

Debugging Java[™] Applications

with Memory Analyzer and the IBM Extensions for Memory Analyzer



Overview

- IBM Monitoring and Diagnostics tool for Java[™] Memory Analyzer
- Dumps used by Memory Analyzer
- Analyzing problems with Memory Analyzer
- The IBM Extensions for Memory Analyzer
- Demo

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IBM Monitoring and Diagnostics tool for Java – Memory Analyzer

- Part of the IBM Monitoring and Diagnostic Tools for Java[™] collection of tools
 - A unified suite of tools to understand different aspects of Java applications
 - Available in the IBM Support Assistant
 - All fully IBM supported tools
- IBM version of the Eclipse Memory Analyzer Tool (MAT)
 - Modified to accept system dumps and IBM heap dumps
 - Further capabilities planned
- Tool that carries out memory analysis of Java applications
- Primary aim is memory leak detection and footprint analysis

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Installing Memory Analyzer

- Installed into the IBM Support Assistant (ISA):
 - http://www-01.ibm.com/software/support/isa/
- Installed using the "Update \rightarrow Find New... \rightarrow Tools Add-ons" menu option
 - Under the "JVM-based Tools" section
 - Called "IBM Monitoring and Diagnostic Tools for Java Memory Analyzer (Tech Preview)"
- Fully supported by the IBM Java Support team
 - Via normal IBM support routes



Dumps used by Memory Analyzer

- HotSpot based Java Runtimes (Solaris and HP-UX):
 HDBOE format bean dumps
 - HPROF format heap dumps
- IBM Java Runtimes (AIX, Linux, Windows, z/OS):
 - System dump (core file, minidump, svcdump), processed by Jextract*
 - IBM PHD heap dump

-		-		Field Names	Field and Array References	Primitive Fields	Primitive Array Contents	Accurate GC Roots	Native Memory and Threads
IBM PHD	20% of Java heap size	\checkmark	with Javacore*	×	 ✓ 	×	×	×	×
HPROF	Java heap size	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	 ✓ 	\checkmark	×
System dump	Java heap size + 30%	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark

* by loading in a both a pair of files consisting of javacore.txt (IBM thread dump file) and a heapdump.phd that have been generated at the same time, thread details become available.



Acquiring Dumps: HotSpot Java Runtimes

- Interactive methods:
 - Using a Ctrl-Break:
 - When the -XX:+HeapDumpOnCtrlBreak command line option is set
 - HPROF format dump is generated along with a thread dump when a Ctrl-Break event is sent
 - Using the JMap tool:
 - jmap -dump:format=b <pid>

(Java 5)

(Java 6)

- jmap -dump[live,]format=b,file=<filename> <pid>
- Using the Operating System:
 - gcore command or the destructive kill -6 or kill -11 commands to produce a core file
 - Then, extract a heapdump from the core file using Jmap
 - jmap -dump:format=b,file=heap.hprof <path to java executable> <core>
- Using the JConsole tool:
 - Under the HotSpotDiagnostic MBean in JConsole a dumpHeap operation is provided. This will request that a HPROF dump is generated.
- Event Based Methods
 - On an OutOfMemoryError:
 - When the -XX:+HeapDumpOnOutOfMemoryError command line option is set
 - no limit to how many heapdumps will be produced on this event per JVM run.

Note: this has been changed in a recent update of HotSpot



Acquiring Dumps: IBM Java Runtimes

- Interactive Methods
 - Using a SIGQUIT or Ctrl-Break:
 - When a Ctrl-Break or SIGQUIT (usually generated using "kill -3") is sent to the IBM runtime
 - a "user" event is generated in the IBM dump engine
 - can however be configured to generate either a PHD format dump, or a System dump using the following command line options to the Java application
 - -Xdump:heap:events=user
 (PHD Heap Dump)
 - -Xdump:system:events=user (System dump)
 - Using the operating system to produce a system dump:
 - AIX: gencore (or the destructive kill -6 or kill -11)
 - Linux/Solaris: gcore (or the destructive kill -6 or kill -11)
 - Windows: userdump.exe
 - z/OS: SVCDUMP/Console Dump
 - Using IBM Monitoring and Diagnostics Tools for Java Health Center:
 - The Health Center tool provides a menu option to request dumps from a running Java process
 - can request either a PHD or system dump



Acquiring Dumps: IBM Java Runtimes

- Event Based Methods
 - Using the IBM dump engine:
 - The dump engine provides a large number of events on which you can produce a "heap" (PHD) or "system" dump

Event	Description	Filtering	Example
gpf	General Protection Fault (crash)		-Xdump:system:events=gpf
user	User generated signal (SIGQUIT or Ctrl-Break)		-Xdump:system:events=user
vmstop	VM shutdown, including call to System.exit()	exit code	-Xdump:system:events=vmstop,filter=#0#10
load	Class load	class name	-Xdump:system:events=load,filter=com/ibm/example/Example
unload	Class unload	class name	-Xdump:system:events=unload,filter=com/ibm/example/Example
throw	An exception being thrown	exception name	-Xdump:system:events=throw,filter=java/net/ConnectException
catch	An exception being caught	exception name	-Xdump:system:events=catch,filter=java/net/ConnectException
systhrow	A Java exception is about to be thrown by the JVM	exception name	-Xdump:system:events=systhrow,filter=java/lang/OutOfMemoryError, range=14
allocation	A Java object is allocated	size of object	-Xdump:system:events=allocate,filter=#5m

• Exceptions can also be filtered on throwing method using '#'

-Xdump:system:events=throw,filter=java/lang/NullPointerException#com/ibm/example/Example.bad



Acquiring Dumps: IBM Java Runtimes

- Event based methods
 - Using the IBM trace engine:
 - the trace engine allows PHD and system dumps to be triggered on method entry or exit
 - achieved using the following command line option to the application:
 - produces a system dump when the Example.trigger() method is called
 - -Xtrace:maximal=mt,trigger=method{com/ibm/example/Example.trigger,sysdump}
 - produces a PHD dump when the Example.trigger() method is called
 - -Xtrace:maximal=mt,trigger=method{com/ibm/example/Example.trigger,heapdump}
 - · set a range so that you don't create dumps every time the method is called

-Xtrace:maximal=mt,trigger=method{com/ibm/example/Example.trigger,sysdump,,5,1}

- Programmatic Methods:
 - provide a com.ibm.jvm.Dump class with three methods:

javaDump(), heapDump() and systemDump()

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Acquiring Dumps: Using Memory Analyzer

- Memory Analyzer also provides an "Acquire Heap Dump" option that allows you to trigger and load a snapshot dump from a Java process running on the same machine as Memory Analyzer.
- On HotSpot based runtimes the Memory Analyzer generates the dump using Jmap.
- For the IBM runtimes the dump is generated using the "late attach" functionality and the the programmatic API.

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Analyzing problems with Memory Analyzer



Overview:

Overview of the heapdump including size and total number of objects.

Provides links to continued analysis

Path to GC Roots:

Provides the reference chain that prevents an object being garbage collected.

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Dominator Tree grouped by Class Loader:

Lists the biggest objects using a "keep alive tree". Grouping by Class

Loader limits the analysis to a single application in a JEE environment



Analyzing problems with Memory Analyzer

- Additional datais available in the HPROF and IBM System Dumps

 particularly the field names and field values
- Makes it possible to diagnose a range of other problem types.
- Objects selected in Memory Analyzer have additional data show in the Inspector view

 including the Class Hierarchy, Attributes and Statics



- This additional data is used by the IBM Extensions for Memory Analyzer



IBM Extensions for Memory Analyzer

- IBM alphaWorks project to extend Memory Analyzer with IBM product knowledge
- Provides additional capabilities for debugging:
 - generic Java applications
 - WebSphere Application Server
 - WebSphere eXtreme Scale
 - CICS Transaction Gateway
 - ...and more to come
- Provides "always on" extensions, and status reports of aspects of the applications, including:
 - WebSphere Application Server Overview
 - Web Container Analysis
 - HTTP Session Analysis
 - Thread Pool Configuration and Status



Installing the IBM Extensions for Memory Analyzer

- Installed into the IBM Support Assistant (ISA) for use by Memory Analyzer

 Can also be installed into the Eclipse Memory Analyzer Tool
- Installed into ISA using the updater
 - First needs to be configured with a new update site
 - "File \rightarrow Preferences \rightarrow Updater Preferences"
 - Add http://dl.alphaworks.ibm.com/ettktechnologies/updates
 - Then run "Update \rightarrow Find New... \rightarrow Tools Add-ons" menu option
 - Under the "JVM-based Tools" section
 - Select the plug-ins starting with: "IBM Extensions for Memory Analyzer "
- Must install "IBM Extensions for Memory Analyzer Utilities (required)"
 - Others are optional:
 - Java SE Runtime, WebSphere Application Server, CICS Transaction Gateway



Using the IBM extensions inside Memory Analyzer

- Always on Extensions:
 - Add information to the description of the Java objects when they are displayed in one of the Memory Analyzer views





Using the IBM extensions inside Memory Analyzer

- Query Extensions:
 - executable queries that can be found under the Query Browser pull down menu

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- Produce reports covering a number of aspects of each of the supported products



Demo



IBM

Additional Resources

- IBM Monitoring and Diagnostic Tools for Java:
 - http://www.ibm.com/developerworks/java/jdk/tools
- IBM Extensions for Memory Analyzer:
 - http://www.alphaworks.ibm.com/tech/iema
- IBM Java Runtimes and SDKs Forum:
 - http://www.ibm.com/developerworks/forums/forum.jspa?forumID=367
- IBM on Troubleshooting Java Applications Blog:

- https://www.ibm.com/developerworks/mydeveloperworks/blogs/troubleshootingjava/?lang=en



Questions?