above.

My service runs correctly, but terminates unexpectedly when it shuts down.

Your service is given a limited time to respond when it receives a shut down request from the Service Control Manager. When an application shuts down, DevPartner Error Detection performs many checks, looking for memory, resource and interface leaks, and re-checking allocated memory blocks for memory overruns. If the `dwWait` value specified for acknowledging the shut down request is too small, the Service Control Manager will terminate the service. In this case, increase the `dwWait` value.

If the problem persists, consider modifying your service using the alternate method discussed above.

Analyzing ActiveX Controls Using the Test Container

You can use DevPartner Error Detection with the Test Container utility provided with Visual Studio to monitor ActiveX controls and any other COM object that can be used with the Test Container.

Follow these steps to use DevPartner Error Detection with the Test Container:

- 1 Run DevPartner Error Detection.
- 2 Select **File > Open** and choose the Test Container.
If you installed Visual Studio in the standard directory you will find the test container in one of the following locations:
C:\Program Files\Microsoft Visual Studio 8\Common7\Tools\TestCon32.exe
C:\Program Files\Microsoft Visual Studio 9\Common7\Tools\TestCon32.exe
- 3 Bring up the **Modules and Files** settings.
- 4 De-select TestCon32.exe.
- 5 Click **Add Module**.
- 6 Add the DLL that contains your ActiveX or COM control into the list of modules and files.
- 7 Add any additional DLLs required for your control.
- 8 Run your application.

When the Test Container application starts, follow these steps:

- 1 Click **New Control** on the toolbar.
- 2 Add your control from the list provided (for example, Calendar Control 8.0).
- 3 Use the Invoke Methods and Properties toolbar buttons to manipulate your control.
- 4 When you have finished exercising your control, exit from the Test Container.

During the run, DevPartner Error Detection reports errors as they are detected. When you exit Test Container, DevPartner Error Detection reports memory, resource and interface leaks that were not reported during the run.

Common Test Container Issues

Why is DevPartner Error Detection reporting errors in *TestCon32.exe*?

By default, DevPartner Error Detection reports errors in the executable and all DLLs associated with a process unless the DLLs and EXEs were explicitly excluded using either **Modules and Files** or **System directories**. To prevent DevPartner Error Detection from reporting errors on *TestCon32.exe*, exclude this executable from the list of modules to check.

DevPartner Error Detection COM Call Reporting is not logging calls to my object.

DevPartner Error Detection logs methods only for COM interfaces that it has been instructed to recognize. Tell DevPartner Error Detection about your ActiveX control by selecting **Enable COM method call reporting on objects that are implemented in the selected modules** in the **COM Call Reporting** settings to activate method logging.

DevPartner Error Detection is not reporting COM interface leaks in my object.

To collect COM interface leak information, select **Enable COM object tracking** in the **COM Object Tracking** settings, then select the COM classes to monitor.

To track your own objects, review the list of COM classes in the **COM Object Tracking** settings and select only your classes. If you are unsure which classes to select, select **All COM classes**.

Analyzing Applications That Use COM

DevPartner Error Detection can analyze COM components. For DevPartner Error Detection to analyze COM components, you need to edit the **COM Component Services** settings to establish DevPartner Error Detection as the debugger for the COM component.

Follow these steps to set up DevPartner Error Detection as the debugger for your COM component.

- 1 Choose **Start > Settings > Control Panel > Administrative Tools** -> **Component Services**.
- 2 Use the tree control in the **Component Services** window to open **COM Applications**.
- 3 Select your component from the tree control.

Tip: To avoid deleting `dllhost.exe`, cut and paste or type the path instead of clicking **Browse**.

- 4 Right-click your component and choose **Properties**.
- 5 In the property sheet for your component, click the **Advanced** tab.
- 6 In the **Advanced** tab, select **Launch in debugger**.
- 7 Change the **Debugger path** to point to `bc.exe`. Provide the full path. If you chose the default path when you installed DevPartner Error Detection, this path would be:

```
C:\Program Files\Compuware\DevPartner  
Studio\BoundsChecker\bc.exe
```

Note: For installs on 64-bit versions of Windows, DevPartner Error Detection is located at: `\Program Files (x86)\Compuware\DevPartner Studio\BoundsChecker\bc.exe`.

Caution: Do not delete `dllhost.exe /ProcessID:{...}` from the end of the debugger path.

- 8 Click **OK** to save the changes.

After you establish DevPartner Error Detection as the debugger for your component, follow these steps:

- 1 Start your component using one of the following methods:
 - ◇ Run an application that uses the component.
 - ◇ Start your application using **Component Services**.
 - Select your component from the tree control.
 - Right-click on the component and choose **Start**.
 - 2 When DevPartner Error Detection starts up, select the settings you would like to use, then begin an error detection run.
- Note:** To see errors and events in your COM component only, remove `dllhost.exe` and any other DLLs from the list of modules in the DevPartner Error Detection **Modules and Files** settings.
- 3 After you finish exercising your component, shut down your component. Follow these steps:
 - a In the **Component Services** window, select your component from the tree control.
 - b Right-click the component and choose **Shut down**.
 - 4 DevPartner Error Detection will then perform the normal end-of-process error and leak detection.
 - 5 After you finish debugging, clear the **Launch in debugger** check box:

- a Select the component in the tree view of the **Component Services** window.
- b Right-click the component and choose **Properties**.
- c Click the **Advanced** tab in the property sheet and clear **Launch in debugger**.
- d Click **OK**.

Common COM Issues

Why is DevPartner Error Detection reporting errors in `dllhost.exe`?

By default, DevPartner Error Detection reports errors in the executable and all DLLs associated with a process unless the DLLs and EXEs were explicitly excluded using either **Modules and Files** or **System directories**. To prevent DevPartner Error Detection from reporting errors on `dllhost.exe`, exclude this executable from the list of modules to check.

Why isn't DevPartner Error Detection COM Call Reporting logging calls to my component?

DevPartner Error Detection will log COM method calls only for interfaces that it can recognize. Select **Enable COM method call reporting** (on objects that are implemented in the selected modules) in the **COM Call Reporting** settings to activate method logging.

Why isn't DevPartner Error Detection reporting COM interface leaks in my component?

DevPartner Error Detection will report COM interface leak information only if you select **Enable COM object tracking** in the **COM Object Tracking** settings. You must also indicate which COM classes should be monitored.

To track only your interfaces, review the list of COM classes in the **COM Object Tracking** settings, select your classes and clear all others. If you are unsure what classes should be selected, select **All COM classes**.

DevPartner Error Detection appears to hang and not respond for a long time after I stop exercising my component.

DevPartner Error Detection is waiting for `dllhost.exe` to time out and terminate the process. When `dllhost.exe` terminates, DevPartner Error Detection will perform the final memory, resource and interface leak detection.

To terminate `dllhost.exe` before it times out, locate your component in the **Component Services** window, then right-click your component and choose **Shut down**.

Is there a way to debug `dllhost.exe` using **Wait for Process**?

Debugging `dllhost.exe` using **Wait for Process** is strongly discouraged. Given the number of components being created on Windows 2000 and Windows XP systems, it is safer to use the supported mechanisms provided by COM using the component services debugging options.

Failure to use the supported debugging mechanisms could cause strange system failures when other COM components are requested. The components may not start up properly because you have associated all instances of `dllhost.exe` with DevPartner Error Detection.

Analyzing ISAPI Filters Under IIS 5.0

You can use DevPartner Error Detection to analyze ISAPI filters within an IIS process. Follow these steps to analyze your ISAPI filter with DevPartner Error Detection:

- 1 Build your ISAPI filter with the Debug configuration with symbols and no optimization (optionally with FinalCheck).
- 2 Stop the Internet Information Server (IIS) Service.
- 3 Configure Error Detection for `inetinfo.exe`:
 - a Open `inetinfo.exe` in the Error Detection application (`BC.EXE`). You can find `inetinfo.exe` in:
`%WINDIR%\System32\Inetsrv\inetinfo.exe`
 - b Open **Modules and Files** under **Options/Settings** and clear all EXEs and DLLs.
 - c Click **Add Module** to add your ISAPI filter to the list of modules.
 - d Update the remaining settings appropriately for your ISAPI filter.
- 4 Configure the virtual directory that contains the ISAPI extension you want to test to use the High (Isolated) Application Protection mode.
 - a Open the Internet Information Services Manager.
 - b Browse to the virtual directory.
 - c Right-click and choose **Properties**.
 - d Configure **Application Protection** in the **Virtual Directory** tab to **High (Isolated) Application Protection Mode**.
- 5 Select **Wait for Process** from the **Program** menu.
Error Detection initializes itself for IIS and waits for it to start.
- 6 Start the IIS Admin service from the **Services** control panel.

- 7 Generate a series of HTTP requests to the IIS server to exercise your ISAPI filter.
- 8 After you finish exercising your ISAPI filter, use the Service Control Panel to stop the IIS Service.
- 9 Error Detection then performs end-of-process error and leak detection.

Common ISAPI Filter Issues

Many of the common problems associated with debugging ISAPI filters have already been discussed in the Common issues for Services.

The following issues are specific to IIS and ISAPI filter debugging.

Why does IIS startup and then hang?

DevPartner Error Detection requires Administrative privileges to debug a service. If the account used does not have Administrator privileges, IIS will either hang or terminate almost immediately with an error.

Why does the DevPartner Error Detection log contain so much unwanted information?

Use the Modules and files settings to exclude `inetinfo.exe` and all DLLs except your ISAPI filter.

When you run `inetinfo.exe` the first time, DevPartner Error Detection automatically adds any DLLs that were dynamically loaded into the process to the list of modules and files. Use the **Modules and Files** settings dialog to clear any unwanted DLLs. Do not remove them from the list or they will simply be added back to the list and turned on during the next run.

Are there other sources of information about debugging services and ISAPI filters?

- ◆ There are a number of excellent articles available on MSDN discussing debugging techniques for IIS and ISAPI filters.
- ◆ There are a number of knowledge base articles available on our web site.

Are there tips for debugging IIS interactively with DevPartner Error Detection?

- ◆ You must be logged into an account with Administrative rights.
- ◆ If these suggestions do not solve the your problem, review Microsoft Technical Note 63: Debugging an ISAPI Application:

Analyzing ISAPI Filters under IIS 6.0

You can use DevPartner Error Detection to analyze ISAPI filters if you have configured IIS 6.0 in one of the following ways:

- ◆ IIS 5.0 Isolation Mode
- ◆ IIS 6.0 default configuration

To analyze your ISAPI filter with DevPartner Error Detection, first build your ISAPI filter with Debug and no optimization (optionally with FinalCheck). Then, follow the instructions for the IIS configuration you are using.

IIS 5.0 Isolation Mode

When running IIS 6.0 in the IIS 5.0 Isolation Mode configuration, you will run DevPartner Error Detection against the `inetinfo.exe` executable.

Follow these steps to analyze your ISAPI filter:

- 1 Configure Error Detection for `inetinfo.exe`:
 - a Open `inetinfo.exe` in the Error Detection application (BC.EXE). You can find `inetinfo.exe` in:
`%WINDIR%\System32\Inetsrv\inetinfo.exe`
 - b Open **Modules and Files** under **Options/Settings** and clear all EXEs and DLLs.
 - c Click **Add Module** to add your ISAPI filter to the list of modules.
 - d Update the remaining settings appropriately for your ISAPI filter.
- 2 Configure the virtual directory that contains the ISAPI extension you want to test to use the High (Isolated) Application Protection mode.
 - a Open the IIS Admin utility.
 - b Browse to the virtual directory.
 - c Right-click and choose **Properties**.
 - d Configure **Application Protection** on the **Virtual Directory** tab of this dialog box to be **High (Isolated) Application Protection Mode**.
- 3 Open the **Services** dialog box in the **Control Panel**.

- 4 Select **Wait for Process** from the **Program** menu.
Error Detection initializes itself for IIS and waits for it to start.
 - 5 Start the **IIS Admin** and **World Wide Web Publishing** services.
DevPartner Error Detection will automatically start up and monitor the `inetinfo.exe` process and your ISAPI filter.
 - 6 Generate a series of HTTP requests to the web server to exercise your ISAPI filter.
 - 7 After you finish exercising your ISAPI filter, use the IIS Manager to stop IIS.
When the **Shutting Down** dialog box appears, click **End Now**. This stops the `inetinfo.exe` process.
- Note:** If you click the **Stop** button in DevPartner Error Detection, both DevPartner Error Detection and the `inetinfo.exe` process will be terminated, and you will lose the data you have collected.
- 8 Error Detection will perform end-of-process error and leak detection.

IIS 6.0 Default Configuration

When running IIS 6.0 in the default configuration mode you will run DevPartner Error Detection against the `W3WP.exe` executable.

Follow these steps to analyze your ISAPI filter:

- 1 Configure Error Detection for `W3WP.exe`:
 - a Open `W3WP.exe` in the Error Detection application (`BC.EXE`).
You can find `W3WP.exe` in:
`%WINDIR%\System32\Inetsrv\W3WP.exe`
 - b Open **Modules and Files** under **Options/Settings** and clear all EXEs and DLLs.
 - c Click **Add Module** to add your ISAPI filter to the list of modules.
 - d Update the remaining settings appropriately for your ISAPI filter.
- 2 Configure the virtual directory that contains the ISAPI extension you want to test to use the `MSSharePointAppPool`.
 - a Open the **Internet Information Server (IIS) Manager**.
 - b Browse to the virtual directory.
 - c Right-click and choose **Properties**.
 - d Configure **Application Pool** in the **Virtual Directory** tab to `MSSharePointAppPool`.
- 3 Select **Wait for Process** from the **Program** menu.
Error Detection initializes itself for IIS and waits for it to start.

- 4 Start the **IIS Admin** and **World Wide Web Publishing** services. Error Detection will automatically start up and monitor the W3WP.exe process and your ISAPI filter.
 - 5 Generate a series of HTTP requests to the web server to exercise your ISAPI filter.
 - 6 After you finish exercising your ISAPI filter, use the IIS Manager to stop IIS.
When the **Shutting Down** dialog box appears, click **End Now**. This stops the W3WP.exe process.
- Note:** If you click the **Stop** button in DevPartner Error Detection, both Error Detection and the W3WP.exe process will be terminated, and you will lose the data you have collected.
- 7 Error Detection will perform end-of-process error and leak detection.

Common IIS 6.0 ISAPI Filter Issues

All of the items in the IIS 5.0 Common ISAPI Filter issues section apply. In a few cases you may need to substitute W3WP.exe for inetinfo.exe.

See “[Common ISAPI Filter Issues](#)” on page 43.

The following new issues apply to IIS 6.0:

- ◆ Microsoft has re-designed the IIS 6.0 default configuration to be more secure. One of these changes disables ISAPI Extensions by default. To debug an ISAPI extension, go to the Web Services Extensions tab in the IIS Admin tool and modify IIS to allow Unknown ISAPI extensions.
 - ◆ Use the IIS Manager tool to Start, Stop or Restart IIS. To perform these operations, right-click the <**MachineName**> node in the tree and select **All Tasks->Restart IIS**. This opens a dialog box with controls that enable you to start and stop IIS.
 - ◆ For best results, turn off logging functions, such as API Call Logging, before you monitor IIS. With logging functions on, DevPartner Error Detection creates extremely large log (.DPBcl) files and will impact the performance of the IIS server.
- Note:** Do not turn off **Log events** on the general dialog. Error Detection will not report anything as long as **Log events** is disabled. Use this feature only when you want to suppress all reporting until you specifically enable event logging via the menu bar button.

Frequently Asked Questions

What is the difference between DevPartner Error Detection ActiveCheck and FinalCheck or technologies?

DevPartner Error Detection has two modes of operation:

- ◆ **ActiveCheck** - In this mode DevPartner Error Detection will operate on any 32-bit Windows program and will intercept all calls to the operating system and C run-time library looking for memory leaks, resource leaks, and usage of pointers that are passed to functions that aren't valid (or have been de-allocated).
- ◆ **FinalCheck** - In this mode you must re-compile your C or C++ program using DevPartner Error Detection FinalCheck instrumentation logic. To build using FinalCheck:, click DevPartner > **Native C/C++ Instrumentation Manager**

With FinalCheck instrumentation, DevPartner Error Detection can watch every pointer fetch, store, or indirect occurring within the modules you instrument. DevPartner Error Detection can also watch variables go in and out of scope.

Caution: Instrumenting code without a well defined order of evaluation can cause unexpected results, including erroneous data, hangs, and even crashes.

"Basically, in C and C++, if you read a variable twice in an expression where you also write it, the result is undefined." -Bjarne Stroustrup

The C/C++ standard explicitly does *not* define the order of evaluation when there are "side effects", such as storing a value in an object. For example, the following statement does not have a well defined order of evaluation: `i = ++i + 2;`

There are two points in this statement when values are stored in the variable *i*, and the language does not define what order they occur in. Instrumenting code like this may change the order of evaluation and change the result.

Note that when you run in FinalCheck mode, all ActiveCheck analysis is still performed along with the extended FinalCheck analysis.

FinalCheck specializes in finding dangling pointers, double deallocations, pointer overruns, uninitialized memory errors, read / write to unallocated memory.

When should I enable Call Validation?

Enabling Call Validation will cause DevPartner Error Detection to find many more memory and pointer errors in your program. This feature is off by default because the volume of detected events can be large.

[What is DevPartner Error Detection doing when I select the **Enable memory block checking** feature under **Call Validation**?](#)

When you select **Enable memory block checking**, (which is turned off by default), DevPartner Error Detection performs a more detailed ActiveCheck analysis. Note that this feature can cause DevPartner Error Detection to run as much as 20% slower.

[How do I use the DevPartner Error Detection **Guard byte** settings under **Memory Tracking**?](#)

To alter the Guard bytes settings in the Memory Tracking configuration, first make sure that **Enable guard bytes** is checked.

Increase **Count** from 4 to a larger value of 8 or 16.

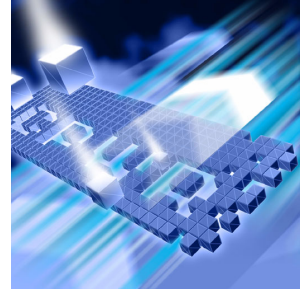
Increasing the number of guard bytes will increase the spacing between heap blocks and will provide an area between your blocks for DevPartner Error Detection to monitor for overruns.

Change the settings of **Check heap blocks at runtime** to either **Use adaptive analysis** or **On all memory API calls**.

This option tells DevPartner Error Detection to validate each heap block whenever you make a call into a memory function. This will make your program run much slower but will isolate heap corruption to a localized area of your program, making it easier to track down.

Chapter 4

Working with User-Written Allocators



- ◆ Introduction
- ◆ Gathering Necessary Information
- ◆ Creating Entries in UserAllocators.dat
- ◆ Coding UserAllocator Hook Requests
- ◆ Debugging UserAllocator Hooks
- ◆ How to Diagnose Errors in UserAllocators.dat

This chapter provides information to help you implement user-written memory allocators.

Introduction

DevPartner Error Detection can perform memory analysis on user-written memory allocators. To do this, add descriptions of your memory allocators to a text file called `UserAllocators.dat`, which is installed in the data sub-directory of the DevPartner Error Detection installation. After you add user-written allocators to this file, DevPartner Error Detection treats them like memory allocation routines provided with the operating system. If DevPartner Error Detection detects a leak caused by a user-written allocator described in `UserAllocators.dat`, the user-written allocator will be shown in the Program Error Detected dialog box instead of the lower-level allocator within the user-written allocator.

Gathering Necessary Information

Before adding a user-written allocator to `UserAllocators.dat`, you need to gather the following information:

- 1 The exact names of the allocation, deallocation, reallocation and size functions of your user-written allocator.
- 2 Find out if your user-written memory allocator is statically linked to the application or is provided in a separate module (DLL).
- 3 The name of the module (DLL) that contains your user-written allocator.
- 4 Examine the parameters to your routines to determine how the size of the block and pointer associated with the memory block is either passed or returned to the caller.
- 5 Any special assumptions made in your allocator such as zeroing memory on allocation or a user-written allocator that stores data in deallocated blocks.

Finding the Names of User-Written Allocators

To add records to `UserAllocators.dat` you need to provide the exact name of your `allocate`, `deallocate`, `realloc` and `size` functions.

Follow these steps to locate the name of the routine:

- 1 Determine the name of the following functions:
 - ◇ Allocation function (such as `malloc`, `calloc`, or `new`)
 - ◇ Deallocation function (such as `free` or `delete`)
 - ◇ Reallocation function (such as `realloc` or `realloc`)
 - ◇ Memory block size function (such as `_msize`)
- 2 There are two basic cases to consider:
 - ◇ You have symbols (pdb files) for the module that contains the function that you are defining.
If a pdb file is available, internal symbols can be used. To find the mangled or expanded function name, use the linker/debugger options to create a map file when compiling the module. Then look under the **Publics by Value** section of the map file to determine the name of the function. This method always requires the `Static` keyword in the `userAllocator` function definition.

- ◇ You do not have symbols, or the symbols are invalid.
If no pdb file is available, enter `dumpbin /exports yourlibrary.dll` at the Visual Studio command prompt. Use the function names as they appear in the output.

The name of your allocation functions may be either unmangled or mangled depending on the calling convention used and your choice of languages. If you are using C++, names will usually be mangled. Consider the following small C++ program:

```
#include <malloc.h>
#include <memory.h>

class SampleClass
{
public:
    SampleClass(){}
    void *operator new( size_t stAllocateBlock );
    void operator delete( void * pBlock);
};
void *SampleClass::operator new( size_t stAllocateBlock )
{
    void *pvTemp = malloc( stAllocateBlock );
    if( pvTemp != 0 )
        memset( pvTemp, 0, stAllocateBlock );
    return pvTemp;
}
void SampleClass::operator delete(void * pBlock)
{
    free(pBlock);
    return;
}
int main(int argc, char * argv[])
{
    SampleClass *pClass = new SampleClass;
    return 0;
}
```

Before building the application, select **Generate mapfile** under the Visual Studio Project settings. After you build your application, open the map file and search for the operator new and operator delete methods. They will look something like this:

```
global operator new:      ??2SampleClass@@SAPAXI@Z
global operator delete:  ??3SampleClass@@SAXPAX@Z
```

These operators could be described to `UserAllocators.dat` as follows:

```
Allocator
  Module=myModule
  Function=??2SampleClass@SAPAXI@Z
  MemoryType=MEM_CUSTOM1
  NumParams=1
  Size=1
  NoFill Static Debug
Deallocator
  Module=myModule
  Function=??3SampleClass@SAXPAX@Z
  MemoryType=MEM_CUSTOM1
  NumParams=1
  Address=1
  Static Debug
```

Special Assumptions Made By User-Written Allocators about Memory

Normally, DevPartner Error Detection will fill allocated memory with a fill pattern before returning the pointer to the user program and will “poison” the block of memory after it has been deallocated.

If your memory allocator initializes the block with special data, you will need to use the NOFILL flag so you do not overwrite the block and lose the data.

If your memory allocator assumes that it can read from the block after it has been deallocated, you will need to use the NOPOISON flag. There are various reasons why you might not want “poisoning” to occur:

- ◆ Your memory allocator stores data in the deallocated block to track the allocation status, link it to other deallocated blocks, etc.
- ◆ Your application assumes that deallocated blocks can continue to be referenced until the block has been reallocated. Continuing to reference deallocated blocks is a dangerous practice, but many applications that do this are still in use.

Creating Entries in UserAllocators.dat

After you collect the information described in “[Gathering Necessary Information](#)” on page 50, you can describe your allocator in `UserAllocators.dat`.

To describe a function, create one record in the file per function. Each record follows this form:

Record_Type Parameter_1 Parameter_2 Etc...

Record_Type describes the type of function you are creating. The parameters that follow provide additional information about your allocator function.

When you create a record, separate each field with one or more space or tab characters. Records may span multiple lines.

[Table 4-1](#) shows the Record Types that are currently defined.

[Table 4-1](#). Record Types

Record Type	Description
Allocator	Functions that allocate memory.
Deallocator	Functions that deallocate memory.
QuerySize	Functions that can query the size of a given memory block that was previously allocated by the Allocator function.
Reallocator	Functions that can adjust the size of a memory block that was previously allocated using the Allocator function. Note that the Reallocator function may or may not return the same block of memory.
Ignore	Allocator or deallocator functions that you want DevPartner Error Detection to ignore (not track memory).

Modules

Each of the UserAllocator record types requires you to specify the module that contains the function being described. There are three different types of modules that can be described.

Table 4-2. Module types

Module Type	Description
Named module	<p>An explicitly named module (DLL) that contains the user allocation function or method (for example, <code>foo.dll</code>).</p> <p>Note: Module names do not support the use of wildcards.</p>
Statically linked user allocator	<p>An explicitly named module (DLL or executable) that contains the user allocation function or method. However, in this case, the function or method was originally part of a library (.lib file). Once linked into the module, the customer code can reference the functions or methods but they are not externally visible. You must provide debug symbols for the module and use the optional <code>STATIC</code> keyword to alert DevPartner Error Detection to look for the function or method in the debug symbols.</p> <p>Note: Failure to include the <code>STATIC</code> keyword in the optional parameters for the record will prevent DevPartner Error Detection from properly monitoring the user-written allocation function or method.</p>
*CRT	<p>This is a special case that enables you to reference a function wherever it appears in your application.</p> <p>Note: The * in *CRT is not a wildcard character.</p> <p>*CRT covers the following 3 cases:</p> <ul style="list-style-type: none">• The Microsoft C Runtime Library• The statically linked C runtime library• Any user function that has the same mangled name as anything that you are patching (for example, <code>global operator new</code>.)

Allocator Records

Create an allocator record to describe a function that allocates memory. Follow this format:

```
Allocator Module=module_name Function=func_name  
MemoryType=mem_type NumParams=param_num Size=size_value  
[Count=count_num] [BufferLoc=buffer_loc] [Optional  
Parameters]
```

Note: By default, the address of the allocated block is the returned value of the specified function. Override this behavior by specifying the BufferLoc parameter to indicate that the address of the allocated block is returned in a parameter. (see `MAPIAllocateBuffer` in the `UserAllocators.dat` file).

DevPartner Error Detection assumes that the allocation failed if the location where it expects to find the address of the allocated block is NULL after the call (either the return value or the value in the parameter specified by BufferLoc).

Table 4-3. Allocator Record Parameters

Parameter	Description
Allocator	The first parameter in the record must be the word <code>Allocator</code> to indicate that you are describing an allocation routine.
module_name	The name of the module (Executable or DLL) that contains the user-written allocator. Note: Module names do not support the use of wildcards.
func_name	The name of the function that allocates blocks of memory in your user-written allocator. If you are using C++, this should be the 'mangled' name of the function. This parameter is case-sensitive.

Table 4-3. Allocator Record Parameters (Continued)

Parameter	Description
mem_type	<p>Use this parameter to describe what type of memory is being allocated. DevPartner Error Detection currently defines the following memory types:</p> <ul style="list-style-type: none"> • MEM_MALLOC Blocks of memory returned from routines such as malloc, calloc, strdup, and so on. Memory of this type is freed using a routine similar to the C runtime library free routine. • MEM_NEW Blocks of memory that are returned from operator new and are freed by operator delete. • MEM_CUSTOM1 through MEM_CUSTOM9 Blocks of memory that must be paired with a particular deallocator. These types allow developers to declare their own custom memory allocators that do not interact with the standard memory allocators described above. <p>DevPartner Error Detection will verify that a block of memory allocated with a given memory type is freed by a function of the same type. If the type does not match, DevPartner Error Detection will display a memory conflict error at runtime.</p>
param_num	<p>The number of parameters passed to your function. This value must be between 1 and 32.</p> <p>Provide the proper number of parameters when describing a user-written allocator function. Failure to provide the correct value can cause unpredictable results.</p>
size_value	<p>The number of the parameter that contains the size of the block to be allocated. The number of the first parameter is 1.</p>
count_num	<p>This optional parameter describes calloc-like functions that accept size and count parameters. If specified, the count indicates how many blocks of the specified size should be allocated. If you omit this parameter, DevPartner Error Detection assumes that the count is always 1.</p>
buffer_loc	<p>The number of the parameter containing the address that will hold the address of the allocated block. The number of the first parameter is 1.</p>

Table 4-3. Allocator Record Parameters (Continued)

Parameter	Description
[Optional Parameters]	<p>You can include the following optional parameters at the end of the record:</p> <ul style="list-style-type: none"> • DEBUG If this parameter is specified, DevPartner Error Detection displays additional information about the hook. The output window (or dbgview) will contain information on any errors that occurred when attempting to place the hook. The transcript pane will display statistics about each hook, including whether the function was successfully hooked and the number of times the hooked function was called. • NODISPLAY If this parameter is specified, DevPartner Error Detection will stop displaying detailed information on each hook requested at the top of the transcript pane. • NOFILL If this parameter is specified, DevPartner Error Detection will not fill the buffer returned with the DevPartner Error Detection 'fill' character. Note: If your user-written allocator initializes the block with data, like calloc does, specify NOFILL to avoid corrupting your data. • NOGUARD If this parameter is specified, DevPartner Error Detection will not add any guard bytes at the end of the blocks created by this allocation function. • STATIC DevPartner Error Detection will statically patch the user-written allocator. Specify the static option if your user-written allocator is linked into your application and is not provided in a separate DLL with an exported interface.

Sample Allocator Records

The following examples show hypothetical allocator record functions.

- Example 1** In this example, the function `mallocXX` is located in a library called `MyAlloc.dll`. The function is assumed to be a `malloc`-type operator with one parameter with the size being passed in the first parameter. DevPartner Error Detection should not fill the memory block before returning it to the application program. Any `MEM_MALLOC` type function can free blocks allocated by this function.

```
Allocator Module=MyAlloc.dll Funtion=mallocXX
MemoryType=MEM_MALLOC NumParams=1 Size=1 NOFILL
```

- Example 2** This example comes from the file used to track a custom global operator new in the Microsoft `iostream` code. Note that this function is located in the C runtime library. The record specifies `*CRT` as the module name so DevPartner Error Detection assumes that the function is located in one of the Microsoft C or C++ runtime libraries.

This function takes four parameters with the size being stored in the first parameter. DevPartner Error Detection is allowed to fill the block before returning to the program requesting the memory.

```
Allocator Module=*CRT Function=??2@YAPAXIHPBDH@Z
MemoryType=MEM_NEW NumParams=4 Size=1
```

- Example 3** This example describes a function called `CustomAllocXX` that takes one parameter with the size being passed in the first parameter.

DevPartner Error Detection should not fill the buffer before returning it to the application program. Note that this record specifies `MEM_CUSTOM1` as the `MemoryType`. DevPartner Error Detection verifies that the memory allocated with this function is deallocated by a routine that is also of type `MEM_CUSTOM1`. Using other deallocation routines will generate an allocation conflict message after freeing the memory.

```
Allocator Module=foo.dll Function=CustomAllocXX
MemoryType=MEM_CUSTOM1 NumParams=1 Size=1 NOFILL
```

- Example 4** In this example, a function called `MyAlloc` has been built as a `.LIB` file and is statically linked to a data collection component called `DataStore.dll`. `MyAlloc` accepts four parameters. The first is the size of the data record; the second is the number of records to be allocated in a single block. The third parameter contains the address of the location holding the address of the allocated block. The memory retrieved from the application has been pre-initialized so DevPartner Error Detection should not fill the block.

```
Allocator Module=DataStore.dll Function=MyAlloc BufferLoc=3
MemoryType=MEM_MALLOC NumParams=4 Size=1 Count=2
NOFILL STATIC
```

Note: The `STATIC` keyword must be specified if the function name is not exported from the DLL.

Deallocator Records

Create a Deallocator record to describe a function that deallocates memory. Follow this format:

```
Deallocator Module=module_name Function=func_name  
           MemoryType=mem_type NumParams=param_num  
           Address=address_value [Optional Parameters]
```

Table 4-4. Deallocator Record Parameters

Parameter	Description
Deallocator	The first parameter in the record must be the word Deallocator to indicate that you are describing a deallocation routine.
module_name	The name of the module (Executable or DLL) that contains the user-written allocator. Note: Module names do not support the use of wildcards.
func_name	The name of the function that deallocates blocks of memory in your user-written allocator. If you are using C++, this should be the 'mangled' name of the function. This parameter is case-sensitive.

Table 4-4. Deallocator Record Parameters (Continued)

Parameter	Description
mem_type	<p>This parameter provides a mechanism to describe what type of memory is being deallocated. DevPartner Error Detection currently defines the following memory types:</p> <ul style="list-style-type: none"> • MEM_MALLOC Describes blocks of memory returned from routines such as malloc, calloc, strdup, and so on. Memory of this type is freed using a routine similar to the C runtime library free routine. • MEM_NEW Describes blocks of memory that are returns from operator new and are freed by operator delete. • MEM_CUSTOM1 through MEM_CUSTOM9 Describes blocks of memory that must be paired with a particular deallocator. These types allow developers to declare their own custom memory allocators that do not interact with the standard memory allocators described above. <p>DevPartner Error Detection will verify that a block of memory allocated with a given memory type is freed by a function of the same type. If the type doesn't match, DevPartner Error Detection will display a memory conflict error at runtime.</p>
param_num	<p>The number of parameters passed to your function. This value must be between 1 and 32.</p> <p>Provide the proper number of parameters when describing a user-written allocator function. Failure to provide the correct value can cause unpredictable results.</p>
address_value	<p>The number of the parameter that contains the pointer to the block being deallocated. The number of the first parameter is 1.</p>

Table 4-4. Deallocator Record Parameters (Continued)

Parameter	Description
[Optional Parameters]	<p>The following optional parameters may be included at the end of the record:</p> <ul style="list-style-type: none"> • DEBUG If this parameter is specified, DevPartner Error Detection displays additional information about the hook. The output window (or dbgview) will contain information on any errors that occurred when attempting to place the hook. The transcript pane will display statistics about each hook, including whether the function was successfully hooked and the number of times the hooked function was called. • NODISPLAY If this parameter is specified, DevPartner Error Detection will stop displaying detailed information on each hook requested at the top of the transcript pane. • NOPOSION When you specify NOPOISON, DevPartner Error Detection will not 'poison' the block of memory after it has been deallocated. If your user-written allocator stores data in the block after it has been deallocated or your application continues to use data in the block after it has been deallocated, specify NOPOSION to avoid corrupting your data. • STATIC DevPartner Error Detection will statically patch the user-written allocator. Specify the static option if your user-written allocator is linked into your application and is not provided in a separate DLL with an exported interface.

DevPartner Error Detection does not check the return value from a deallocation function.

Sample Deallocator Records

The following examples show hypothetical deallocator records.

Example 1 In this example, a function called `freeXX` is located in a library called `MyAlloc.dll`. The function takes one parameter with the pointer to the block to be deallocated being passed in the first parameter. DevPartner Error Detection should not poison the memory before returning to the application program.

```
Deallocator Module=MyAlloc.dll Function=freeXX
MemoryType=MEM_MALLOC NumParams=1 Address=1 NOPOISON
```

Example 2 This example describes a function called `MyFree` in `foo.dll`. The function takes one parameter with the pointer to the block to be deallocated being passed in the first parameter. DevPartner Error Detection should poison the memory before returning to the application program. When the block is deallocated, DevPartner Error Detection verifies that the block was allocated by an allocator of type `MEM_CUSTOM1`. If the block was not from this group, an error would be generated.

```
Deallocator Module=foo.dll Funtion=MyFree
MemoryType=MEM_CUSTOM1 NumParams=1 Address=1
```

Example 3 In this example, a function called `MyFree` has been built as a `.LIB` file and is statically linked to a data collection component called `DataStore.dll`. `MyFree` accepts three parameters. The first and last parameters are of no interest to DevPartner Error Detection. The second parameter contains the address to be deallocated. Also, the private deallocation routine maintains private information in the deallocated block after the block has been freed.

```
Deallocator Module=DataStore.dll Function=MyFree
MemoryType=MEM_MALLOC NumParams=3 Address=2 NOPOISON
STATIC
```

Note: Specify `STATIC` if the function name is not exported from the DLL.

QuerySize Records

Create a QuerySize record to describe a function that returns the size of an allocated block of memory. Follow this format:

```
QuerySize Module=module_name Function=func_name  
          MemoryType=mem_type NumParams=param_num  
          Address=address_value [Optional Parameters]
```

Note: if you omit a QuerySize record for a user-defined allocator, DevPartner Error Detection will return an incorrect block size for that function.

Table 4-5. QuerySize Records

Parameter	Description
QuerySize	The first parameter in the record must be the word QuerySize to indicate that you are describing a size routine.
module_name	The name of the module (Executable or DLL) that contains the user-written allocator. Note: Module names do not support the use of wildcards.
func_name	The name of the function that returns the size of allocated blocks of memory in your user-written allocator. If you are using C++, this should be the 'mangled' name of the function. This parameter is case-sensitive.

Table 4-5. QuerySize Records (Continued)

Parameter	Description
mem_type	<p>This parameter provides a mechanism to describe what type of memory is being queried. DevPartner Error Detection currently defines the following memory types:</p> <ul style="list-style-type: none"> • MEM_MALLOC Describes blocks of memory returned from routines such as malloc, calloc, strdup, and so on. Memory of this type is freed using a routine similar to the C runtime library free routine. • MEM_NEW Describes blocks of memory that are returns from operator new and are freed by operator delete. • MEM_CUSTOM1 through MEM_CUSTOM9 Describes blocks of memory that must be paired with a particular deallocator. These types allow developers to declare their own custom memory allocators that do not interact with the standard memory allocators described above. <p>DevPartner Error Detection will verify that a block of memory allocated with a given memory type is freed by a function of the same type. If the type doesn't match, DevPartner Error Detection will display a memory conflict error at runtime.</p>
param_num	<p>The number of parameters passed to your function. This value must be between 1 and 32.</p> <p>Provide the proper number of parameters when describing a user-written allocator function. Failure to provide the correct value can cause unpredictable results.</p>
address_value	<p>The number of the parameter that contains the pointer to the block being queried. The number of the first parameter is 1.</p>

Table 4-5. QuerySize Records (Continued)

Parameter	Description
[Optional Parameters]	<p>The following optional parameter may be included at the end of the record:</p> <ul style="list-style-type: none"> • DEBUG If this parameter is specified, DevPartner Error Detection displays additional information about the hook. The output window (or dbgview) will contain information on any errors that occurred when attempting to place the hook. The transcript pane will display statistics about each hook, including whether the function was successfully hooked and the number of times the hooked function was called. • NODISPLAY If this parameter is specified, DevPartner Error Detection will stop displaying detailed information on each hook requested at the top of the transcript pane. • STATIC DevPartner Error Detection will statically patch the user-written allocator. Specify the static option if your user-written allocator is linked into your application and is not provided in a separate DLL with an exported interface.

The return value from this function is assumed to be a `size_t` that provides the size of the block.

Sample QuerySize Records

The following examples show hypothetical QuerySize records.

Example 1 In this example, a function called `MySize` is located in a library called `foo.dll`. The function takes one parameter with the pointer to the block being queried in the first parameter

```
QuerySize Module=foo.dll Function=MySize
MemoryType=Mem_Custom1 NumParams=1
Address=1
```

Example 2 In this example, a function `MySize` has been statically linked into a data collection component called `DataStore.dll`. The `MySize` function accepts two parameters and the address being queried is passed in the first parameter.

```
QuerySize Module=DataStore.dll Function=MySize
MemoryType=MEM_NEW NumParams=2
Address=1 STATIC
```

Note: Specify `STATIC` if the function name is not exported from the DLL.

Reallocator Records

Create a Reallocator record to describe a function that reallocates memory. Follow this format:

```
Reallocator Module=module_name Function=func_name  
MemoryType=mem_type NumParams=param_num  
Address=address_value Size=size_value  
[Count=count_num] [BufferLoc=buffer_loc] [Optional  
Parameters]
```

Note: By default, the address of the allocated block is the returned value of the specified function. Override this behavior by specifying the BufferLoc parameter to indicate that the address of the allocated block is returned in a parameter. (see `MAPIAllocateBuffer` in the `UserAllocators.dat` file).

Table 4-6. Reallocator record parameters

Parameter	Description
Reallocator	The first parameter in the record must be the word Reallocator to indicate that you are describing a Reallocation routine.
module_name	The name of the module (Executable or DLL) that contains the user-written allocator. Note: Module names do not support the use of wildcards.
func_name	The name of the function that reallocates blocks of memory in your user-written allocator. If you are using C++, this should be the 'mangled' name of the function. This parameter is case-sensitive.

Table 4-6. Reallocator record parameters (Continued)

Parameter	Description
mem_type	<p>This parameter provides a mechanism to describe what type of memory is being reallocated. DevPartner Error Detection currently defines the following memory types:</p> <ul style="list-style-type: none"> • MEM_MALLOC Describes blocks of memory returned from routines such as malloc, calloc, strdup, and so on. Memory of this type is freed using a routine similar to the C runtime library free routine. • MEM_NEW Describes blocks of memory that are returns from operator new and are freed by operator delete. • MEM_CUSTOM1 through MEM_CUSTOM9 Describes blocks of memory that must be paired with a particular deallocator. These types allow developers to declare their own custom memory allocators that do not interact with the standard memory allocators described above. <p>DevPartner Error Detection will verify that a block of memory allocated with a given memory type is freed by a function of the same type. If the type doesn't match, DevPartner Error Detection will display a memory conflict error at runtime.</p>
param_num	<p>The number of parameters passed to your function. This value must be between 1 and 32.</p> <p>Provide the proper number of parameters when describing a user-written allocator function. Failure to provide the correct value can cause unpredictable results.</p>
address_value	<p>The number of the parameter that contains the pointer to the block being reallocated. The number of the first parameter is 1.</p>
size_value	<p>The number of the parameter that contains the size of the block to be reallocated. The number of the first parameter is 1.</p>
count_num	<p>This optional parameter describes calloc-like functions that accept size and count parameters. If specified, the count indicates how many blocks of the specified size should be allocated. If you omit this parameter, DevPartner Error Detection assumes that the count is always 1.</p>

Table 4-6. Reallocator record parameters (Continued)

Parameter	Description
buffer_loc	The number of the parameter containing the address that will hold the address of the reallocated block. The number of the first parameter is 1.
[Optional Parameters]	<p>The following optional parameters may be included at the end of the record:</p> <ul style="list-style-type: none"> • DEBUG If this parameter is specified, DevPartner Error Detection displays additional information about the hook. The output window (or dbgview) will contain information on any errors that occurred when attempting to place the hook. The transcript pane will display statistics about each hook, including whether the function was successfully hooked and the number of times the hooked function was called. • NODISPLAY If this parameter is specified, DevPartner Error Detection will stop displaying detailed information on each hook requested at the top of the transcript pane. • NOFILL If this parameter is specified DevPartner Error Detection will not fill any additional bytes added to the end of the previous allocation with the DevPartner Error Detection 'fill' character. Note: If your user-written allocator initializes the block with data, like calloc does, specify NOFILL to avoid corrupting your data. • NOGUARD If this parameter is specified, DevPartner Error Detection will not add any guard bytes at the end of the blocks created by this allocation function. • STATIC DevPartner Error Detection will statically patch the user-written allocator. Specify the static option if your user-written allocator is linked into your application and is not provided in a separate DLL with an exported interface.

DevPartner Error Detection checks the return value from the reallocation function and assumes that a NULL value indicates error. Non-NULL addresses are assumed to be the address of the newly allocated block of memory.

Sample Reallocator Records

The following examples show hypothetical Reallocator records:

Example 1

A function called `reallocXX` that is declared in a module called `foo.dll`. This function accepts two parameters. The first parameter is the address of the existing memory block and the second parameter is the size of the requested block. Since no optional parameters were specified, DevPartner Error Detection will fill any new memory (assuming the block is larger) with the fill pattern before returning control to the application program.

```
Reallocator Module=foo.dll Function=reallocXX  
MemoryType=MEM_MALLOC NumParams=2 Address=1 Size=2
```

Example 2

A function called `reallocClear` is declared in a module called `foo.dll`. This function accepts three parameters. The first parameter is the address of the existing memory block and the third parameter is the size of the requested block. This reallocation routine performs its own fill operation on any additional memory allocated in the new block so DevPartner Error Detection should *not* fill additional memory in new blocks.

Note: DevPartner Error Detection will ignore the contents of parameter 2 since it is not of interest.

```
Reallocator Module=foo.dll Function=reallocClear  
MemoryType=MEM_MALLOC NumParams=3 Address=1 Size=3  
NOFILL
```

Example 3

A function called `MyRealloc` has been built in a `.LIB` file and is statically linked into a data collection component called `DataStore.dll`. `MyRealloc` accepts four parameters. The first and fourth parameters are of no interest to DevPartner Error Detection. The second parameter contains the address of the existing block and the third parameter contains the new size of the block. The data collection routine pre-loads new data into the block on reallocation.

```
Reallocator Module=DataStore.dll Function=MyRealloc  
MemoryType=MEM_ALLOC NumParams=4 Address=2 Size=3  
NOFILL STATIC
```

Note: Specify `STATIC` if the function name is not exported from the DLL.

Ignore Records

Create an Ignore record to describe a function that should be ignored by the DevPartner Error Detection memory tracking system. Follow this format:

```
Ignore Module=module_name Function=func_name [Optional Parameters]
```

Use Ignore records to instruct DevPartner Error Detection to either ignore a user-written allocator or ignore a lower-level access routine used by a user-written allocator. Ignore records tell the DevPartner Error Detection memory tracking system not to track APIs that would normally be monitored.

Caution: If you create Ignore records, the DevPartner Error Detection memory tracking system will no longer monitor memory allocated or freed from those APIs. As a result, DevPartner Error Detection will no longer be aware of this memory. This may cause the Call Validation and FinalCheck analysis modules to generate incorrect or incomplete error messages. If you have any questions about the use of this feature please contact technical support for assistance.

Table 4-7. Ignore record parameters

Parameter	Description
Ignore	The first parameter in the record must be the word Ignore to indicate that you are describing an API to be ignored.
module_name	The name of the module (Executable or DLL) that contains the function to be ignored. Note: Module names do not support the use of wildcards.
func_name	The name of the function to be ignored by the memory tracking system. If you are using C++, this should be the 'mangled' name of the function. This parameter is case-sensitive.

Table 4-7. Ignore record parameters

Parameter	Description
[Optional Parameters]	<ul style="list-style-type: none"> • DEBUG If this parameter is specified, DevPartner Error Detection displays additional information about the hook. The output window (or dbgview) will contain information on any errors that occurred when attempting to place the hook. The transcript pane will display statistics about each hook, including whether the function was successfully hooked and the number of times the hooked function was called. • NODISPLAY If this parameter is specified, DevPartner Error Detection will stop displaying detailed information on each hook requested at the top of the transcript pane. • STATIC DevPartner Error Detection will statically patch the user-written allocator. Specify the static option if your user-written allocator is linked into your application and is not provided in a separate DLL with an exported interface.

Sample Ignore Records

The following examples show hypothetical ignore records.

Example 1

This example creates an ignore record that will cause DevPartner Error Detection to monitor memory allocated by `GlobalAlloc` but will not see any requests to free the memory returned to the operating system using `GlobalFree`.

Note: This will cause DevPartner Error Detection to report a large number of false memory leaks.

```
Ignore Module=Kernel32.dll Function=GlobalFree
```

Example 2

This example tells DevPartner Error Detection to ignore memory manipulated by the `GlobalAlloc` family of calls.

Note: This will cause DevPartner Error Detection to report a large number of false Call Validation and FinalCheck errors.

```
Ignore Module=Kernel32.dll Function=GlobalAlloc
Ignore Module=Kernel32.dll Function=GlobalReAlloc
Ignore Module=Kernel32.dll Function=GlobalFree
```

Note: Adding these three lines to `UserAllocators.dat` is not recommended.

Example 3 This example tells DevPartner Error Detection to ignore memory manipulated by a statically linked function within a specified module. You might need to add lines like these if you write your own replacement memory allocation library and use the same names as the standard C runtime library and don't want DevPartner Error Detection to monitor your library usage.

```
Ignore Module=MyDLL.dll Function=Malloc STATIC
Ignore Module=MyDLL.dll Function=free STATIC
Ignore Module=MyDLL.dll Function=realloc STATIC
```

Note: Before adding lines like this to your `UserAllocators.dat` file, you should contact technical support for assistance.

Coding UserAllocator Hook Requests

When you create UserAllocator hook requests, keep the following important notes in mind:

- ◆ Use MEM_CUSTOM1 through MEM_CUSTOM9 to segregate your memory allocations from the system's allocations.
- ◆ Designate unique custom allocator types for each distinct and separate allocator type.
- ◆ Always deallocate memory using the type that corresponds to the allocator. For example, if the allocator was hooked with type MEM_CUSTOM1, you must free the memory with a deallocator that is also hooked with type MEM_CUSTOM1. If the deallocator is different, an allocation conflict error will be reported.

Code Requirements for UserAllocators

To make use of the UserAllocator memory allocation hooks, the application code must include functions that control memory allocation and deallocation.

Allocator Function Hooks

- ◆ The allocator function being called must include a parameter specifying the number of bytes of memory requested.
- ◆ The function must either return the location of the allocated memory, or include a parameter containing an address pointing to the location.

- ◆ Other parameters may also be included in the function.

Examples

```
void *GetMemory(int BytesRequested);
```

```
Allocator  
    Module=bcheap.dll  
    Function=GetMemory  
    MemoryType=MEM_CUSTOM1  
    NumParams=1  
    Size=1  
    Static  
    Noguard  
    NoFill  
    Debug
```

Or

```
void *pVoid;
```

```
HRESULT GetMemoryAgain(int BytesRequested, &pVoid);
```

```
// in the above example, the memory allocator will place the  
location of the allocated memory in the pVoid pointer.
```

```
Allocator  
    Module=bcheap.dll  
    Function=GetMemoryAgain  
    MemoryType=MEM_CUSTOM1  
    NumParams=2  
    Size=1  
    BufferLoc=2  
    Static  
    Noguard  
    NoFill  
    Debug
```

Deallocator Function Hooks

- ◆ The deallocator function being called must include a parameter specifying the address of the memory being deallocated.
- ◆ Other parameters may also be included in the function.

Example

```
; static void *mark_free(void *p, int nLen, void *pExclude, int  
nExcludeLen)
```

```
Deallocator
```

```
Module=bcheap.dll  
Function=mark_free  
MemoryType=MEM_CUSTOM1  
NumParams=4  
Address=1  
Static  
NoPoison  
Debug
```

Reallocator Function Hooks

- ◆ The reallocator function being called must include a parameter specifying the number of bytes of memory requested.
- ◆ The reallocator function must include a parameter specifying the address of the 'old' memory being reallocated.
- ◆ The reallocator function must either return the location of the 'new' memory that was allocated, or include a parameter containing an address pointing to the location.
- ◆ Other parameters may also be included in the function.

Example

```
; void *DoMyRealloc(MyHeap *me, void *p, uint32 uSize)
```

```
ReAllocator
```

```
Module=bcheap.dll  
Function=DoMyRealloc  
MemoryType=MEM_CUSTOM1  
NumParams=3  
Address=2  
Size=3  
NoFill  
NoGuard  
Static  
Debug
```

Debugging UserAllocator Hooks

Error Detection provides two keywords you can use to modify the presentation of information about your UserAllocator hooks, making debugging those hooks easier.

NoDisplay

By default, Error Detection displays the details of the hook as interpreted from the file request at the top of the Transcript pane. For example:

```
Allocator Module=bcheap.dll Function=MarkNodeAllocated  
MemoryType=MEM_CUSTOM1 NumParams=3 Size=1 BufferLoc=3 NoFill  
NoGuard Static Debug
```

If you do not want the detailed hook information displayed at the top of the Transcript pane, add the keyword `NoDisplay` to the hook request.

Debug

Error Detection also provides the `Debug` keyword, which will provide extended details when you add it to the hook request.

The Transcript Pane

The presence of the `Debug` keyword in a hook request will show extended details at the bottom of the Transcript pane after Error Detection completes the run. The details displayed at the bottom of the Transcript pane include statistics about each hook, including whether the function was successfully hooked and the number of times the hooked function was called.

Error Details

If the bottom of the Transcript pane indicates that the function was not hooked, Error Detection provides more details to aid in debugging the failed hook:

If you are working inside Visual Studio, the output window provides the error details.

If you are running the standalone version of Error Detection, the `DbgView` tool provides the error details.

How to Diagnose Errors in UserAllocators.dat

If you add records to `UserAllocators.dat` you may receive one or more of the following types of errors:

- ◆ File access errors
UserAllocators.dat is a text file stored in the Data sub-directory of the DevPartner Error Detection installation directory. If the file is deleted or made non-readable, DevPartner Error Detection will report an error.
- ◆ File write errors
When the DevPartner Error Detection session is started, it creates a file named `UserAllocators.nlb`. If the location specified in **Options | Data | NLB File Directory** is invalid or read-only, a failure will occur. To resolve this, either change the directory specification under **Options**, or change the properties of the directory to make it writeable.
- ◆ Parsing errors
If DevPartner Error Detection encounters errors while parsing the `UserAllocators.dat` file, DevPartner Error Detection will log the errors in the Errors tab. If Memory Tracking or Resource Tracking are enabled when these `UserAllocators.dat` errors are encountered, these features will be disabled.

Token Parsing Errors

DevPartner Error Detection will parse the file one line at a time using the following rules:

- ◆ Blank lines and lines that start with semi-colons (;) or double-slashes (//) will be ignored.
- ◆ Each UserAllocator definition that is added must begin with a valid record type.
- ◆ All parameters for each definition must be separated by one or more spaces or tabs, and must follow the rules for each record type.

Semantic Errors

Each record type will be parsed according to the rules for each parameter. Parameters may be case-sensitive and in some cases must fall inside a valid range (for example, the maximum number of parameters supported on a function is 32).

Duplicate entries in the same file may also generate errors if the records conflict with one another. `UserAllocators.dat` is assumed to be an advanced feature, so extensive cross checking is not performed.

If Your Application becomes Unstable after Changing UserAllocators.dat

When you add records to `UserAllocators.dat`, you are telling DevPartner Error Detection to monitor calls to and from your user-written allocator. If you did not properly describe the APIs to DevPartner Error Detection, your application may crash or function unpredictably. Specifying the incorrect number of parameters for your functions is one of the most common causes of such problems.

You may also encounter problems if you depend on the contents of memory remaining constant and you did not add the `NOFILL` or `NOPOSITION` options to your description.

If you encounter an error and are unsure how to proceed please contact technical support for assistance. When you contact technical support, please provide the following information:

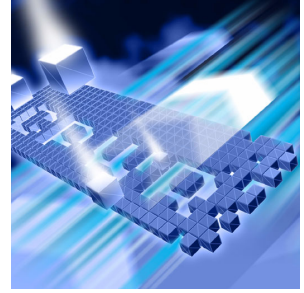
- ◆ The version of DevPartner you are running
- ◆ A copy of your `UserAllocators.dat` file
- ◆ A description of the problem you are encountering

In some cases, you may be asked to provide a copy of the DLL containing your user allocator functions and a map file used to link the DLL.

If possible, avoid using Ignore records. Ignore records can cause DevPartner Error Detection to respond unpredictably when you analyze an application.

Chapter 5

Deadlock Analysis



- ◆ Background: Single and Multi-threaded Applications
- ◆ Deadlock - A Basic Definition
- ◆ Techniques for Avoiding Deadlocks
- ◆ Potential Deadlocks
- ◆ Other Synchronization Objects
- ◆ Additional Information

Deadlock Analysis provides an automated method to search for deadlocks, potential deadlocks and other synchronization errors in your customer applications.

This chapter provides:

- ◆ An overview of the terms used in deadlock analysis
- ◆ Examples of deadlocks and potential deadlocks
- ◆ Sources of additional information on synchronization topics.

Background: Single and Multi-threaded Applications

Old style C/C++ programs had a simple main routine that called a number of functions, performed various operations, and then exited. These programs used a single thread of execution. In other words, the program executed one instruction at a time. If you were to step through the program using a debugger, you could watch every operation pass by like the frames in a movie.

Threads

Newer applications can be multi-threaded. A *thread* is a flow of control. A multi-threaded application has two or more flows of control. You can create additional threads by calling the Windows `CreateThread` function. `CreateThread` accepts a number of parameters including the address of a function that should be run on the newly created thread. If the `CreateThread` function is successful, the application will have an additional thread of execution.

There are many ways to implicitly create a thread. A few examples include calling `_beginthread`, using third-party libraries, using COM or DCOM, or by using the Common Language Runtime.

If you have more than one thread executing in your program, it is possible for the two threads to try to access the same resources at the same time. This might include variables, files, handles, Windows resources, and so on. If multiple threads try to access the same resource at the same time, synchronization problems can occur. For example, if two threads, called T1 and T2, both attempt to print out the numbers from 1 to 100, the output from each thread might look like:

```
1 2 3 4 5 6 7 8 9 10 11 12 ... 95 96 97 98 99 100
```

When both threads run at the same time, the output will be jumbled, as in the example below. The output from thread T1 is in plain type; the output from thread T2 is in bold italic type.

```
1 2 3 4 1 2 5 6 3 4 5 6 7 8 7 ... 95 96 97 94 95 96 97 98 99 98 99 100 100
```

Critical Sections

To prevent such problems, you need to coordinate the interactions between threads. Most modern operating systems provide a series of synchronization functions that can be called to coordinate access to shared resources. The easiest to use and most common synchronization object is called a *critical section*. A critical section is a simple function that allows only one thread to have access to a resource at a time.

Consider the example of threads T1 and T2, each written to print the numbers from 1 to 100, as described above. Defining a critical section C1 will prevent jumbled output when both threads are running. This critical section controls access to the output stream. The functions executed by threads T1 and T2 would need to be modified as follows:

- 1 One of the threads would create the critical section C1.

- 2 Each thread would then perform the following steps:
 - a Request critical section C1
 - b Print out the list of numbers from 1 to 100
 - c Release critical section C1
- 3 The threads would then go off and do whatever additional processing was required that did not interact with the other thread.

Step 2- a translates into an `EnterCriticalSection` call asking the operating system to grant the thread exclusive access to critical section C1. If the critical section is not available, the operating system will pause the thread and wait until C1 becomes available.

Once a thread has access to the critical section, any other thread following the critical section rules for C1 will not attempt to print its output. After the thread prints the numbers from 1 to 100, **step 2- c** tells the operating system to `LeaveCriticalSection`. This releases the critical section for some other thread.

There is no rule that states that every thread in your program must use the critical section to print its output to the terminal. However, if you follow this rule, your output will always appear correctly.

This same rule can be applied to accessing variables, structures, files, or any other shared resource.

Note: In most cases you do not need to wrap console output in critical sections unless you are writing code that causes the two output streams to collide with each other.

Deadlock - A Basic Definition

Based on the preceding example, a critical section seems to be a very simple mechanism to grant access to a shared resource. However, it can cause problems.

Consider a program that creates multiple critical sections named C1, C2 and C3. Each of these critical sections is used to guard access to a separate resource shared between the threads.

If a thread is granted access to one critical section (for example, C1) and then attempts to gain access to another critical section (for example, C2), it is possible that C2 has already been allocated by another thread. If the other thread quickly releases C2, there is no problem. The first thread will wait until C2 becomes available and will then be granted access to C2 so that the operation can continue.

On the other hand, if the thread that holds C2 needs to wait for some other synchronization object to become available (such as C1), both threads will stall waiting to gain access to the necessary resources. When two or more threads stall while waiting for resources that never become available, the result is called a *deadlock*.

Techniques for Avoiding Deadlocks

Deadlocks occur when multiple threads attempt to use shared resources but are unable to gain access to those resources. There are a number of methods to avoid deadlocks.

- ◆ Request access to synchronization objects only when you need them. Once you gain access to the objects, use them as quickly as possible and release the objects so other threads can use them.
- ◆ If you need to gain access to multiple synchronization objects at once to perform a given operation, request the first object and then try to gain access to the second object. If the second object is not available, release both objects and wait a short random interval. After the wait completes, attempt to gain access to the resources again. It is very important to release ownership of a resource if your thread will become blocked waiting for another resource. Failure to release the object might cause a “deadly embrace” and will only make the deadlock situation worse.
- ◆ Always ask for resources in the same order. For example, if you are required to gain access to C1, C2 and C3 to perform an operation, always access them in the same order (C1, C2, and C3) and release them in the opposite order (C3, C2, C1).
- ◆ Once you have acquired all the synchronization objects you need to perform an operation, do not perform an operation that might block waiting for another resource.

There are many more techniques for dealing with synchronization objects. “[Additional Information](#)” on page 87 lists MSDN resources and books that discuss synchronization objects.

Potential Deadlocks

DevPartner Error Detection will report a *potential deadlock* when it detects that you are not accessing resources in a safe manner. An example would be an application with three threads T1, T2, and T3, all of which make use of a series of resources controlled by critical sections C1, C2, and C3.

Table 5-1 illustrates the critical sections each thread requires to perform a given operation:

Table 5-1. Potential deadlock example: Threads and their required critical sections.

Thread	Critical Section
T1	C1, C2
T2	C2, C3
T3	C3, C1

Each thread can run independently and acquire the necessary critical sections to perform their designated tasks. However, a problem can occur when all three threads try to perform these operations at the same time.

The Dining Philosophers

The *Dining Philosophers* is a classic example often used to illustrate potential deadlocks in computer science classes. The DevPartner Error Detection software contains sample code for a version of the Dining Philosophers. You can find it under:

```
... \DevPartner Studio \Examples \DeadlockPhilosophers
```

The Dining Philosophers problem is based on a group of philosophers sitting at a round table with a large plate of food in the middle. Between each philosopher is a single chopstick.

The philosophers seated around the table can do three different things:

- 1 Rest:** Resting philosophers sit and do nothing. They rest for a random period of time.
- 2 Talk:** Talking philosophers speak to anyone else at the table interested in listening. They talk for a random period of time.

- 3 Eat:** A hungry philosopher will attempt to eat. To do this, they try to pick up a chopstick. In the simplest case, the philosopher always tries to pick up the left chopstick first, and, if successful, will then try to pick up the right chopstick. A philosopher with both left and right chopsticks will eat for a random amount of time, and then put down the chopsticks and either rest or start talking.

A philosopher who can't pick up the first chopstick will wait a few seconds and try again. A philosopher who succeeds will then attempt to pick up the right chopstick. If the right chopstick isn't available, the philosopher will wait a few seconds and then try again.

The problem occurs when all philosophers pick up the left chopstick at once. If this occurs, none of them will ever put down the left chopstick so they will all starve to death (deadlock).

Depending on how you configure the Dining Philosopher algorithm, it might deadlock immediately or might run for several minutes before deadlocking. If you add philosophers and chopsticks to the table, the number of actual deadlocks tends to decrease. However, the potential for all philosophers to get hungry at once still exists. This is called a *potential deadlock*.

Potential deadlocks are often the hardest deadlocks to track down because they tend to occur on heavily loaded production systems. Attempts to duplicate these problems on development systems are usually time consuming and often don't find the real root of the problem.

DevPartner Error Detection will notify you if a potential deadlock is detected long before the actual deadlock occurs. DevPartner Error Detection will also provide detailed information describing how the actual deadlock will occur. This can make it easier to modify your code to prevent the problem from occurring.

Monitoring Synchronization Objects

Deadlock analysis also monitors all the synchronization objects in your application for errors and questionable usage such as:

- ◆ Waits over a user specified duration
- ◆ Threads that re-enter an already owned critical section
- ◆ A wait on a mutex that is already owned by the thread
- ◆ Exiting a thread without releasing a synchronization object

In addition, you can configure DevPartner Error Detection to verify that synchronization objects that can be named follow your naming rules. For example, you might decide that your synchronization objects should be unnamed so that they cannot be accessed from outside the process. Any named synchronization objects will be flagged as potential errors. You can then use this list to verify that the named synchronization objects contain the necessary security descriptors to prevent unwanted access by other processes on the system.

A complete list of synchronization errors appears in the online help, under *Deadlock Errors* in the *Descriptions of Detected Errors* section.

Other Synchronization Objects

The Windows operating system provides many different types of synchronization objects beyond the critical sections described on [page 80](#). Below is a list of synchronization objects and excerpts of their definitions from MSDN. Excerpted text is printed in italics. With each term, the URL for the complete definition and a URL for a related code example are provided.

Critical Section

Critical section objects provide synchronization similar to that provided by mutex objects, except that critical section objects can be used only by the threads of a single process.

Complete definition:

http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/Critical_Section_Objects.asp

Code example:

http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/using_critical_section_objects.asp

Event

An event object is a synchronization object whose state can be explicitly set to be signaled by use of the `SetEvent` function. The event object is useful in sending a signal to a thread indicating that a particular event has occurred.

Complete definition:

http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/event_objects.asp

Code example:

```
http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/using\_event\_objects.asp
```

Mutex

A mutex object is a synchronization object whose state is set to signaled when it is not owned by any thread, and nonsignaled when it is owned. Only one thread at a time can own a mutex object.

Mutex objects are considerably slower than critical sections.

Complete definition:

```
http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/mutex\_objects.asp
```

The following URL shows an example of using Mutex objects:

```
http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/using\_mutex\_objects.asp
```

Semaphore

A semaphore object is a synchronization object that maintains a count between zero and a specified maximum value. The count is decremented each time a thread completes a wait for the semaphore object and incremented each time a thread releases the semaphore.

Complete definition:

```
http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/semaphore\_objects.asp
```

Code example:

```
http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/using\_semaphore\_objects.asp
```


Additional Information

MSDN References

For more information on synchronization objects please refer to the following links on MSDN:

Synchronization Overview: http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/about_synchronization.asp

Synchronization Objects: http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/synchronization_objects.asp

Wait Functions: http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/wait_functions.asp

Using Synchronization Objects: http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/using_synchronization.asp

Synchronization Reference: http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dllproc/base/synchronization_reference.asp

Other References

The following books contain more information on synchronization objects:

Win32 Multithreaded Programming, by Aaron Cohen and Mike Woodring

Debugging Applications for Microsoft .NET and Microsoft Windows, by John Robbins

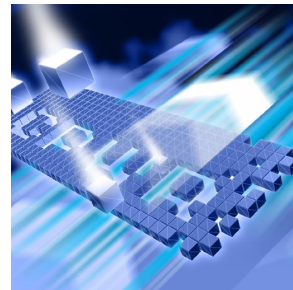
Debugging Windows Applications, 1st Edition, by John Robbins

Operating Systems, 4th Edition, by William Stallings

Foundations of Multithread, Parallel and Distributed Programming, by Gregory R. Andrews.

Appendix A

Troubleshooting Error Detection



Troubleshooting

If you encounter the following problems, try the corresponding solutions. If you encounter further difficulties, contact the Technical Support Center.

Problem	Solution
Error Detection is stepping on my memory.	<ul style="list-style-type: none">• Disable Poison on Free under Memory Tracking in the Options/Settings dialog.• Disable Enable Fill on Allocation under Memory Tracking in the Options/Settings dialog.
Error Detection fails to stop in the debugger when the Program Error Detected dialog box is dismissed with the Debug button.	<ul style="list-style-type: none">• When you dismiss the Program Error Detected dialog box with the Debug button, Error Detection puts a temporary breakpoint in your application at the start of the first line after the error. The breakpoint is automatically removed when the application stops in the debugger. If your application has an exception handler that catches the breakpoint exception and continues execution, the debugger will not get a chance to catch the breakpoint and stop the application for you.
I am getting a <i>Memory Allocation Conflict: Function Mismatch</i> error, and Error Detection is reporting that the block was deallocated by <code>Free</code> .	<ul style="list-style-type: none">• If you are using <code>new</code> and <code>delete</code>, and Error Detection is complaining that the block was deallocated by <code>free</code>, then you may be using a release version of the C Run Time Library DLL (<code>/MD</code>). To fix this, build against the debug version of the C Run Time Library DLL (<code>/MDd</code>). This is controlled on the C++ Code Generation properties page by the Runtime Library entry.
Error Detection complains about an allocation conflict between operator <code>new</code> and <code>free</code> .	<ul style="list-style-type: none">• Make sure that you have added all user written allocators to <code>userallocators.dat</code>. See the comments in the <code>... \Data \UserAllocators.dat</code> file.

Problem

Error Detection appears to be ignoring my memory and resource allocations. Why?

Solution

- If you are running Error Detection on a managed C++ application with the managed debugger, memory and resource allocations will appear to be coming from `mscorlib.dll` or `mscorlibsrv.dll` instead of the application, and Error Detection will ignore them. To use Error Detection on a mixed or managed code application, follow these steps:

- 1 Open the Visual Studio version you will be using to debug your process.
- 2 Start the DevPartner Error Detection standalone application.
- 3 Open your target process inside Error Detection, and select **Program > Start** to run your process.
- 4 Attach the debugger to your target process by clicking **Tools > Attach to Process**

Note: Specify **Managed Code Debugging** (not **Mixed** or **Auto**) to allow the debugger to hit your managed code breakpoints correctly. Once you complete the steps, you can set and hit breakpoints in your managed code, and Error Detection will detect your memory and resource allocations.

Problem

I am getting an *Invalid String* error when I run my application under Error Detection.

Solution

- When ASCII strings are cast to wide-char strings and used as API parameters, we may report errors that do not appear to be related to the actual problem. A cast means ‘trust me, I know what type of data this is’, and a cast is not detectable by Error Detection. For example:

```
BSTR m_DSNName;  
m_DSNName=SysAllocString(BSTR(""));
```

Is interpreted by the compiler as:

```
m_DSNName=SysAllocString((wchar_t *) "");
```

We report:

```
Invalid String: In call to SysAllocString, address  
0x0FE2751F is not null terminated in block  
0x0FDF0000 (290816).
```

The `SysAllocString` statement casts an empty ASCII string to a wide-char string to use as the input parameter to `SysAllocString`. `SysAllocString` looks for the first double-byte null to find the end of the `wchar_t` string. It uses the length determined by the location of this double-byte null to determine the size of the new BSTR. `SysAllocString` validly creates a new BSTR for `m_DSNName` that holds a copy of all of the junk that exists between the beginning of the single-byte ASCII string & the first double-byte null that happened to occur later in memory.

In the example above, Error Detection examines the input `wchar_t` string (which is actually a 1-byte empty ASCII string) and reports an invalid string (not null terminated). In the test code used for this case, we knew about a valid block of memory that physically existed between the beginning of the single-byte ASCII string and the accidental double-byte null. We scan the input string only as far as we ‘know’ that the memory is not allocated for anything else. So in this case we are scanning only a few bytes, then reporting that we did not find a double-byte null in that area of memory. To avoid this problem, change the code to use a wide-char string as input.

Problem

Solution

Error Detection is not reporting any errors.

- Enable **Log Events** under **General** in the **Options/Settings** dialog.
- There are two situations in which DCOM or COM-based applications or components try to run under the restrictions of the `aspnet` account. By default, when a DCOM or COM application or component is launched from within an `ASP.NET` enabled web page, it will run in the context of the `aspnet` account. For security reasons, the `aspnet` account is a restricted account (it is a member of the Users group and has equivalent privileges). In this situation your COM component will not have the security privileges required for Error Detection to function properly. To work around this issue, you must configure your DCOM or COM application or component to execute within the context of the interactive user (via `dcomcnfg.exe`). To configure your DCOM or COM application or component to run under the context of the interactive user:

- 1 Open a command prompt and run `dcomcnfg.exe`.

- 2 Expand **Component Services > Computers > My Computer > DCom Config**.

- 3 Right-click on your COM component, and select **Properties**.

- 4 Select the **Identity** tab.

- 5 Ensure that you have selected **The interactive user**.

- 6 Click **OK**.

Error Detection is running exceedingly slow.

- Verify that you have not turned on all of the Error Detection options. Some options are very expensive when it comes to processor and memory usage, and you should only use those you really need.
 - Limit your maximum call stack depth on allocation (via **Data Collection** in the **Options/Settings** dialog). Deep allocation call stacks consume large amounts of memory.
 - Limit your analysis by excluding modules and files (via **Modules and Files** in the **Options/Settings** dialog).
 - Only use FinalCheck at major development milestones.
 - Disable .NET Call Reporting, or limit the number of assemblies selected in the **All types** tree view.
 - If you are only interested in detecting leaks in your application, consider enabling leak-only analysis. Checking the **Enable Leak Analysis Only** check-box under **Memory Track** options disables everything in Memory Track, with the exception of monitoring for leaks. Memory Track will not look for overruns, use of uninitialized memory, or dangling pointers. Call Validation **Memory Block Checking** is also disabled because Memory Track is not evaluating any memory allocated by system modules.
-

Problem	Solution
The log is far too large.	<ul style="list-style-type: none"> • Disable Log Events under General in the Options/Settings dialog. • Limit the Parameter Encoding depth (via Data Collection in the Options/Settings dialog). • Limit your analysis by excluding modules and files (via Modules and Files in the Options/Settings dialog). • Use Filters and Suppressions to limit the scope of what is reported. • Disable .NET Call Reporting, or limit the number of assemblies selected in the All types tree view. • Disable Collect API Method Calls and Returns under API Call Reporting. • Disable Resource Tracking, or limit the resources being tracked.
I get an error stating that Error Detection failed to create the <code>UserAllocators.log</code> file.	<ul style="list-style-type: none"> • If you attempt to run an application with Error Detection in a directory to which you do not have write access, you may receive an error similar to the following: <p data-bbox="629 690 1308 769"> <pre>UserAllocatorsError: An error was discovered when processing the UserAllocators.dat file. Failed to create UserAllocators.log file Error:0x00000005</pre> </p> <p data-bbox="629 803 1286 887">You can control the directory that the <code>UserAllocators</code> file is written to by setting the NLB File Directory on the Data Collection settings page.</p>
I receive errors when I try to open my target application using Error Detection under Windows Vista.	<ul style="list-style-type: none"> • Error Detection creates data files for each target application. You must ensure that you have write access to the directory containing the target executable before starting Error Detection.
Error Detection has incomplete or erroneous call stacks.	<ul style="list-style-type: none"> • Error Detection cannot locate the symbols, or the symbols are out of date. Enable Microsoft Symbol Server to retrieve symbols that match your current files, then rerun your application. • The application under test uses a mixture of managed and unmanaged code. Transitions between the two kinds of modules can throw off the call stack.
Symbol Server is taking far too long.	<ul style="list-style-type: none"> • Error Detection is trying to retrieve symbols from Microsoft Symbol Server every time you run. Disable Microsoft Symbol Server once you have retrieved the symbols that match your current files, and run your application using local symbols. • Download and permanently install a symbol server package for you specific operating system. See Microsoft's symbol download page: http://www.microsoft.com/whdc/devtools/debugging/symbolpkg.msp

Problem	Solution
COM Object Tracking (or COM Call Reporting) does not appear to be working correctly.	<ul style="list-style-type: none"> • Check your Modules and Files settings in the Options/Settings dialog to verify that you have not disabled reporting of events for certain modules. • Check your Suppression and Filter settings in the Options/Settings dialog to verify that you have not previously set a filter or suppression for certain COM Tracking event(s). • Allow Error Detection to monitor more COM interfaces via the All Interfaces check-box under COM Call Reporting in the Options/Settings dialog.
My application does not start, or it starts and immediately crashes.	<ul style="list-style-type: none"> • Clear the Enable Poison On Free check-box under Memory Tracking in the Options/Settings dialog — your application may be referencing deallocated memory. • Uncheck the Fill Output Arguments Before Call check-box under Call Validation in the Options/Settings dialog. • Investigate your user written allocators if you have any (see the <code>... \Data \UserAllocators.dat</code> file). • Does your system have OS symbols present? If so, you could have a bad symbol file. • Is the crash timing related? If so, disable some of the Error Detection features and try running your application again.
My service starts and immediately hangs.	<ul style="list-style-type: none"> • Make sure you are running your service with Administrative privileges.
My service starts and almost immediately terminates.	<ul style="list-style-type: none"> • The most likely cause is that the Windows NT Service Control Manager terminated your service. Increase the value of <code>dwWait</code> in your service's initialization logic and re-run your service. • Verify that Error Detection has a valid working directory. Specify the working directory via the General settings, under Settings in the Program menu.
My service runs for a while then terminates unexpectedly.	<ul style="list-style-type: none"> • Your service may be responding too slowly to a control message requesting your service state. Increase the time out value in <code>dwWait</code> when responding to service state requests. • Error Detection may have poisoned memory in your application, causing the crash. Disable the Memory Tracking feature under Options/Settings. If this eliminates the crash, instrument your service with <code>FinalCheck</code>, then re-run your application looking for uninitialized memory references, buffer overruns, and dangling pointers.
My service runs correctly, but terminates unexpectedly when it shuts down.	<ul style="list-style-type: none"> • Your service is given a limited time to respond when it receives a shut down request from the Service Control Manager. When an application shuts down, Error Detection performs many checks, looking for memory, resource and interface leaks, and re-checking allocated memory blocks for memory overruns. If the <code>dwWait</code> value specified for acknowledging the shut down request is too small, the Service Control Manager will terminate the service. In this case, increase the <code>dwWait</code> value.

Problem	Solution
Error Detection fails to analyze my service.	<ul style="list-style-type: none"> • Error Detection may fail to analyze a service. A common cause is that one (or more) of the directories used to monitor the process is not writable to the process being created. The following directories must be writable: <ul style="list-style-type: none"> • The <code>TMP</code> and <code>TEMP</code> environment variables must reference a directory that is writable to the process. If you have configured your service to run the <code>LOCAL_SYSTEM</code> context, you will need to assign these environment variables system wide. • The service must have write access to the NLB File directory. • The service may require write access to the working directory.
Visual Studio crashes when I try to run an application with Error Detection.	<ul style="list-style-type: none"> • Narrow down the cause of the crash by using at least one of the following methods. <ul style="list-style-type: none"> • Set breakpoints at various locations in the application test code. • Reconfigure the Error Detection settings by disabling various sub-systems or modules. See "changing program settings" in the help for more details.
I see memory growth in Task Manager, but Error Detection is not reporting any leaks. Why not?	<ul style="list-style-type: none"> • Make sure that you have fully instrumented your application with <code>FinalCheck</code>. • Make sure Log Events is enabled under General in the Options/Settings dialog. • Make sure your application test modules are enabled via Modules and Files in the Options/Settings dialog.
When running Error Detection on a managed C++ application, I am not seeing as many leaks and errors reported as I was expecting.	<ul style="list-style-type: none"> • This is a known limitation of Error Detection. You must be using the native debugger (or both the managed and native debugger) for Error Detection to see the memory allocations and report them properly. When using just the managed debugger, memory and resource allocations will appear to be coming from <code>mscorlib.dll</code> instead of the application, and will be ignored.
ActiveCheck does not find a memory leak, but FinalCheck does. Why?	<ul style="list-style-type: none"> • Instrumentation with <code>FinalCheck</code> allows for more robust memory tracking. <code>FinalCheck</code> is scope-aware, and allows Error Detection to track every pointer as well as all memory usage. For more information, refer to <i>ActiveCheck and FinalCheck</i> in the Error Detection section in the Quick Reference.

Problem

My application fails when run under Error Detection (usually with Memory Track enabled).

Solution

- Uncheck the **Enable Poison On Free** check-box under **Memory Tracking** in the **Options/Settings** dialog.
- Try using alternate fill patterns for the **Enable Guard Bytes** and **Enable Fill On Allocation** settings under **Memory Tracking** in the **Options/Settings** dialog.
- You may have bad PDBs. Create an ASCII text file named **NMSYMDATA.DAT** in the **NMShared\4.7** directory. This file should contain the names of the modules associated with bad PDB files followed by `", 0x0"`. For example: `ADVAPI32.DLL, 0x0`
- If you are debugging an application generated using the Visual Studio MFC application wizard, and have enabled the Memory Track subsystem's memory filling features, Error Detection may cause the application to crash. MFC sets an obscure pragma that causes the compiler to generate "minimal debugging information". If the OS structures you are using have had additional fields added to them, Error Detection may get the wrong structure size from the debugging information when it attempts to determine how big the structure is, causing it to fill memory it should not be touching. Add `_AFX_FULLTYPEINFO` to the Preprocessor Definitions on the C++ Preprocessor settings page for your project, and then rebuild your solution.
- If creating the **NMSYMDATA.DAT** file does not solve the problem, you may have to exclude the entire module. To exclude an application module, create an ASCII text file named **EXCLUDEDMODULES.DAT** in the **Data** directory where Error Detection is installed on your system. For example:

```
<InstallationRoot>\Data\EXCLUDEDMODULES.DAT
```

Add the names of each module you want to exclude on a separate line of the file. For example: `MYCUSTOMDRIVER.DLL`

I cannot debug my Web application using Error Detection integrated in Visual Studio.

- To debug applications and services such as Web applications, use the **Wait for Process** option (see ["Analyzing Services"](#) on page 35) available from the Error Detection application (**BC.EXE**). This option is not available when running Error Detection integrated in Visual Studio.

I have a module located in the System files directory that I want to debug. The System files are restricted, and I cannot debug my module. What can I do?

- Enable your modules via **Modules and Files** in the **Options/Settings** dialog, and you can debug it for the current project.
- To make the module valid for all projects and solutions, edit the file named **Unrestricted_modules.txt** in the **Data** directory where Error Detection is installed on your system. For example:

```
<InstallationRoot>\Data\Unrestricted_modules.dat
```

Add the names of each module you want to include on a separate line of the file. For example: `MYCUSTOMDRIVER.DLL`

Problem	Solution
Error Detection is reporting errors in <code>dllhost.exe</code> or <code>TestCon32.exe</code> .	<ul style="list-style-type: none"> To prevent Error Detection from reporting errors on <code>dllhost.exe</code> or <code>TestCon32.exe</code>, exclude the executable from the list of modules to check.
COM Call Reporting is not logging calls to my object or component.	<ul style="list-style-type: none"> Error Detection logs methods only for COM interfaces that it has been instructed to recognize. To tell Error Detection about your ActiveX control, select Enable COM method call reporting on objects that are implemented in the selected modules under COM Call Reporting in the Options/Settings dialog box.
Error Detection is not reporting COM interface leaks in my object or component.	<ul style="list-style-type: none"> To collect COM interface leak information, select Enable COM object tracking under COM Object Tracking in the Options/Settings dialog box, then select the COM classes to monitor. To track your own objects, review the list of COM classes in the COM Object Tracking settings and select only your classes. If you are unsure which classes to select, select All COM classes.
Error Detection appears to hang and not respond for a long time after I stop exercising my component.	<ul style="list-style-type: none"> Error Detection is waiting for <code>dllhost.exe</code> to time out and terminate the process. When <code>dllhost.exe</code> terminates, Error Detection will perform the final memory, resource and interface leak detection.
Why does IIS startup and then hang?	<ul style="list-style-type: none"> Error Detection requires Administrative privileges to debug a service. If the account used does not have Administrator privileges, IIS will either hang or terminate almost immediately with an error.
I cannot instrument my code for Error Detection when I compile automatically via my command line batch process (using <code>VCBUILD.EXE</code>).	<ul style="list-style-type: none"> To instrument your code when you call the compiler from the command line, you need to use the <code>NMVCBUILD</code> variant installed with DevPartner. Refer to “Instrumenting Native C/C++ Code with <code>nmvcbuild</code>” for more information about compiling with <code>NMVCBUILD</code>.
I receive errors when I try to build my target application with instrumentation for Error Detection under Windows Vista.	<ul style="list-style-type: none"> Error Detection creates data files for each target application. You must ensure that you have write access to the directory containing the target executable before starting Error Detection.

Problem

When I run my application under Error Detection, I receive bad data and/or unexpected results.

Solution

- Check to ensure that you do not have expressions in your code that rely on an undefined order of evaluation. Instrumenting code without a well defined order of evaluation can cause unexpected results, including erroneous data, hangs, and even crashes.

The C/C++ standard explicitly does *not* define the order of evaluation when there are "side effects", such as storing a value in an object. For example, the following statement does not have a well defined order of evaluation: `i = ++i + 2;`

There are two points in this statement when values are stored in the variable *i*, and the language does not define what order they occur in. Instrumenting code like this may change the order of evaluation and change the result.

Error Detection is reporting false leaks and overruns in a mixed-mode (managed / unmanaged) environment.

- If you are running Error Detection on a managed C++ application with the managed debugger, memory and resource allocations will appear to be coming from `mscorlib.dll` or `mscorlib.dll` instead of the application, and Error Detection will ignore them. To use Error Detection on a mixed or managed code application, follow these steps:

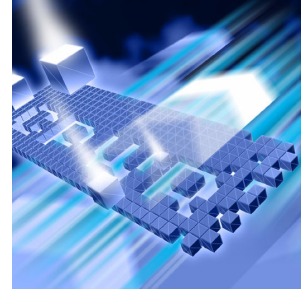
- 1 Open the Visual Studio version you will be using to debug your process.
- 2 Start the DevPartner Error Detection standalone application.
- 3 Open your target process inside Error Detection, and select **Program > Start** to run your process.
- 4 Attach the debugger to your target process by clicking **Tools > Attach to Process**

Note: Specify **Managed Code Debugging** (not **Mixed** or **Auto**) to allow the debugger to hit your managed code breakpoints correctly.

Once you complete the steps, you can set and hit breakpoints in your managed code, and Error Detection will detect your memory and resource allocations.

Appendix B

Important Error Detection Files



Files and Their Purpose

The following table lists the files Error Detection uses to control and define behavior during a session. Included are the file location, name, purpose, and whether the file is user-modifiable.

Filename and Path	Purpose
<code><Program Root>\Data\ctisafe.dat</code>	<p>Specifies functions known to accept pointers without storing the pointer values. MemTrack and FinalCheck use this file to keep track of safe functions. This information prevents an error from being triggered when a pointer visits an unknown function. When a function is listed in this file, MemTrack and FinalCheck assume that the function has not saved a copy of the pointer.</p> <p>Functions may be added when necessary. Consult with Compuware Customer Support before removing any default functions from this list.</p>
<code><Program Root>\Data\BCDefault.DPRul</code>	<p>Lists the default set of suppression and filter files that Error Detection will load.</p> <p>Add to this list using the suppression and filter editing dialogs within Error Detection; the information you add is valid for the current project directory only. To make information valid system-wide, edit the file manually and include the full path name to the suppression/filter file being added.</p>
<code><Program Root>\Data*.DPFlt</code> <code><Program Root>\Data*.DPSup</code>	<p>Defines the filters and suppressions Error Detection should use. Each one of these .DPFlt and .DPSup files contains specific filters and suppressions for system modules.</p> <p>Add, modify, or delete suppressions and filters via the Error Detection suppression and filter editing dialogs. Do not edit these files manually.</p>

Filename and Path	Purpose
<Program Root>\Data\Unrestricted_modules.txt	Specifies modules that should be unrestricted DLLs despite being found in system directories. A module existing in a system directory needs to be marked as unrestricted to be examined for errors. By default, Unrestricted_modules.txt lists the various versions of MFC modules. Edit this file manually to add the names of specific modules existing in system directories so Error Detection will examine them for errors.
<Program Root>\Data\UserAllocators.dat	Specifies custom allocators. For more information on this file and how it is used by Error Detection, see Chapter 4, "Working with User-Written Allocators" .
<Program Root>\ERptApi\NMApiLib.*	Provides access to the Error Detection user-callable interface. NMApiLib.h defines and documents the user-callable interface to Error Detection, which is implemented by linking NMApiLib.lib into your project. For more information on the user-callable interface, see Chapter 3, "Analyzing Complex Applications" .
<Program Root>\Data\ExcludedModules.dat	(User-created File) Contains a list of excluded modules. Each module is listed on a separate line of the file. For example: MYCUSTOMDRIVER.DLL
<Program Root>\DPSErrorDetection.xsd	Contains the schema information used when exporting session file data to XML. Do not edit this file.
<NMShared Root>\NMSymData.dat	(User-created File) Contains the names of any modules associated with bad PDB files, followed by ",0x0". For example: ADVAPI32.DLL,0x0
<Program Root>\DPSErrorDetection.xsd	Specifies the schema to be used by the Data Export to XML feature.

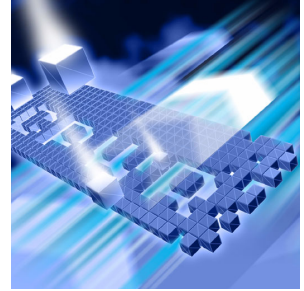
Key

<Program Root> = C:\Program Files\Compuware\DevPartner Studio\BoundsChecker

<NMShared Root> = C:\Program Files\Common Files\Compuware\NMShared\4.7

Note: For installs on 64-bit versions of Windows, DevPartner Studio is located at: \Program Files (x86)\Compuware\DevPartner Studio\ and \Program Files (x86)\Common Files\Compuware\

Index



A

- ActiveCheck 47
- ActiveX 35
 - components 28
 - debugging controls 33
- administrative privileges 37, 43, 97
- applications
 - complex 28
 - multi-threaded 25, 80
 - single-threaded 79
 - transactional 34

B

- BCDefault.DPRul 99

C

- call parameter encoding depth 22
- call validation 16, 18
- CLR analysis 17
- COM
 - components 28
 - servers 35
 - usage 9
- command line 3
- complex applications 28
 - analyzing 19
 - debugging 33
- conditional code 30
- configuration file management 12
- critical section, synchronization object 80
- CTISafe.dat 99
- customer service ix

D

- dangling pointers 26

- deadlock 82
 - potential 83
- default settings 15
- dwWait 36

E

- ExcludedModules.dat 100
- executable files
 - dllhost.exe 40

F

- file extensions
 - .DPFlt 99
 - .DPRul 99
 - .DPSup 99
- filters 30
- FinalCheck 47

G

- guard bytes 10

I

- IIS 28
 - process 42
- important files
 - BCDefault.DPRul 99
 - CTISafe.dat 99
 - ExcludedModules.dat 100
 - NMApiLib 100
 - NMSymData.dat 100
 - Unrestricted_modules.txt 100
 - UserAllocators.dat 100
- instrumenting native code 4

interface
 command line 3
 leaks 19
ISAPI filters 12, 28, 33, 42, 43

L
log file 22

M
managed code 11, 17, 18
memory
 leaks 19
 overrun 16
 poisoning 10
 tracker 12
modules and files 12, 30, 32
 and complex applications 20
 and reverse engineering 24
modules tab 20
multiprocessor application servers 25
multi-threaded applications 25, 80

N
native code 11, 17, 18
NMApiLib 100
NMSymData.dat 100
NMVCBUILD 4

P
P/Invoke 17, 23
 interop monitoring 17
pointers, dangling 26
poisoning memory 10, 25
potential deadlock 83

R
resource leaks 11, 19
resource tracker 12

S
service control logic 36
services, debugging 28
settings 12, 13
 default 2
 refining 3
single-threaded applications 79
StartEvtReporting 32
StopEvtReporting 32
suppression 30

T
technical support ix
test container 34
third-party software 2, 19, 30
thread, definition of 80
transactional applications 34
troubleshooting 89

U
Unrestricted_modules.txt 100
UserAllocators.dat 100

V
VCBUILD 4

W
Windows NT
 service control manager 37, 94
 services 28, 35
 services, debugging 33
worker thread 36