Jonathan Lawrence IBM

IBM Monitoring and Diagnostic Tools for Java™

Agenda

- Why use IBM Monitoring and Diagnostic Tools for Java™?
- IBM Support Assistant
- Garbage Collector and Memory Visualizer
- Memory Analyzer
- Diagnostics Collector
- Dump Analyzer
- Health Center
  - Installation
  - How to enable an application for monitoring

Why use IBM Monitoring and Diagnostic Tools for Java™ ?

- Provide a unified suite of tools to understand different aspects of Java applications.
- Provide more than visualizations – also provide observations and recommendations.
- Fully IBM supported

Fixing problems ...

... is much easier with the right tool for the job!

IBM Support Assistant

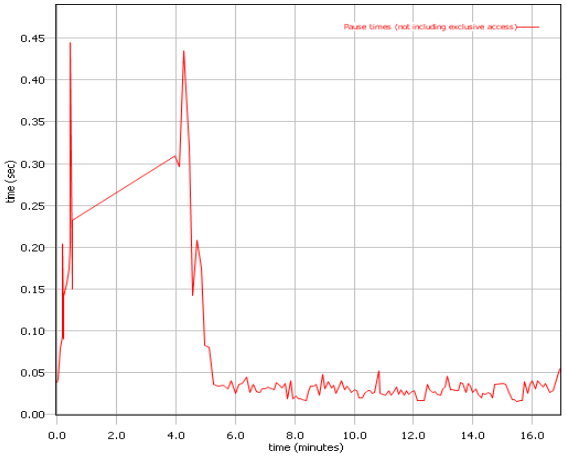
- Provides the “toolbox” in which analysis tools reside
- The place to go for Serviceability Tools across product families
- Assist with opening PMRs and working with IBM Support
- Product information to locate APARs and fixes
- Search feature to query IBM and non-IBM knowledge banks
- Available here http://www.ibm.com/software/support/isa

Garbage Collector and Memory Visualizer (GCMV) overview

- What problem am I solving?
  - How is the Garbage Collector (GC) behaving? Can I do better?
  - How much time is GC taking?
  - How much free memory does my JVM have?

- Tool to analyze Java verbose GC logs
- Graphs to show garbage collection and Java heap statistics over time
- Not only for memory errors, very good for performance tuning
- Recommendations use heuristics to guide you towards issues that may be limiting performance

Garbage Collector and Memory Visualizer (GCMV) overview cont…



Graphical Display of Data

- Allows graphing of all available data: pause times, heap size etc
- Allows zoom, cropping and change of axes value and units
- Allows comparison of multiple files

Tuning recommendation

The garbage collector seems to be compacting excessively. On average 45% of each pause was spent compacting the heap. Compaction occurred on 40% of collections. Possible causes of excessive compaction include the heap size being too small or the application allocating objects that are larger than any contiguous block of free space on the heap.

The garbage collector is performing system (forced) GCs. 5 out of 145 collections (3.448%) were triggered by System.gc() calls. The use of System.gc() is generally not recommended since they can cause long pauses and do not allow the garbage collection algorithms to optimise themselves. Consider inspecting your code for occurrences of System.gc().

The mean occupancy in the nursery is 7%. This is low, so the gencon policy is probably an optimal policy for this workload.

The mean occupancy in the tenured area is 14%. This is low, so you have some room to shrink the heap if required.

Summary

Allocation failure count	140
Concurrent collection count	0
Forced collection count	5
GC Mode	gencon
Global collections - Mean garbage collection pause (ms)	185
Global collections - Mean interval between collections (minutes)	0.13
Global collections - Number of collections	5
Global collections - Total amount tenured (MB)	93.1
Largest memory request (bytes)	127784
Minor collections - Mean garbage collection pause (ms)	48.2
Minor collections - Mean interval between collections (ms)	7193
Minor collections - Number of collections	140
Minor collections - Total amount flipped (MB)	668
Minor collections - Total amount tenured (MB)	38.8
Proportion of time spent in garbage collection pauses (%)	0.76
Proportion of time spent unpaused (%)	99.24
Rate of garbage collection (MB/minutes)	874

Analysis and Recommendations

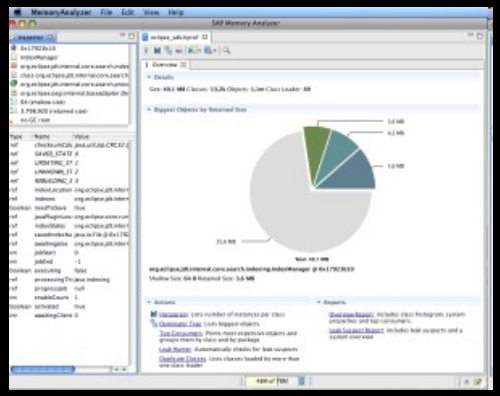
- Provides tuning recommendations based on data and flags errors.
- Analysis can be limited using cropping.
- Values and units used in analysis can be changed by changing axes values and units

Memory Analyzer overview

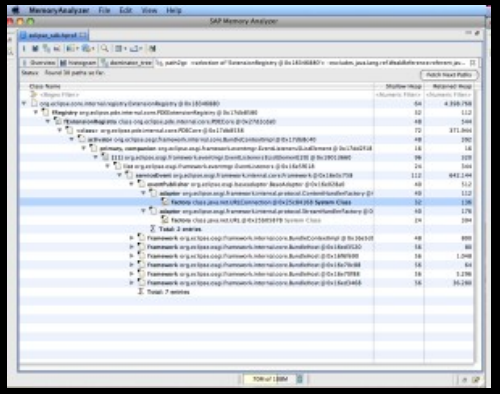
- What problem am I solving?
  - Why did I run out of Java memory?
  - What's in my Java heap? How can I explore it and get new insights?

- Tool for analyzing heap dumps and identifying memory leaks from JVMs
- Works with IBM system dumps, heapdumps and Sun HPROF binary dumps
- Provides memory leak detection and footprint analysis
  - Objects by Class, Dominator Tree Analysis, Path to GC Roots, Dominator Tree by Class Loader
- Shows areas of memory wastage
  - Collections, duplicate strings, substring/char arrays, constant value primitives
- Displays Stack trace with object references
- Provides SQL like object query language (OQL)
- Provides extension points to write analysis plugins

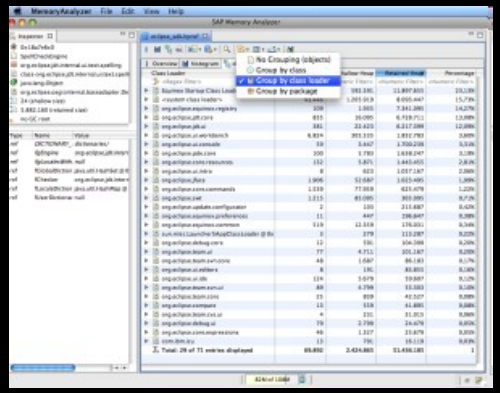
Memory Analyzer overview cont…



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.



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

Diagnostic Collector overview

- What problem am I solving?
  - Something has gone wrong!
  - JVM has detected an error and captured diagnostic information
  - Need to get this diagnostic information to the right people

- Runs as a separate process when the JVM detects a ‘dump event’
  - GPF
  - Java heap OutOfMemoryError
  - Unexpected signal received
  - (optionally) JVM start, JVM stop
- Knows all possible dump locations and searches to gather all dumps into a single zip file
- Collects system dumps, Java dumps, heap dumps, verbose GC logs
- If system dump found jextract runs automatically
- At JVM start it runs a diagnostic configuration check
- Requires IBM SDK for Java version 5.0 or above

Dump Analyzer overview

- What problem am I solving?
  - What was happening when the JVM aborted?
  - What was the native memory situation in my JVM?
  - Why did my JVM deadlock? (show me the locks/threads)

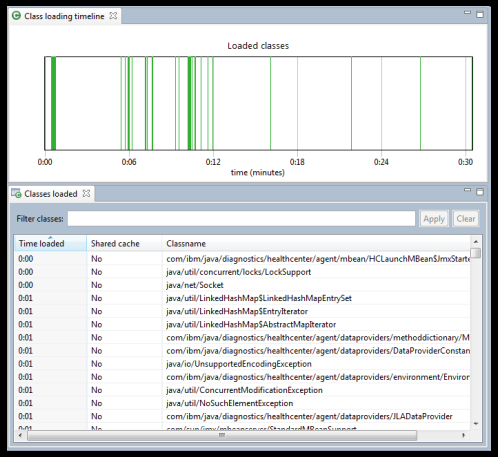
- Provides general analysis of formatted system dumps
- Provides a number of specific analysis modules
- Extracts useful information
- Searches for known problems

Health Center overview

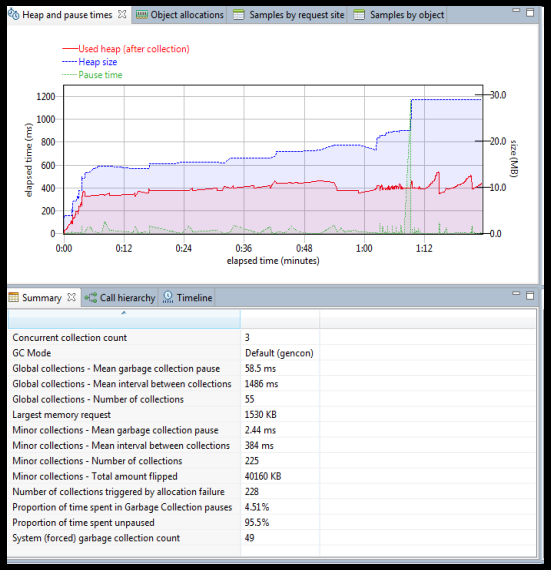
- What problem am I solving?
  - What is my JVM doing? Is everything ok?
  - Why is my application running slowly? Why is it not scaling?
  - Am I using the right options?

- Live monitoring tool with very low overhead
- Understand how your application is behaving
  - Monitor Class loading, File I/O, Environment settings, Garbage Collection, Method Profiling, Locking, Native memory use, Threads
- Diagnose potential problems, with recommendations
- Works at the JVM level
- Suitable for all Java applications

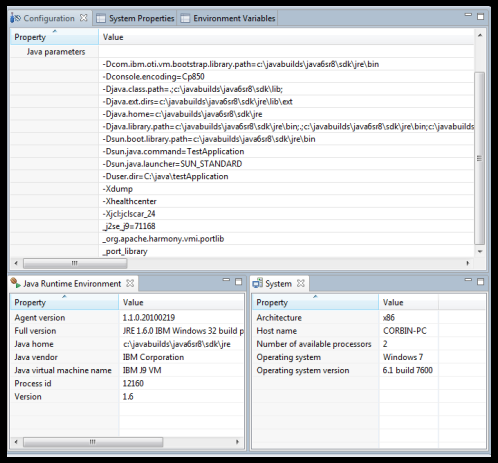
Health Center overview cont…



Class loading visualization
- Shows all loaded classes
- Shows load time
- Identifies shared classes

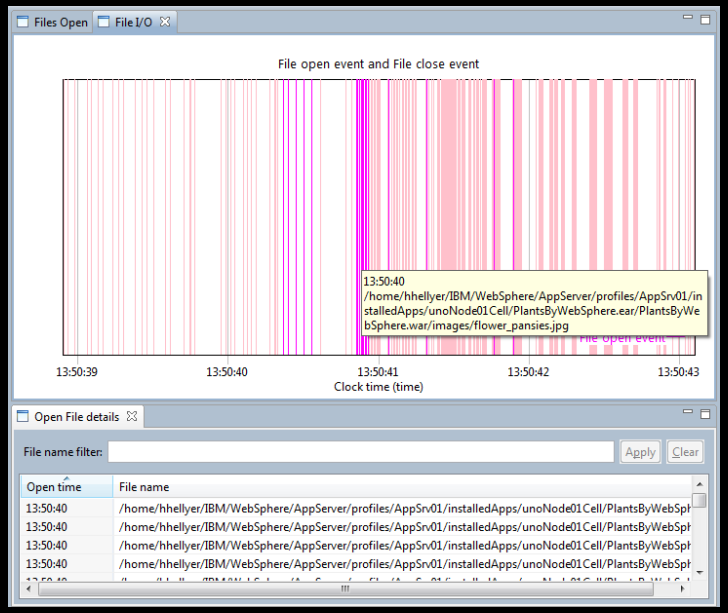


Garbage Collection visualization
- Visualizes heap usage and gc pause times over time
- Identifies memory leaks
- Suggests command-line and tuning parameters
- Same recommendation logic as GCMV

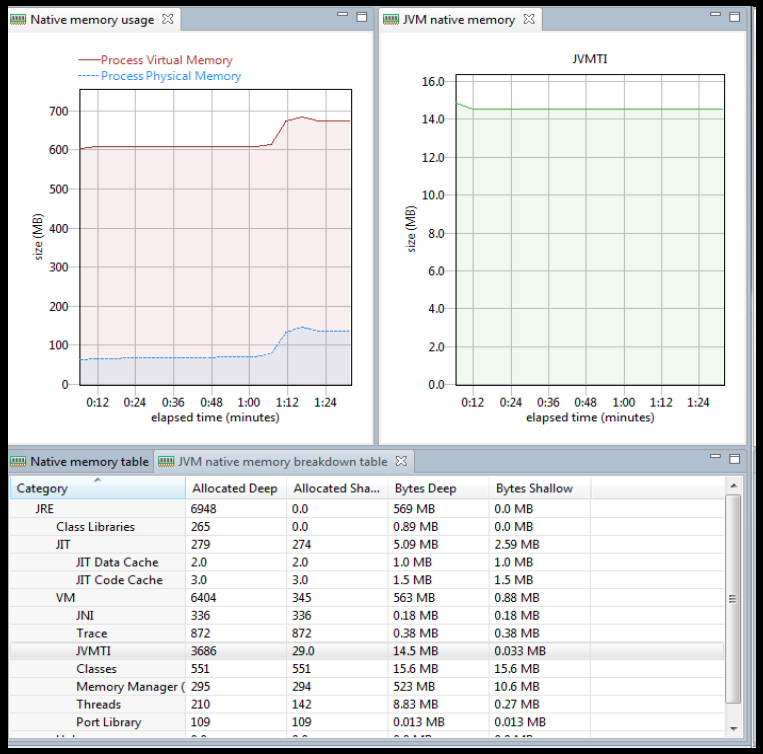


Environment reporting
- Detects invalid Java options
- Detects options which may hurt performance or serviceability
- Useful for remote diagnosis of configuration-related problems

Health Center overview cont…

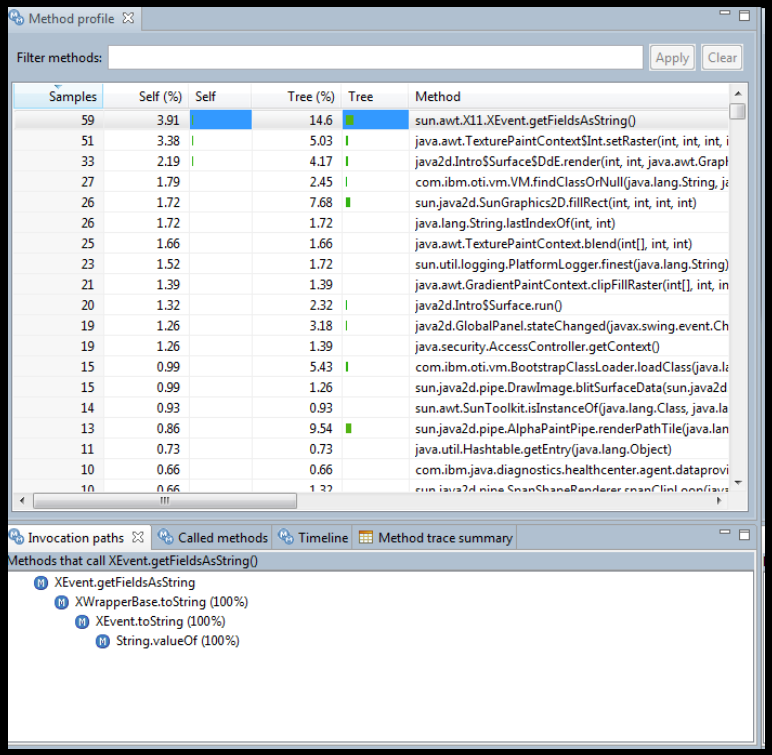


I/O
- Monitor application file open/close events as they occur
- Lists currently open files



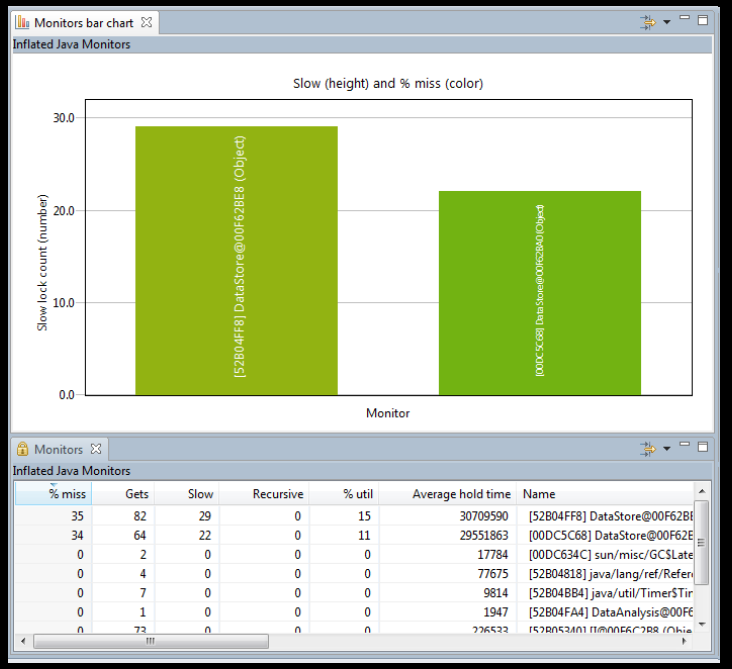
Native Memory
- Detect native memory leaks in application
- Determine if external forces are using more memory
- Memory counters showing which parts of the JVM are using the most native memory

Health Center overview cont…

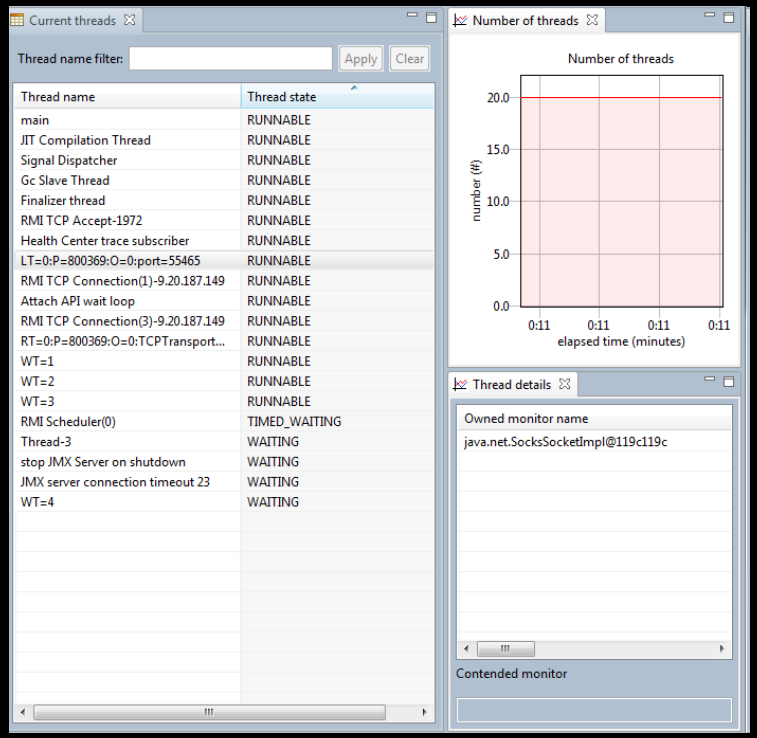


Method Profiling
- Always-on profiling offers insight into application activity
- Identifies the hottest methods in an application
- Full call stacks to identify where methods are being called from and what methods they call
- No byte code instrumentation, no recompiling

Java Lock analysis
- Always-on lock monitoring
- Quickly allows the usage of all locks to be profiled
- Helps to identify points of contention in the application that are preventing scaling

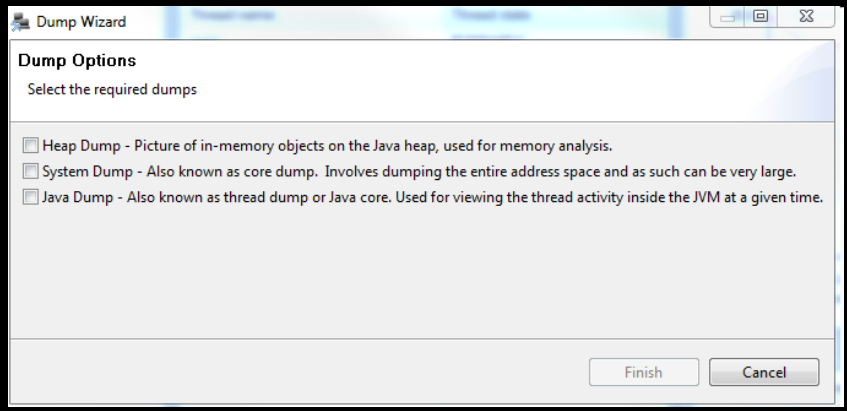


Health Center overview cont…



Threads view
- List of current threads and states
- Number of threads over time
- See contended monitors

Live control of application
- Trigger dumps
- Enable verbosegc collection



Health Center installation

- The tool is provided in two parts:
  - An agent that collects data from a running application.
  - An Eclipse-based client that connects to the agent.
- The Agent ship's with the following vm's:
  - Java 5sr9 and upwards
  - Java 6sr3 and upwards
- The latest version of the agent is always available from within the Health Center Client
  - Recommended to always update to the latest version of the agent
- Agent package unzips over the jre directory of the JVM you are using to run the application to monitor

How to enable an application for monitoring

- Full instructions are provided within the help shipped with the Health Center Client but in most cases as simple as :

  For 5 SR9 and earlier, or Java 6 SR4 and earlier

  ```
  java –agentlib:healthcenter –Xtrace:output=healthcenter.out HelloWorld
  ```

  For Java 5 SR10 and later, or Java 6 SR5 and later

  ```
  java –Xhealthcenter HelloWorld
  ```

Where to find more information

- IBM Monitoring and Diagnostic Tools for Java™ on developerWorks
  http://www.ibm.com/developerworks/java/jdk/tools/
- IBM Support Assistant (ISA)

  http://www.ibm.com/software/support/isa
- Email javatool@uk.ibm.com

Any Questions?