Profiling Java applications using Eclipse* Test and Performance Tools Platform

Facilitators

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Agenda

- Unit 1 – Eclipse* TPTP Overview
  - Please work with facilitators during this presentation to get TPTP and samples installed during this presentation
- Unit 2 – Using the TPTP Java Profiler
  - Profiler Architecture
  - Profiling and Logging Perspective
  - Launch and Attach
  - Profiling options and views
  - Demo

Participants

Tell me a little about yourselves…

- From where
- Company or academic institution
- Users or Adopters
- Eclipse* and TPTP experience
- Java* experience
- Have you used a Java* profiler before?
- Tutorial expectations

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Eclipse* TPTP Overview

- Eclipse* Tools Project, Hyades, Dec 2002
  - Promoted to Eclipse* project, 2004
- Open-source platform for Automated Software Quality (ASQ) tools including reference implementations for testing, tracing and monitoring software systems
- Addresses the entire test and performance life cycle, from early testing to production application monitoring, including test recording, editing and execution, monitoring, tracing and profiling capabilities
- Integration with tools used in the other processes of a software lifecycle under Eclipse* environment
- Reduce the cost and complexity of implementing effective automated software quality control processes
- Share data through an OMG-defined trace, log, statistical and test model implemented via the Eclipse* Modeling Framework (EMF)
- Active participants:

  IBM*, Intel®, OC Systems*
- Former participants:

  Compuware, SAP, Scapa Technologies

More about Eclipse* TPTP Overview

- Composed of 4 sub projects:
  - Platform
  - Trace and Profiling
  - Test
  - Monitoring

  TPTP Profiler developed/maintained by these teams
- Principles:
  - Extension of the Eclipse* Value Proposition
  - Vendor Ecosystem
  - Vendor Neutrality
  - Standards-Based Innovation
  - Agile Development
  - Inclusiveness & Diversity
- TPTP is highly extensible.

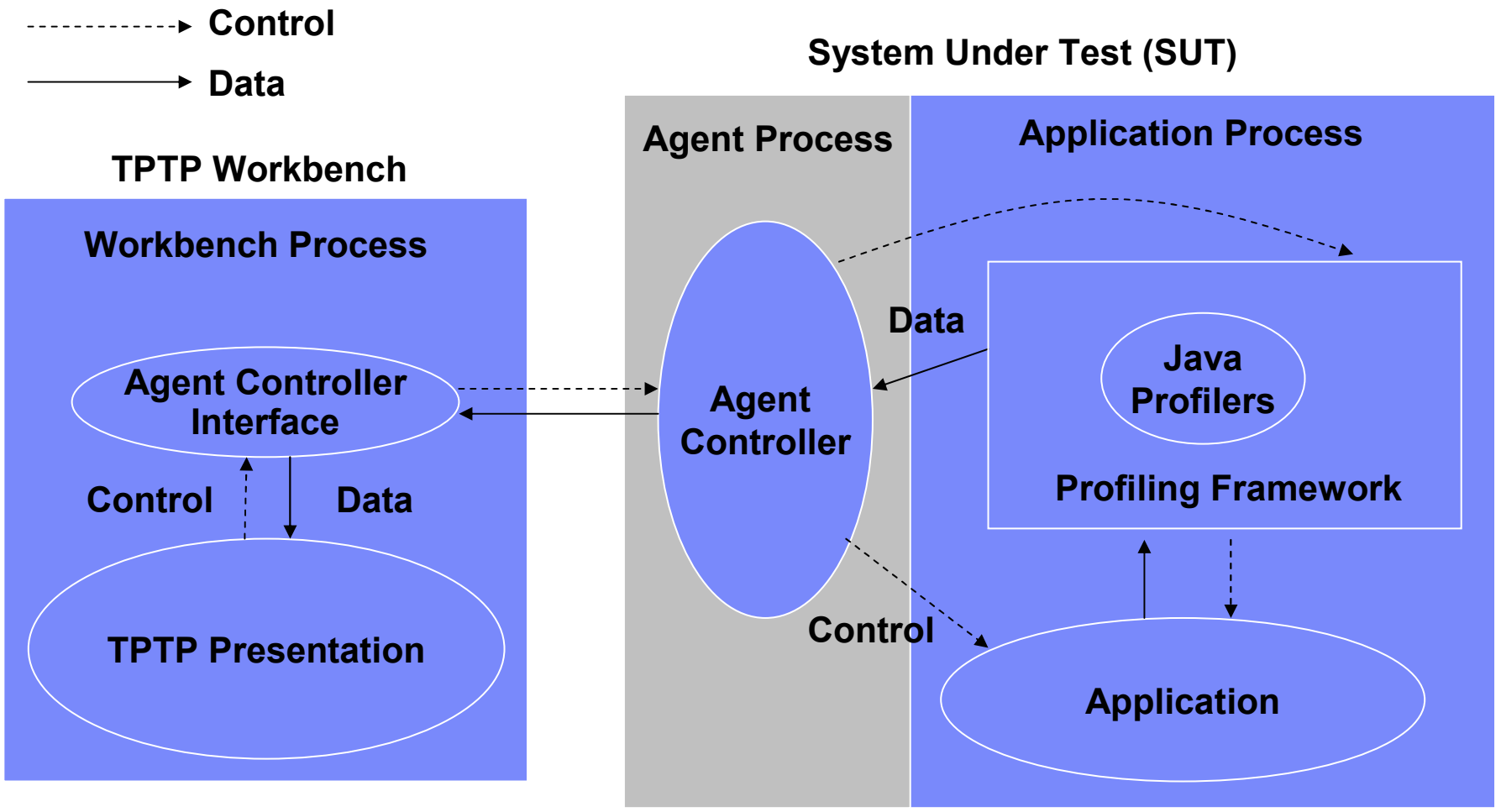
Eclipse* TPTP Profiling Tool Overview – Subject of the day

- Target use cases
  - For performance analysis and deeper understanding of Java* programs
    - Visualization of program execution and threading behavior
    - Pinpointing operations that take most resources
    - Exploring patterns of program behavior
  - For early-in-the-cycle tests of your application
- Easy to use with extensive GUI's
  - Profiling and Logging Perspectives
  - A number of graphical and tabular views
- Low Overhead
  - Enables on-demand profiling by running applications with agent-on at near full speed and later attaching to gather data in various phases
- Advanced data processing
  - Assorted filtering functionalities to help localize problems and reduce data volume for long running applications
  - Sophisticated input stream analyzer

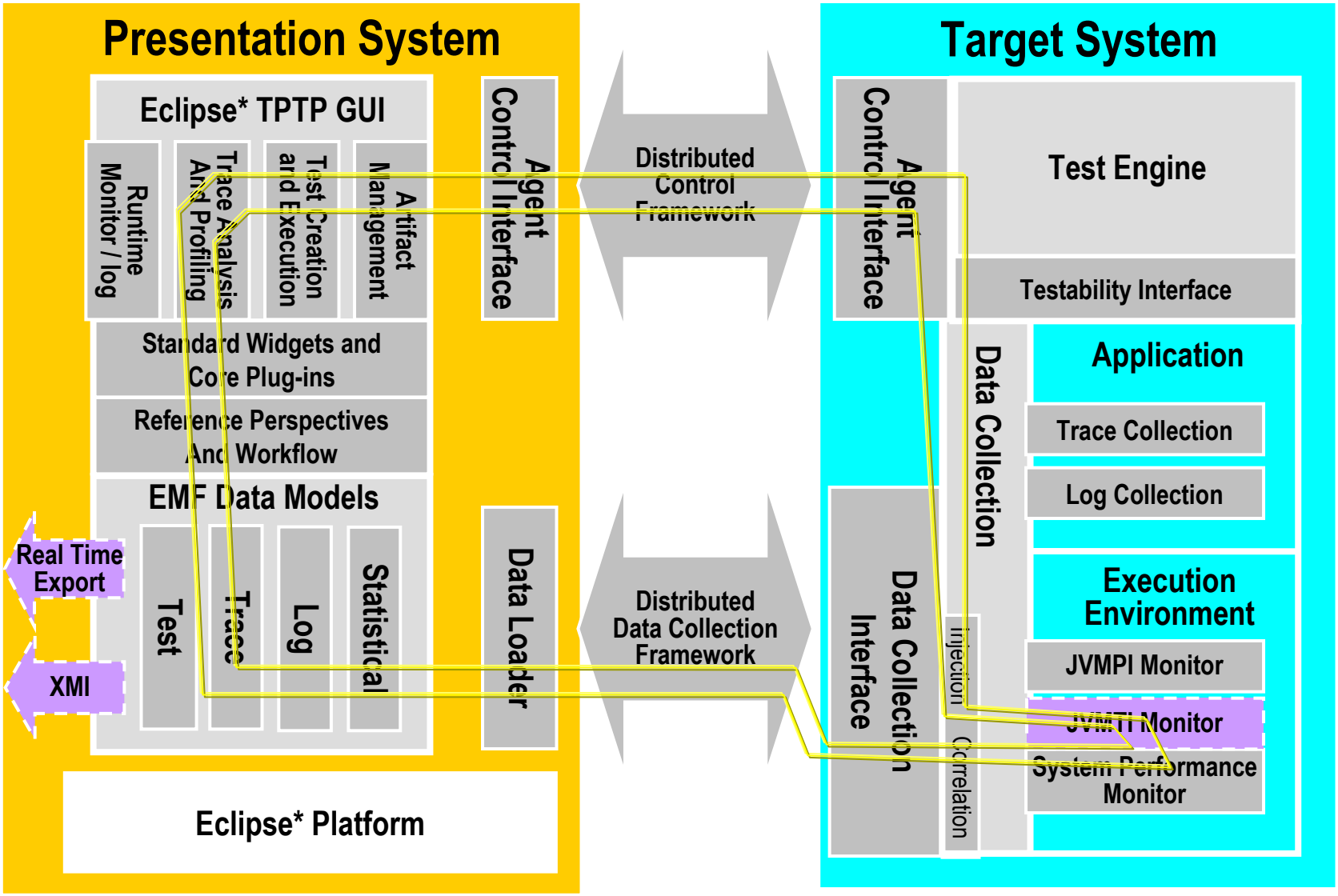
Eclipse* TPTP Agent Controller & Java Profiler

- A daemon process that resides on each system under test (SUT) and the TPTP workbench
  - Enables workbench to launch processes on SUT (or locally)
  - Interacts with other agents that coexist on the SUT (or locally)
  - Capable to manage local or remote applications from a local TPTP workbench
  - Option to use integrated agent controller when the workbench and the SUT are the same system
- The Java* profiler is a managed agent that can be used to profile local or remote Java* applications from a local TPTP workbench

Data Collection Workflow



TPTP Architecture



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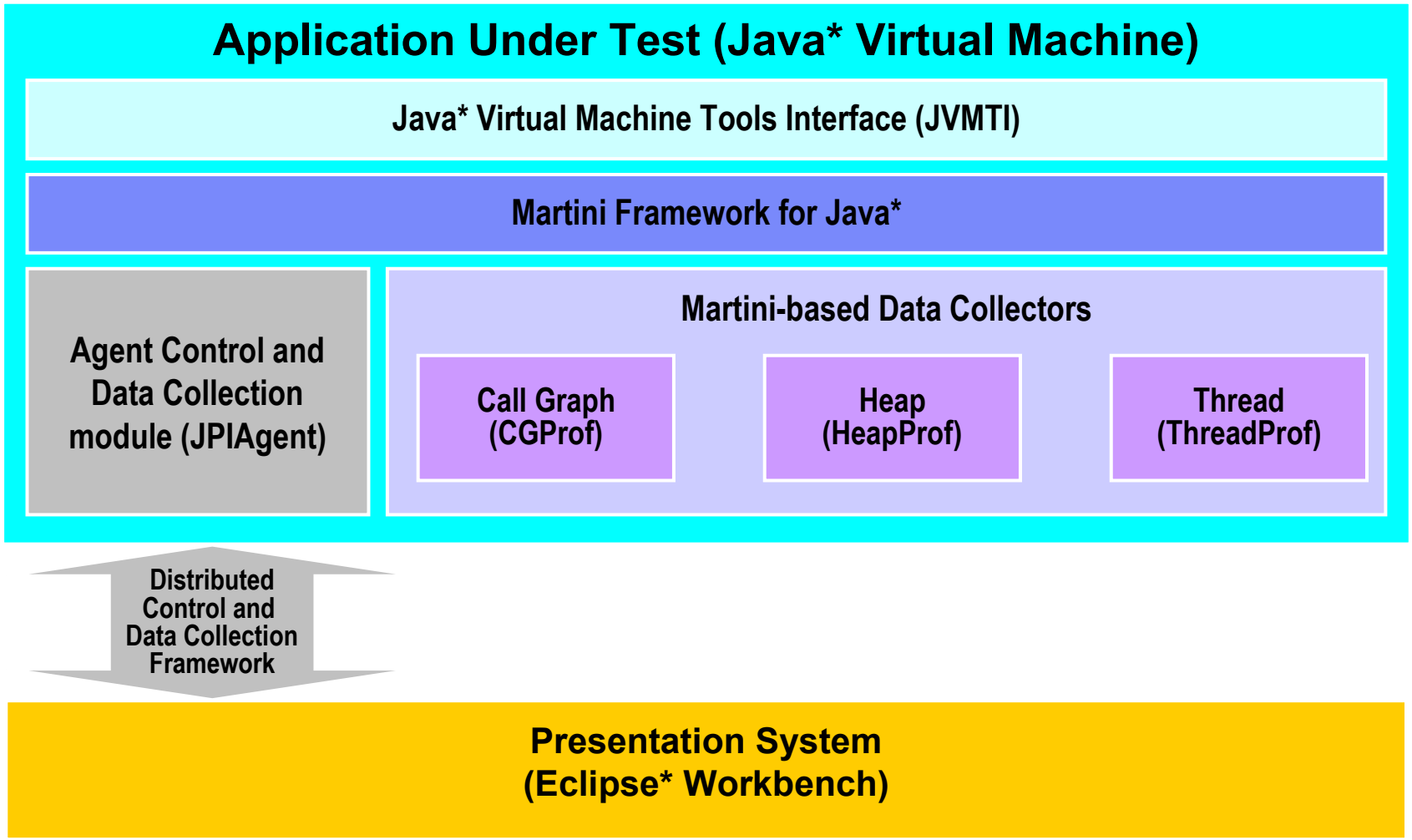
The Java Profiler

- Set of libraries to attach to JVM & record Java App behavior
- Identify performance details (e.g.,): classes or methods responsible for execution bottlenecks; analyze application heap to find memory leaks; visualize threading behavior.
- Applications under test can reside in Eclipse workspace, binaries on file system, or hosted in a J2EE application server.
- Can be launched from the Eclipse IDE or as a standalone program using Java command-line options
- Output in the form of XML fragments (XML4Profiling)
- Extensible framework: core runtime component (Martini); agent managed by the Agent Controller (JPIAgent); set set of data collection libraries built on top of the Martini runtime.

JVMTI-based Java* Profiler Architecture



Profiling and Logging Perspective

- Profiling and Logging perspective provides resources for starting a profiling session as well as obtaining comprehensive information on the performance of the monitored application
- The profiling tool provides information pertaining to
  - Execution analysis
  - Object allocations
  - Thread interactions

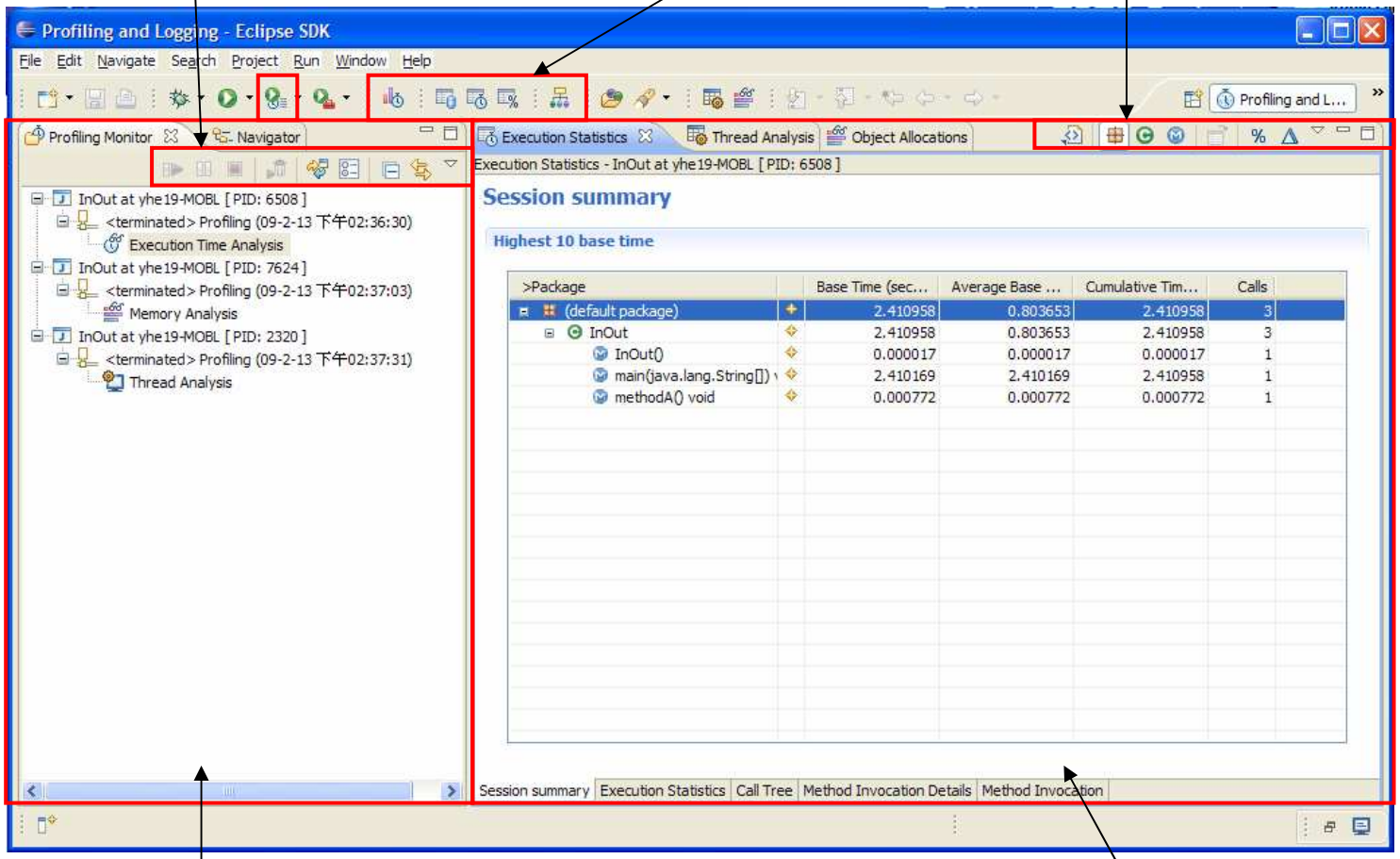
Profiling and Logging Perspective

- Combinations of views and editors that are best suited to perform application profiling
- Profiling Monitor view
  - Administer profiling resources and manage activities
- Profiling views
  - Visualize and analyze profiling data
- Profiling actions
  - Control profiling resources
  - Actions are resource sensitive
  - Choice of action depending on type and status of the object in selection
    - Attach and Detach the agent from process
    - Start and Stop monitoring on an agent
    - Terminate a process

Monitor actions

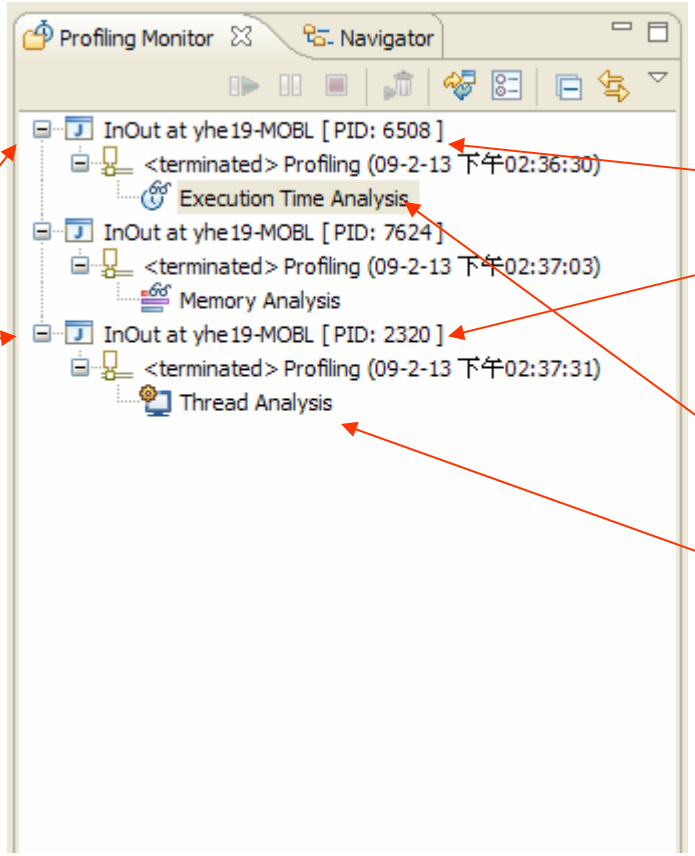
Open view actions

View level actions



Monitor and Navigator view

Profiling views



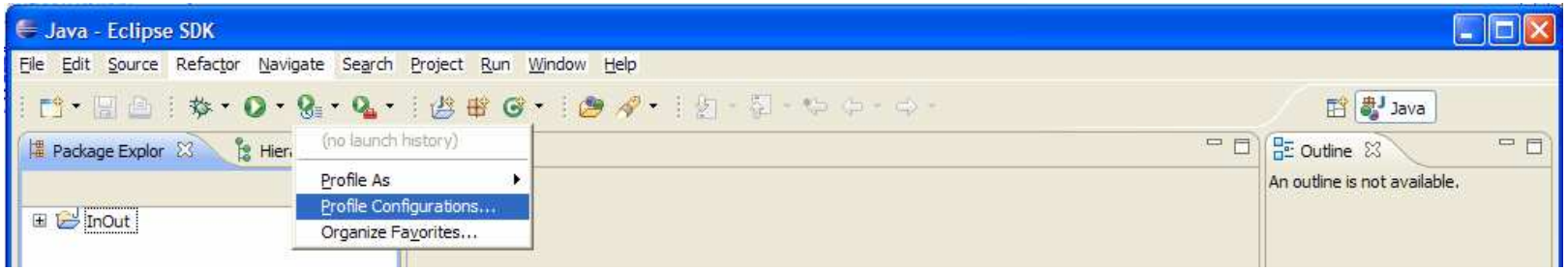
Host: system under profile

Process: application under profile

Profiling Agent & Analysis types

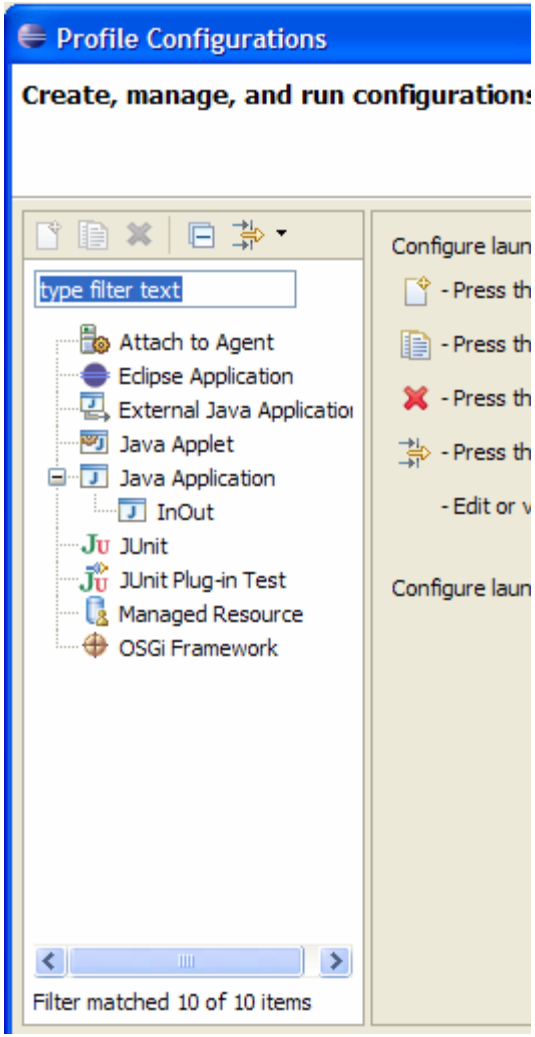
Launch and Attach

- Profiling session is started by launching an application or by attaching to a running application
  - Launch : start an application with a profiling agent
  - Attach : attach to an application which is already started and invoked with a profiling agent
- How? Launch configuration is where you start the session.



Launch and Attach - Configuration

- A place to create, run and manage profiling sessions.
- Configure the details of a profiling session
  - Target host
  - Application to profile
  - Scope of the profile
  - Profile data destination
- Select launch configuration type according to the location of the target Java* application:
  - Within Workbench > "*Java Application*" launch configuration
  - Outside Workbench > *"External Java Application"* launch configuration

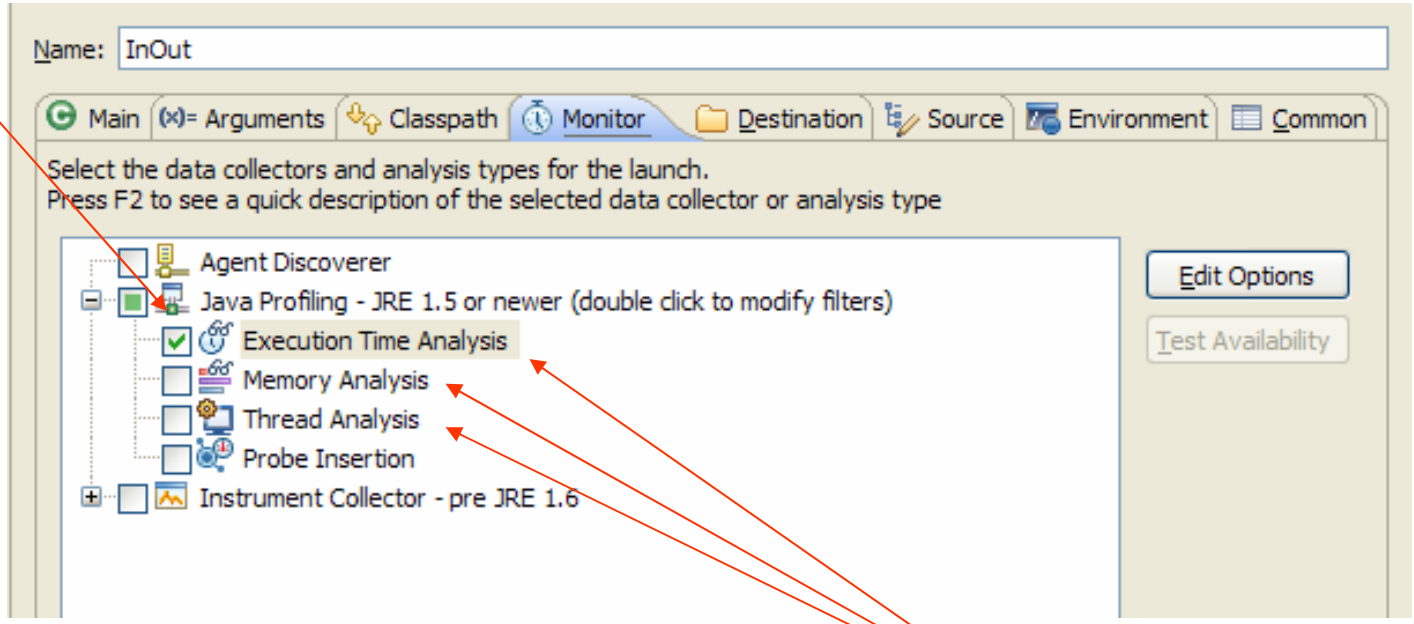


Launch and Attach – Configuration Tabs

- Collect and display detailed information about a configuration
- Tabs for profiling:
  - Monitor tab : defines details of data collection on a profiling session
  - Destination tab : defines the destination of the profiling data
  - Host tab : for external application configurations only, defines the location of the process to be launched or attached
  - Agents tab : for attach configurations only, lists agents available for attaching

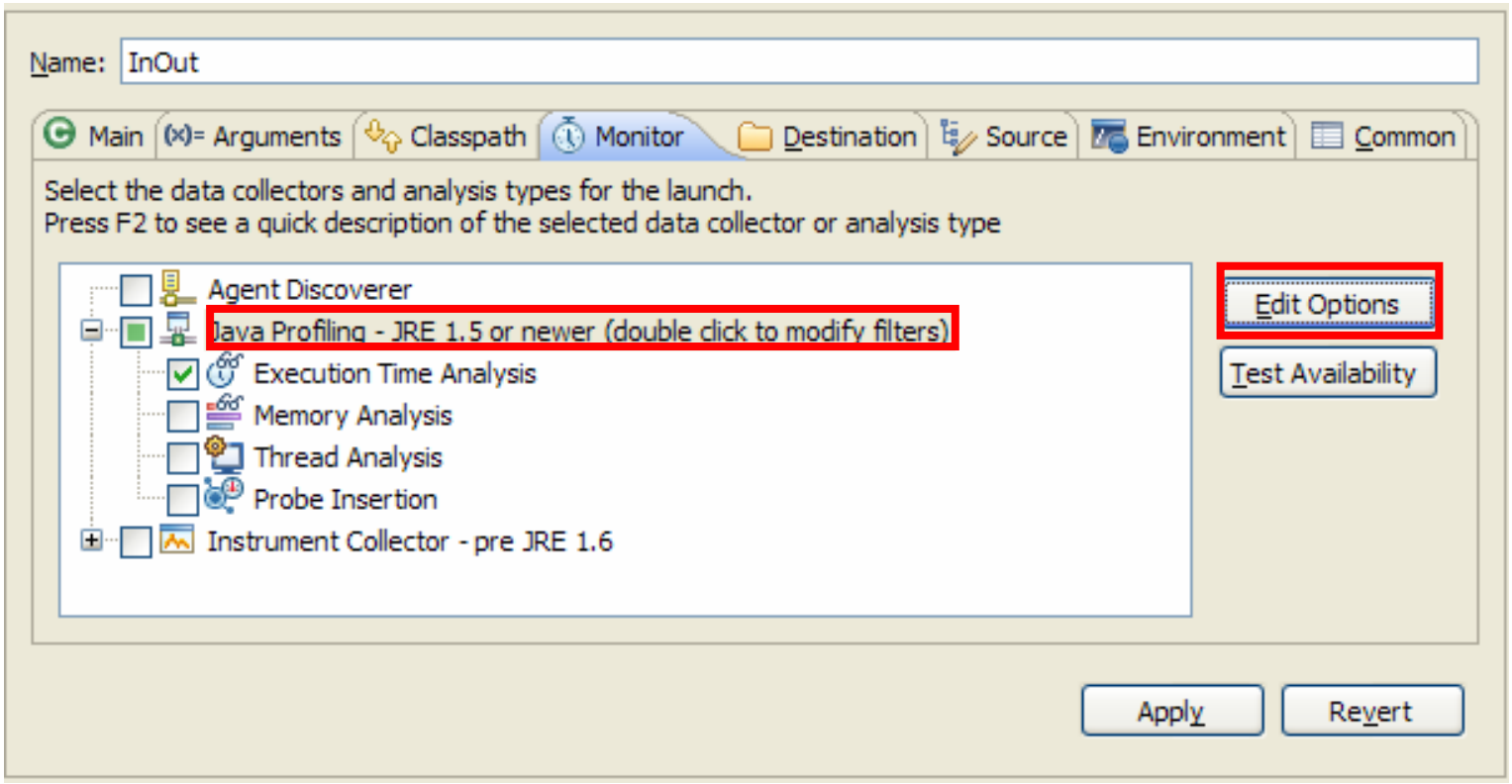
Launch and Attach – Monitor Tab

Data Collectors



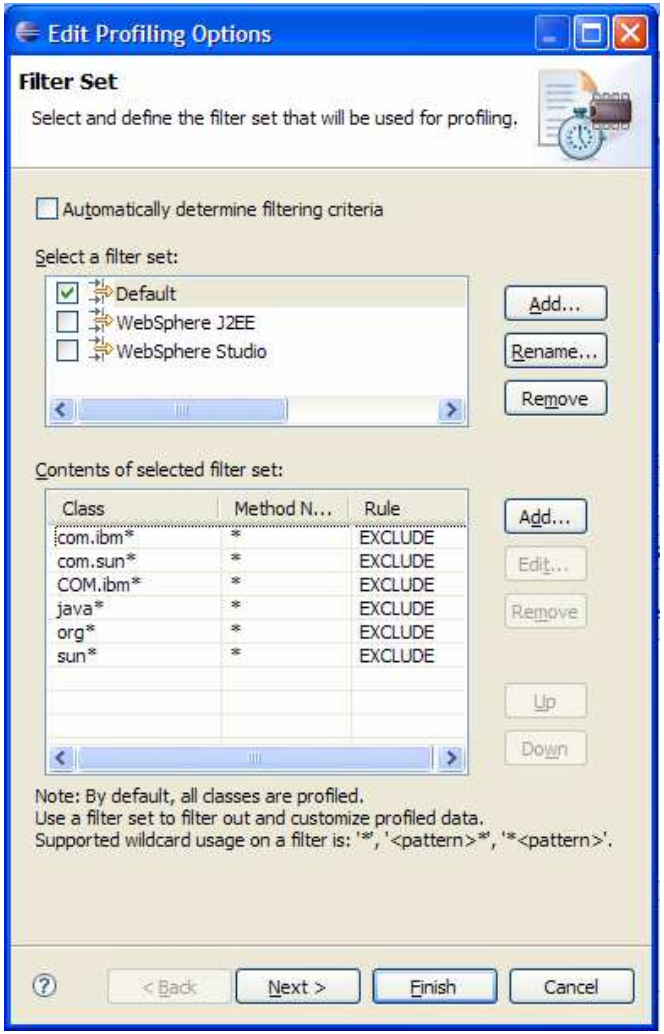
Analysis Types

Launch and Attach – Profiling Options

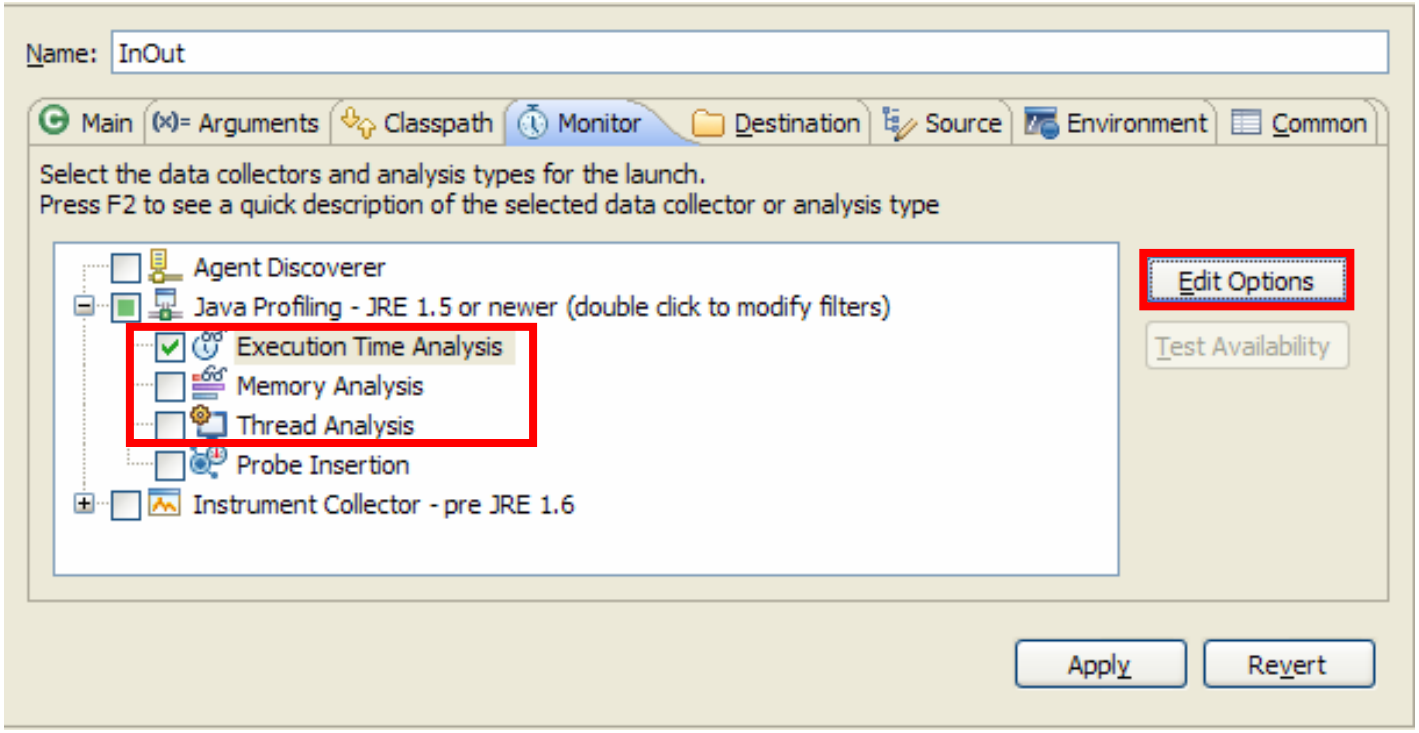


Profiling Options – Filter Set

- Limit the scope of a profiling session
- Ensure that only relevant details are collected
- Especially useful when speed and efficiency is critical
  - Excluded classes and methods will not be instrumented and will execute at full speed
- Only the first applicable filter is applied. When you are specifying filters, ensure that you declare the most specific filter criteria first

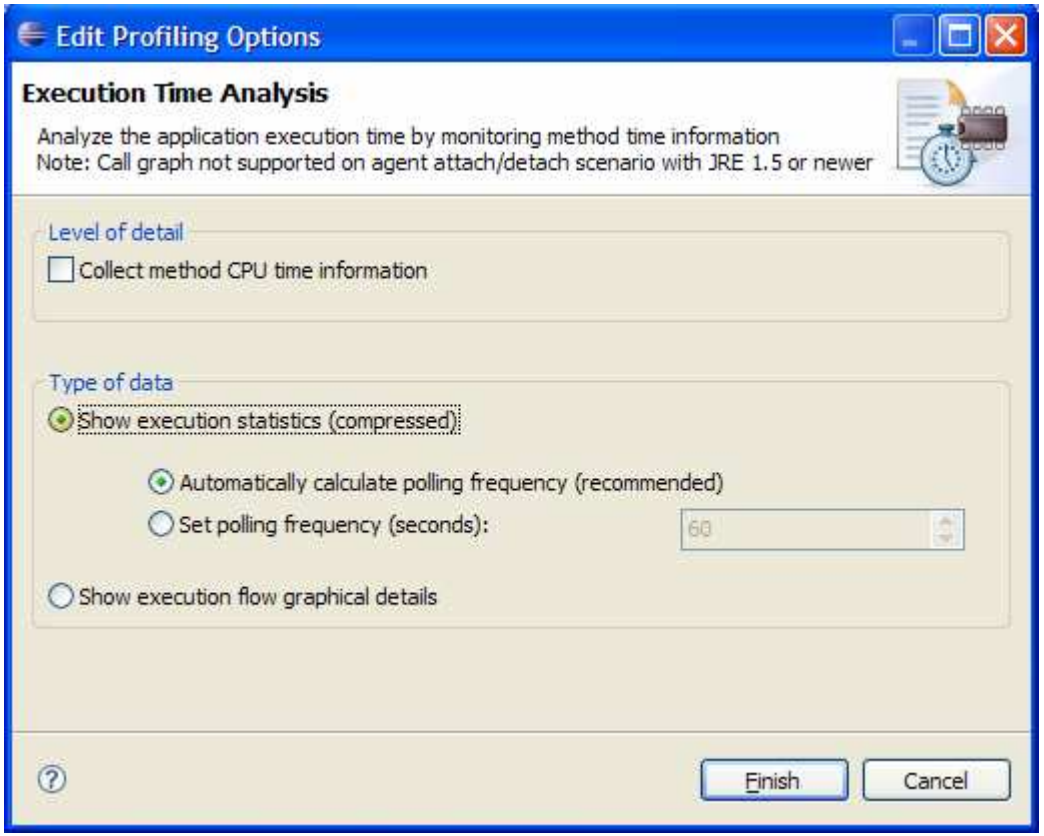


Launch and Attach – Options



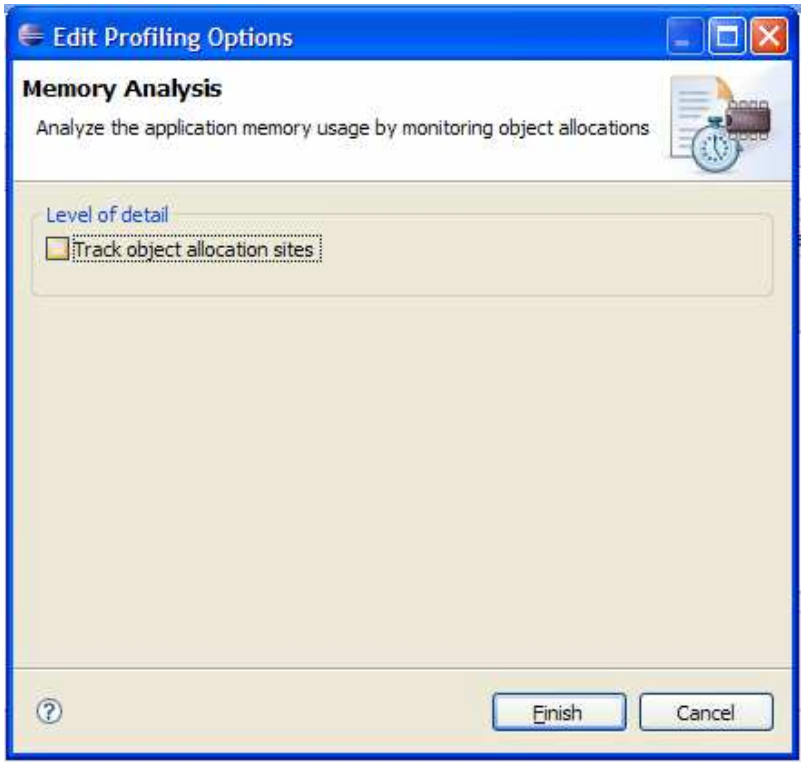
Execution Time Analysis Options

- Specifies the type of information to collect during execution time analysis
- Use the “Show execution statistics” option to identify the most time-consuming methods
  - Low-overhead. Can be used without extensive filtering
- Use the “Show execution flow graphical details” option to identify the relationships between executing methods (call-graph).
  - High-overhead. Filtering is recommended.



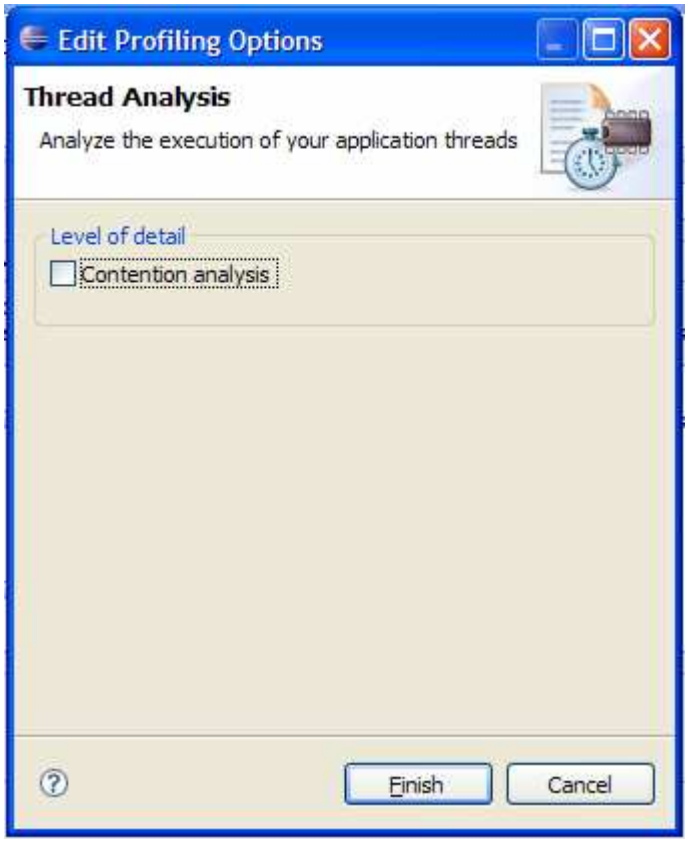
Memory Analysis Options

- Specifies the type of information to collect during memory analysis
- Use the “Track object allocation sites” option to identify the source line where each object is allocated
  - May slightly increase analysis overhead



Thread Analysis Options

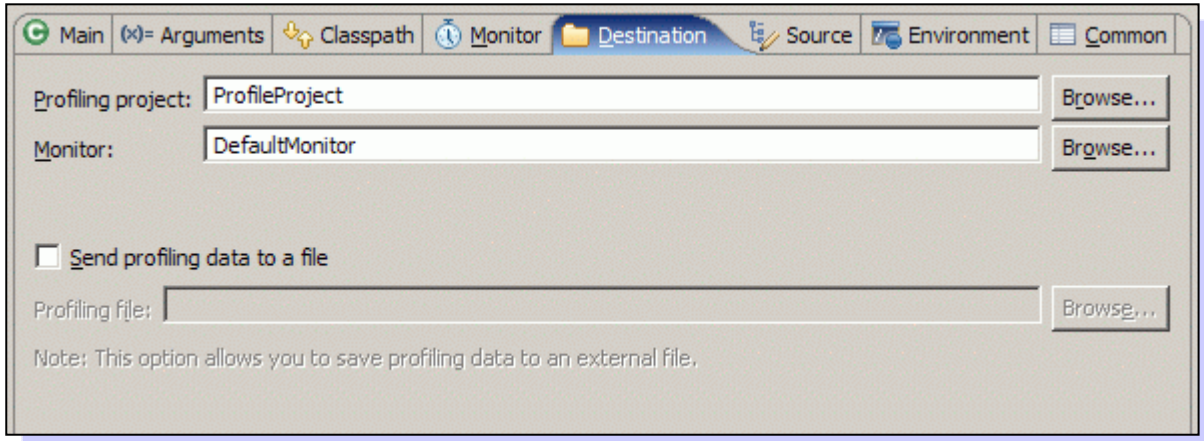
- Specifies the type of information to collect during thread analysis
- Use the “Contention analysis” option to analyze thread contention
  - May slightly increase analysis overhead



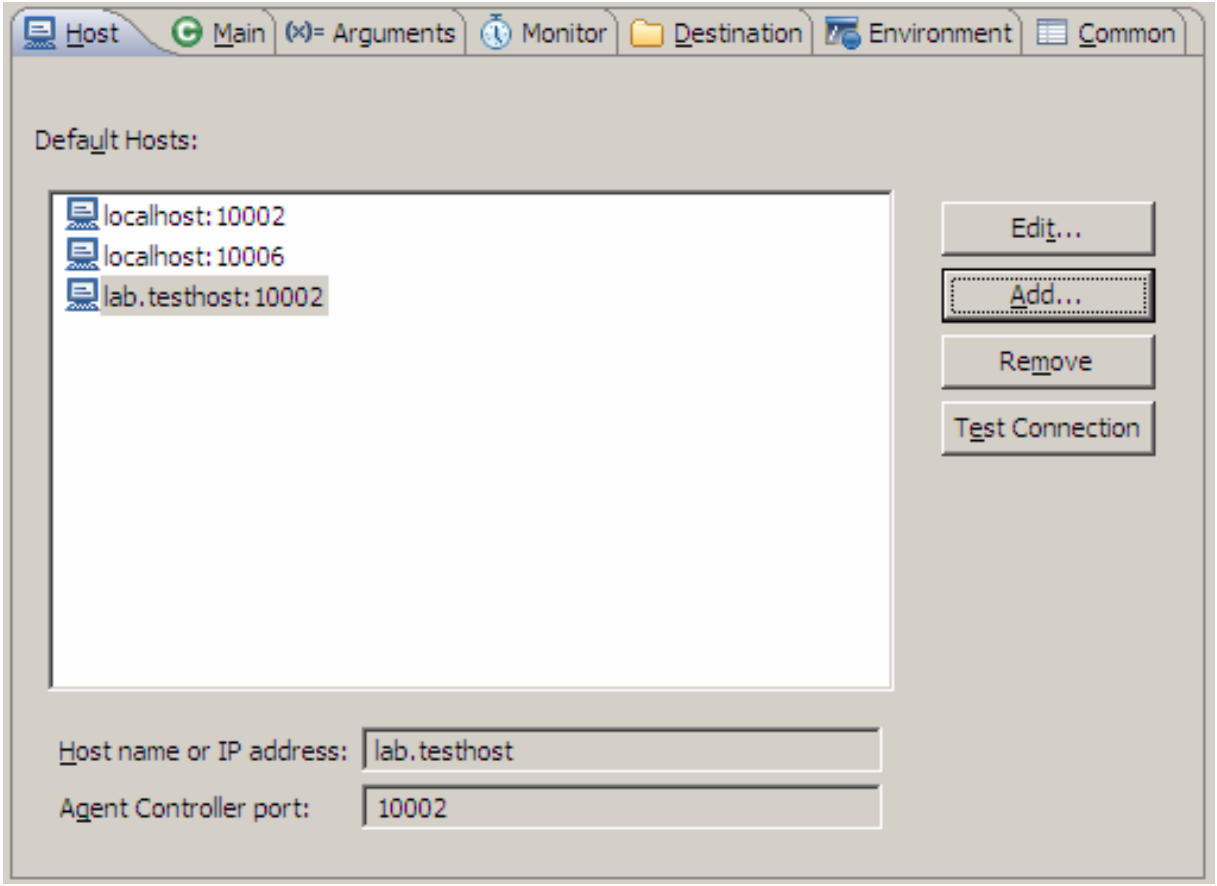
Launch and Attach – Destination Tab

- Specify the destination of the profile data
  - Workbench : Visualize and analyze in profiling views (default)
  - File : export to XML file or Bin file (default), available for import.

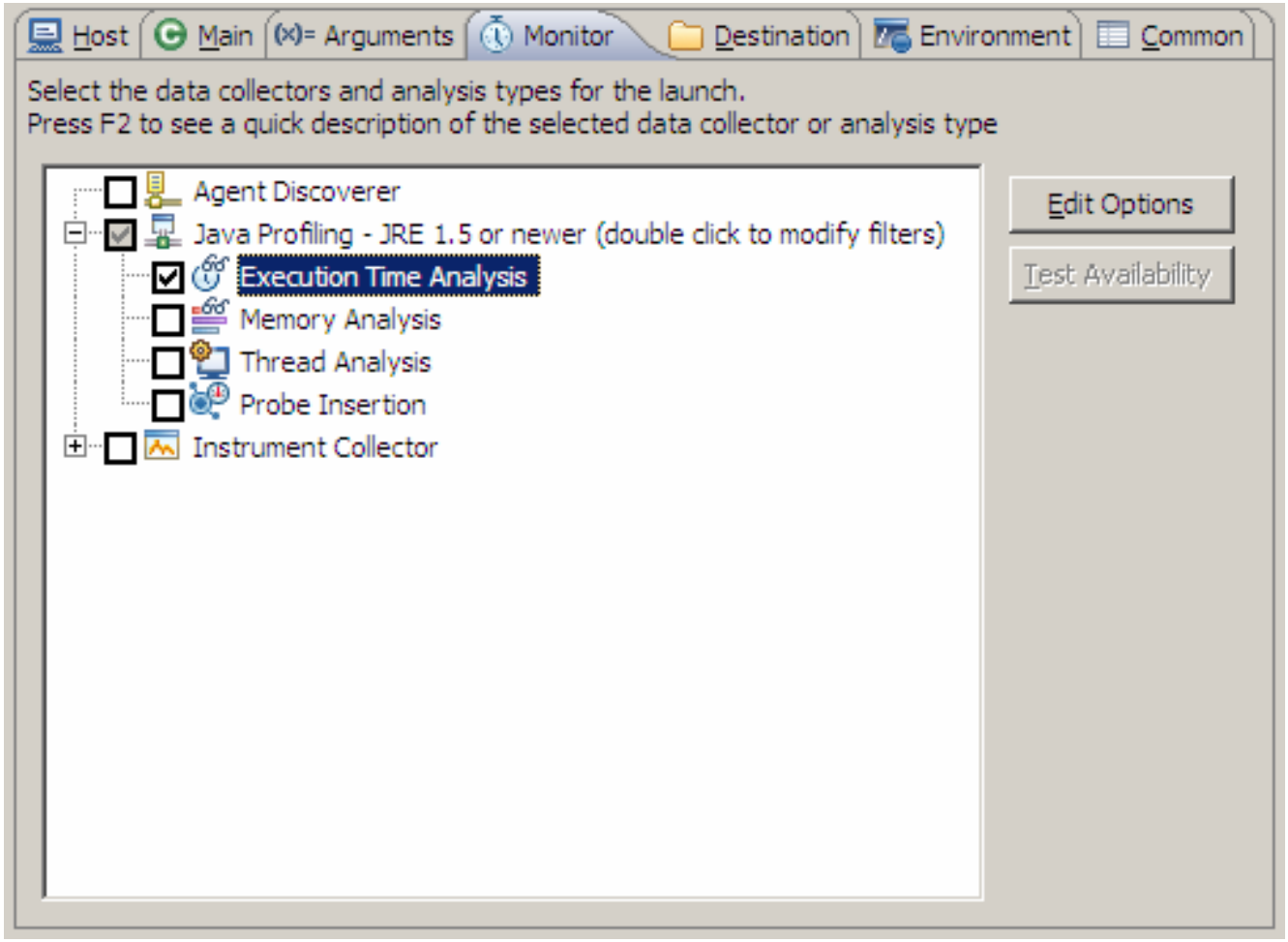
- Import profiling file
  - File > Import ... > Profiling file



Profiling an External Application – Host Tab



Attaching to a Running Application – Monitor Tab



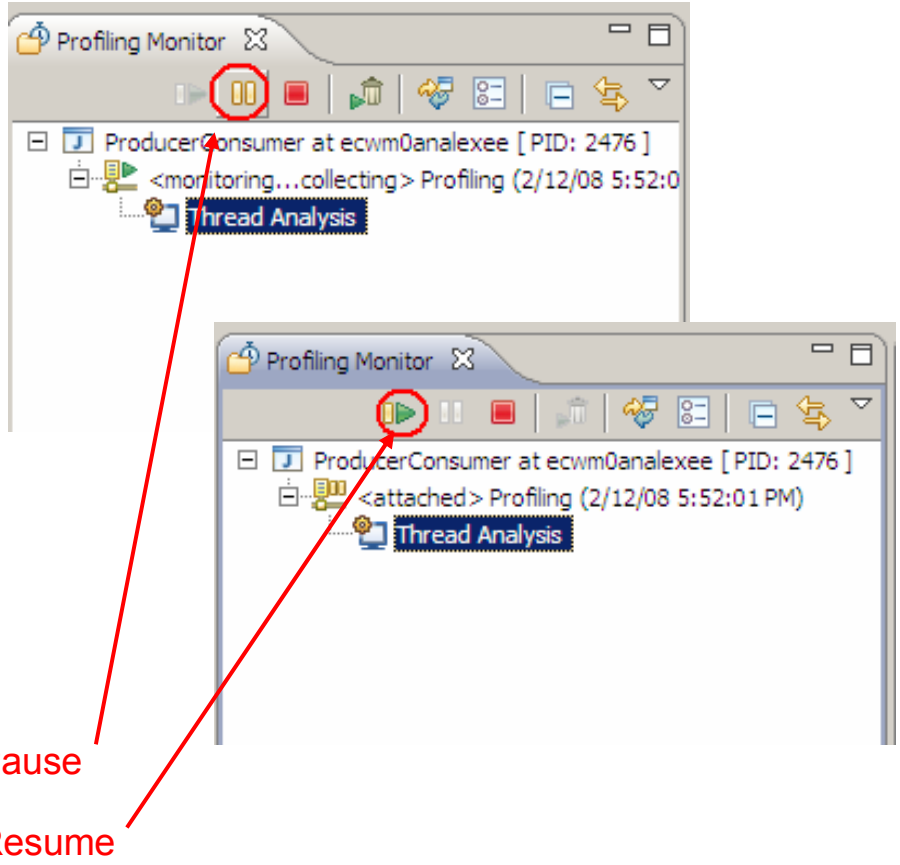
Profiling Views

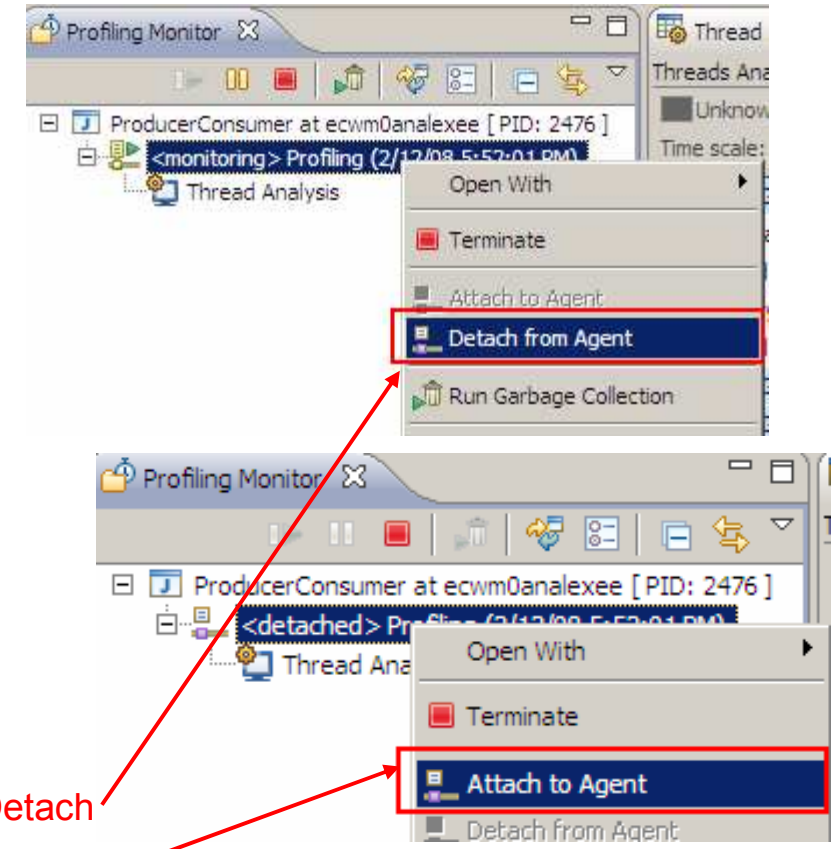
- A collection of views to visualize and analyze profiling data
  - Memory Statistic view (tabular)
  - Execution Statistic view (tabular)
  - Coverage Statistic view (tabular)
  - Method Invocation Detail view (tabular)
  - Execution Flow view and table (graphical + tabular)
  - Method Invocation view and table (graphical + tabular)
  - Execution Call Graph (graphical + tabular)
  - UML2 Trace Interactions view (graphical)

Recommendations for effective profiling

- Use filters to collect only necessary data
- Pause/resume to select activities to profile
- Attach/Detach to eliminate overhead when you don't want to profile

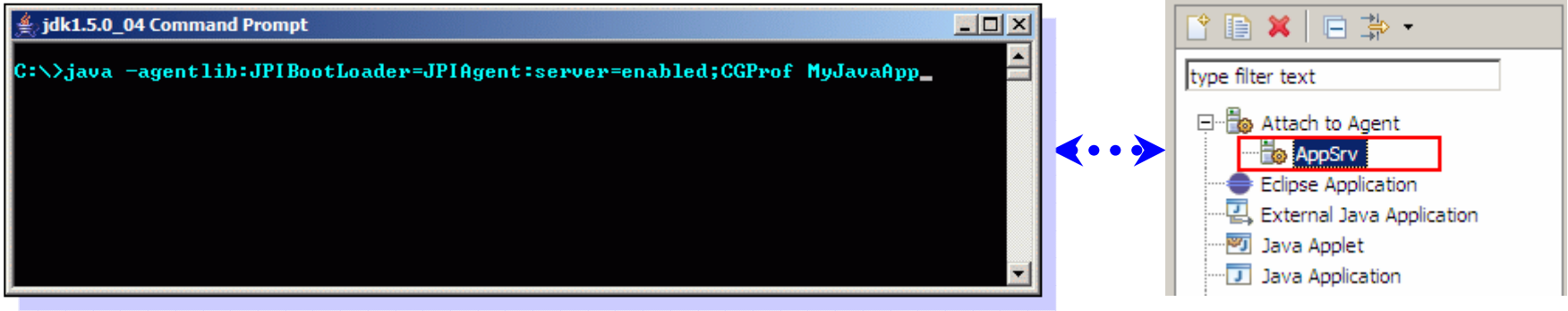
Access to Attach/Detach and Pause/Resume





Java* Profiling - Attach

- Start application under profile in standalone mode
- Invoke the Java* Profiling Agent, a library that attaches to a Java* virtual machine (JVM)
  - Use the -agentlib JVM option to invoke the Java* Profiling Agent (see blow)
  - -agentlib:JPIBootLoader=JPIAgent:server=enabled;{profiler}
- Communication with the invoked agent is done from the client workbench
- Attach to the agent : Profile Configuration... > Attach to Agent

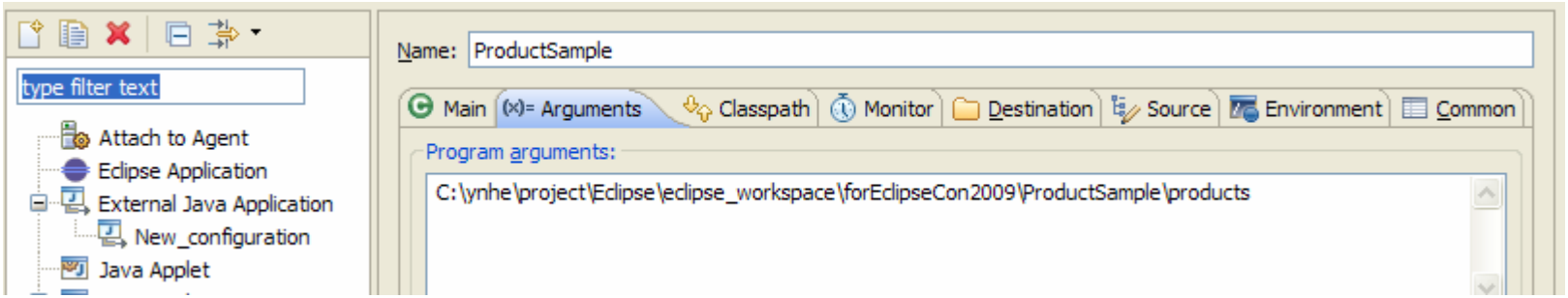


Java* Profiling - Demo

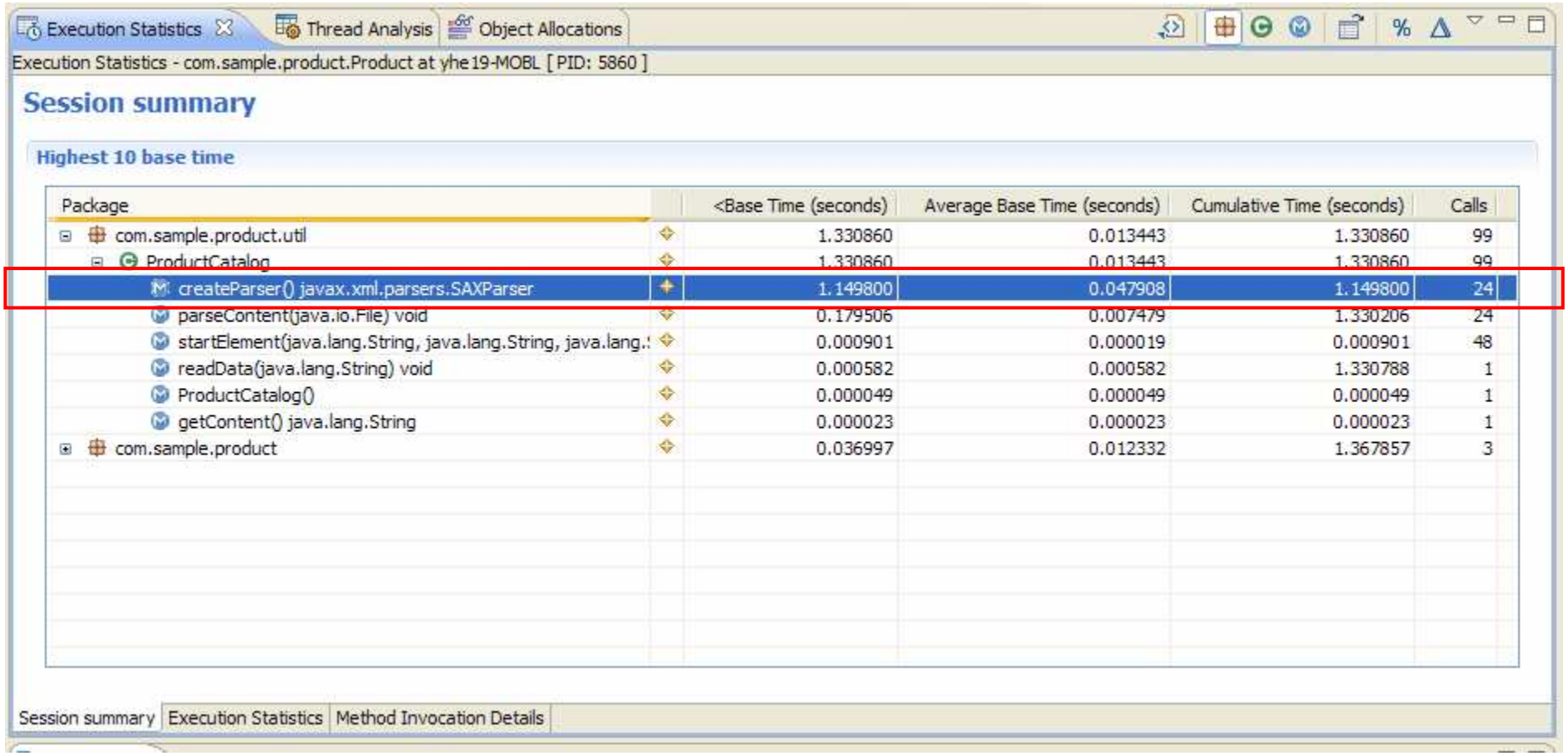
- Profiling a local Java* application
  - Execution Time Analysis
  - Memory Analysis
  - Thread Analysis

Demo: Execution Time Analysis

- Demo application: ProductSample
  - Load product data and display all information
  - Totally 24 products and data is stored in 24 XML files respectively.
- How to launch?
  - Profile as java application
  - Arguments tab: provide the products directory in “Program arguments”
  - Monitor tab: Choose execution time analysis with option “show execution statistics”



Demo: Execution Time Analysis (2)

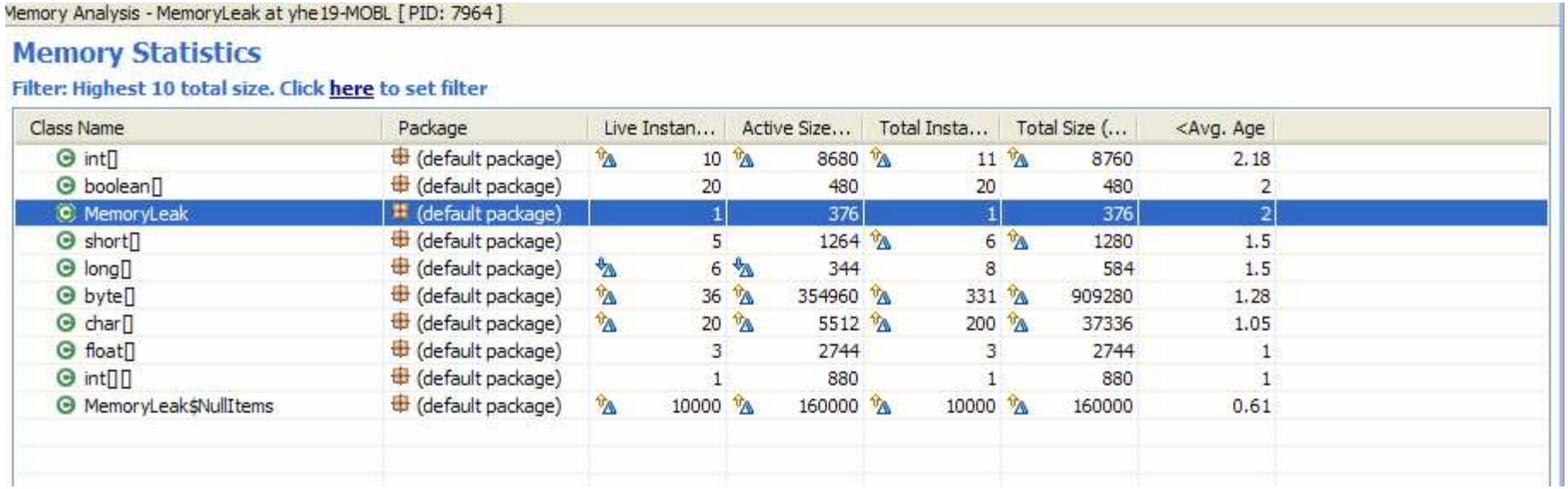


Demo: Memory Analysis

- Demo application: MemoryLeak
  - Three buttons: leak some memory, allocate some memory, run garbage collector
  - Leak some memory action: create new object and store in hash buffer. The newly allocated object will not be used again.
  - Allocate some memory action: create new object and it won't be assigned to any variable.
  - Run garbage collector action: run GC.

Demo: Memory Analysis (2)

- How to launch?
  - Profile as java application
  - Monitor tab: Choose memory analysis with option “track object allocation sites”


Memory Analysis - MemoryLeak at yhe19-MOBL [PID: 7964]

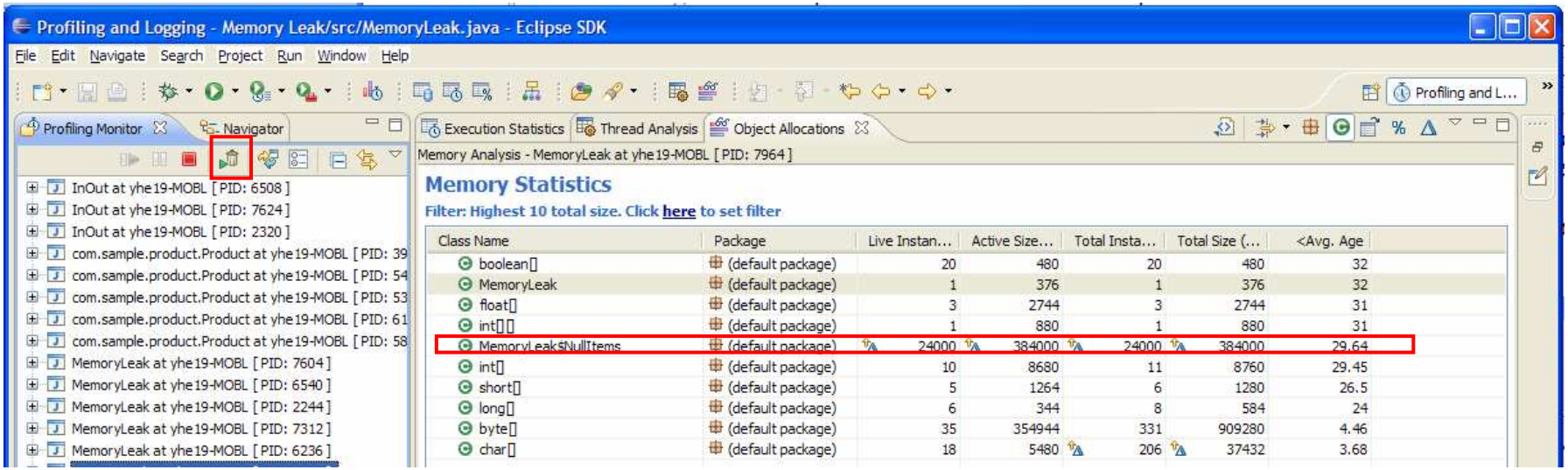
Memory Statistics

Filter: Highest 10 total size. Click here to set filter

Class Name	Package	Live Instan...	Active Size...	Total Insta...	Total Size (...	<Avg. Age
int[]	(default package)	10	8680	11	8760	2.18
boolean[]	(default package)	20	480	20	480	2
MemoryLeak	(default package)	1	376	1	376	2
short[]	(default package)	5	1264	6	1280	1.5
long[]	(default package)	6	344	8	584	1.5
byte[]	(default package)	36	354960	331	909280	1.28
char[]	(default package)	20	5512	200	37336	1.05
float[]	(default package)	3	2744	3	2744	1
int[][]	(default package)	1	880	1	880	1
MemoryLeak$NullItems	(default package)	10000	160000	10000	160000	0.61

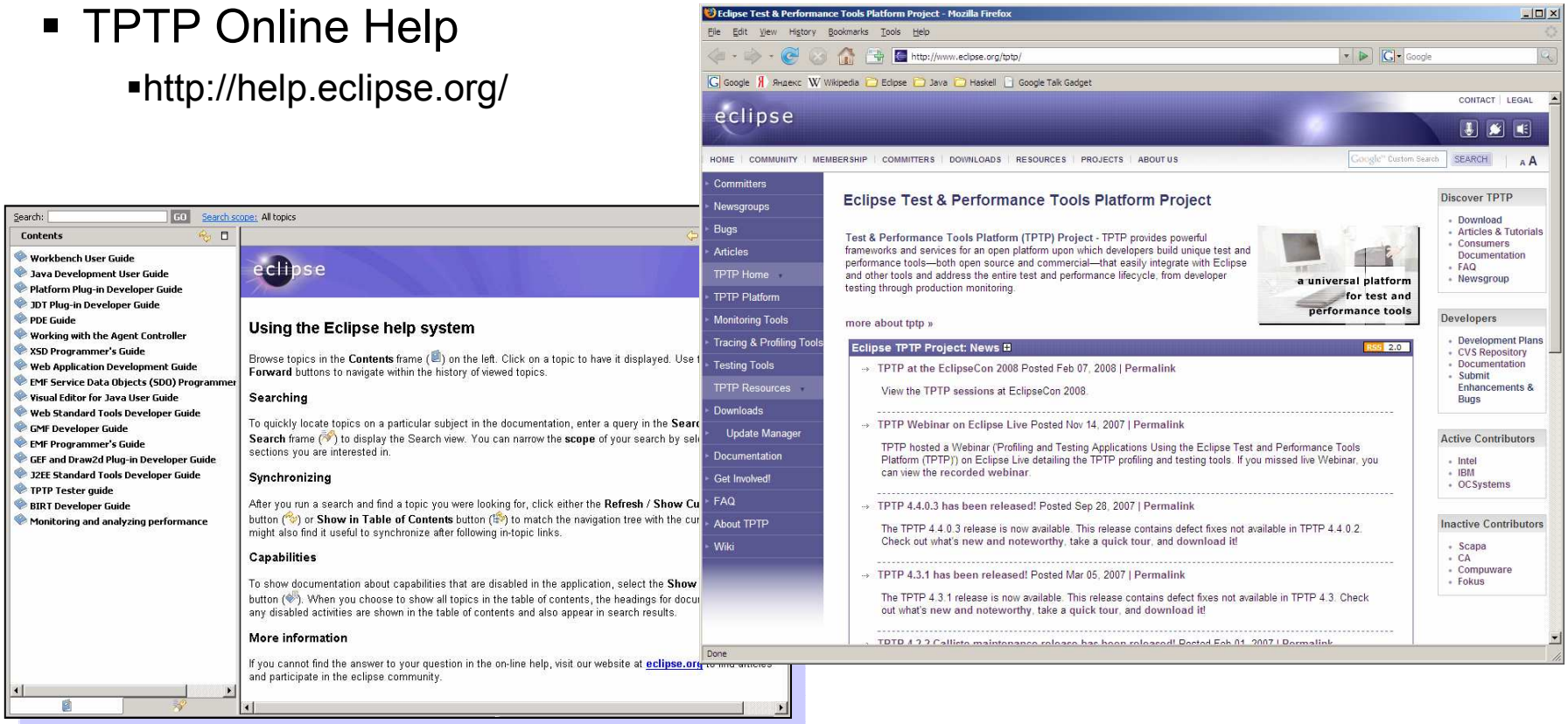
Demo: Memory Analysis (3)

- How to identify memory leak
  - Click on “Run garbage collection” to force a garbage collection event
  - Monitor the age of object, if object age continues to grow then this object is a candidate.
  - Navigate to the allocation details view to analyze the allocation sites



Resources

- TPTP (Documentation, Download, CVS, Newsgroups, mailing list,etc..)
  - http://www.eclipse.org/tptp/
- TPTP Online Help
  - http://help.eclipse.org/



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Q & A

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