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Using the Oracle Solaris Studio IDE

To Dive Deeply into HotSpot JVM Source Code

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Oracle,
Solaris Developer Tools
October 29, 2015



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Session Agenda

- 1 ➤ My challenges as a developer, and HotSpot JVM
- 2 ➤ Mixed Language Development with Studio IDE
- 3 ➤ More highlights about Studio IDE
- 4 ➤ Live Demo!
- 5 ➤ Summary and Q&A

My challenges as a developer

- I develop my applications using OpenJDK
 - And sometimes to debug my app,
I need to dive into OpenJDK
- I'd like to contribute to HotSpot JVM
 - I will certainly need to dive deeply here
- My codebase is a mix of Java and C/C++
 - Moreover, it is very big
- My target platforms are... many!
 - Windows, Mac OS X, Linux, Solaris, ...



HotSpot JVM - facts

- Oracle's JVM for desktops and servers
- Open Source, a part of OpenJDK
- Multi-Platform
- HotSpot is written in C/C++
 - OpenJDK is a mix of Java and C/C++
- **16 years** of development
- **3.3K**: all C/C++ part of OpenJDK
 - **1.4M** lines of code



Developer expectations

- I'd like to edit/build/debug in same integrated environment
 - With Java and C/C++ mix, like OpenJDK is
- I need an IDE which works fast
 - With a really big codebase, like OpenJDK has
- My work platform is...
 - Why should I stick to a particular one?
Let me choose!



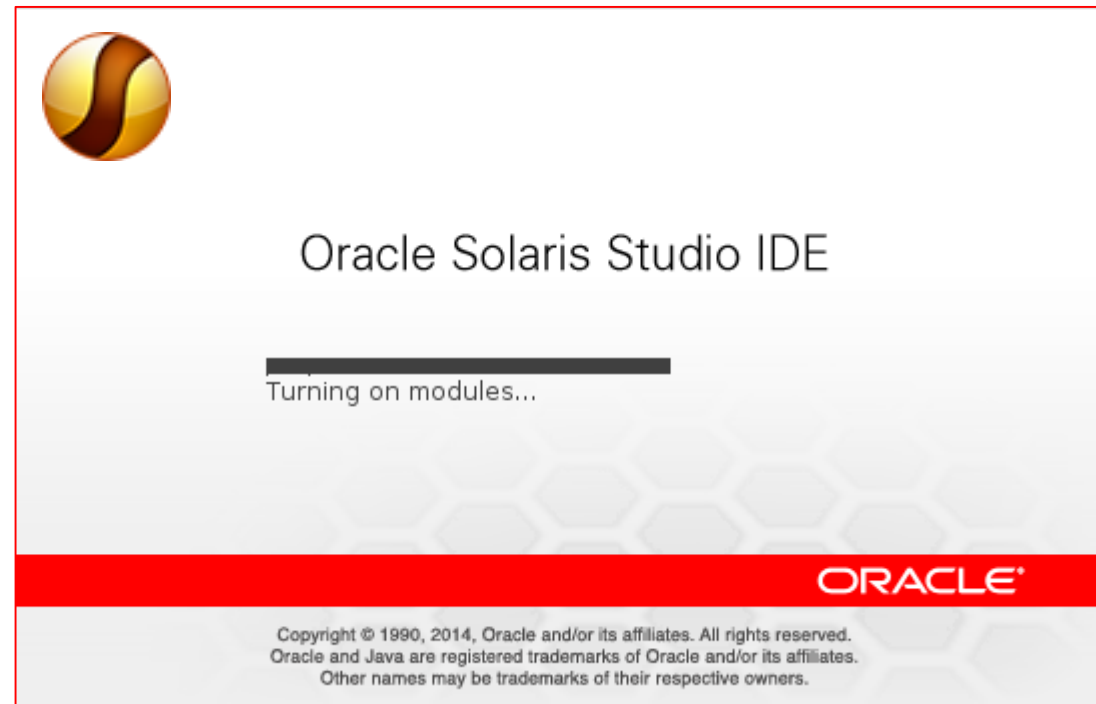
I'd like to be effective at work

- But, is there any IDE which can support my challenges
... and meet my expectations?



So... which IDE?

- There is one!





Mixed Language Development

With Studio IDE

Mixed Language Development


- Java code and native (C/C++) code get mixed
 - Call native code from Java
 - Use Java objects in native method
- Why call native code?
 - Hardware and platform features
 - Existing native code base
 - Legacy binary
 - Performance concerns... really faster than JIT?
- JNI, JNA



JNI vs JNA – w/o Studio IDE

	Easy to use	Works for existing binary	C/C++ experience NOT required	Speedy	Good for complicated C++ code
JNI				✓	✓
JNA	✓	✓	✓		

JNI vs JNA – w/ Studio IDE

	Easy to use	Works for existing binary	C/C++ experience NOT required	Speedy	Good for complicated C++ code
JNI				✓	✓
JNA	✓	✓	✓		

Studio IDE: Unique IDE for Mixed Development

The screenshot displays the Studio IDE interface, which is designed for mixed development. The main editor shows a Java file named `JavaApplicationJNI1.java` with the following code:

```
package javaapplicationjni1;

public class JavaApplicationJNI1 {

    public static native void foo();

    public static native int boo();

    public static native int roo();

    public static void main(String[] args) {
        foo();
        boo(1);
        roo(1.0);
    }
}
```

The left sidebar contains a Project Explorer showing the project structure, including Source Packages, Libraries, and Test Packages. Below it is a main - Navigator showing the members of the `JavaApplicationJNI1` class, including `boo(int param) : int`, `foo()`, `main(String[] args)`, and `roo(double param)`.

The right sidebar shows a Disassembly view for the `socketTransport_readPacket` function. The disassembly code is as follows:

```
static jdwptTransportError JNICALL
socketTransport_readPacket(
    jint length,
    jint n;
) {
    /* packet can't be read
    if (packet == NULL) {
        RETURN_ERROR;
    }

    /* read the length of the packet
    n = recv_fully(
        fd,
        buf,
        length,
        0);

    /* check for EINTR
    if (n == 0) {
        RETURN_ERROR;
    }
}
```

The bottom of the IDE shows a Call Stack and a Thread List. The Call Stack shows the current function `socketTransport_readPacket` and its caller `recv_fully`. The Thread List shows the current thread `Thread 0x7f535befe700 (LWP 15000)` and its executing function `recv`.

Studio IDE: Unique IDE for Mixed Development

- **Generate** JNI library project
 - With only a right-click on Java class!
 - Regenerates header files If Java interface changes later
- **Navigate** from Java code to native code
 - Both for JNI and JNA
- **Debug** mixed languages code:
 - **Seamless** debugging of Java and native code
 - Breakpoints, Step Into, Call Stack, Registers, Variables, Debugger Console etc.



More useful features

Of the Studio IDE

Studio IDE and NetBeans



Java

Python,
PHP

HTML/JS

Version
control

Generic IDE

C/C++,
Fortran

Studio Compiler,
DBX Debugger



Integrated
OCI, Tuxedo
support

Integrated
Advanced
Tools

Studio IDE: Large Codebases

- Low Memory Footprint
- Fast Parse Time
- Fast Search



3.3K files
1.4M LOC
(C/C++ code only)

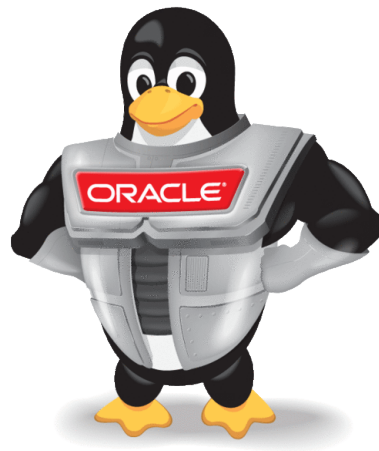


7K files
13M LOC

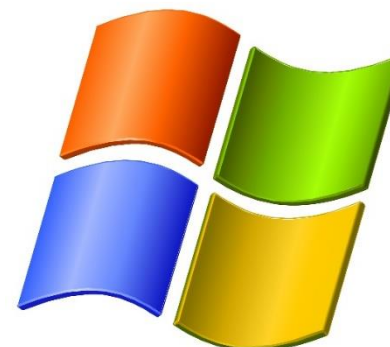


16K files
6M LOC

Studio IDE: Platforms

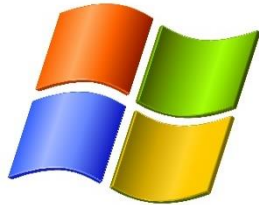


IDE can also run on:



Studio IDE: Remote Development

Increase Efficiency



- Develop applications from virtually any desktop environment
- IDE can remotely build, debug, analyze



Studio IDE: New Features

- Mixed Development has been integrated
- New Project Wizard
- Version Control support in Remote mode
- New Audits, Hints and Refactoring
 - Including Secure Coding rules
- Call Graph enhancements
- In progress: IDE for C/C++ in the Browser

A group of four people (three men and one woman) are gathered around computer monitors in a modern office setting. They are all looking intently at the screens, suggesting a collaborative work environment. The office has large windows in the background and a bicycle hanging on the wall.

Live Demo!

HotSpot diving with Studio IDE

Studio IDE: Summary

- Best fit for developing with OpenJDK and HotSpot
 - Tuned for Enterprise-class Codebases
 - Mixed-Language Development
 - Multi-Platform
 - Cross-Platform Development: Remote modes
 - There is ***already*** configured NetBeans/Studio project for HotSpot! (/common folder)
- You also get
 - Code Editor With Rich Capabilities
 - C++11 Standard Support

Oracle Solaris Studio

Learn More & Resources

- **Main Studio page:** oracle.com/goto/solarisstudio
— Free download!
- **How to setup OpenJDK in the IDE:** <https://dzone.com/articles/hack-openjdk-netbeans-ide>

Oracle Solaris Studio

Please visit this Studio JavaOne session right next after this session, it should be very interesting.

- **Improving the Performance of Your Java Application: Getting Beyond the Basics [CON8342]**
 - Thursday, Oct 29, 4:00 p.m. | Hilton—Imperial Ballroom B

Q&A

CREATE THE FUTURE



Oracle Solaris Studio

Learn More & Resources

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— Free download!
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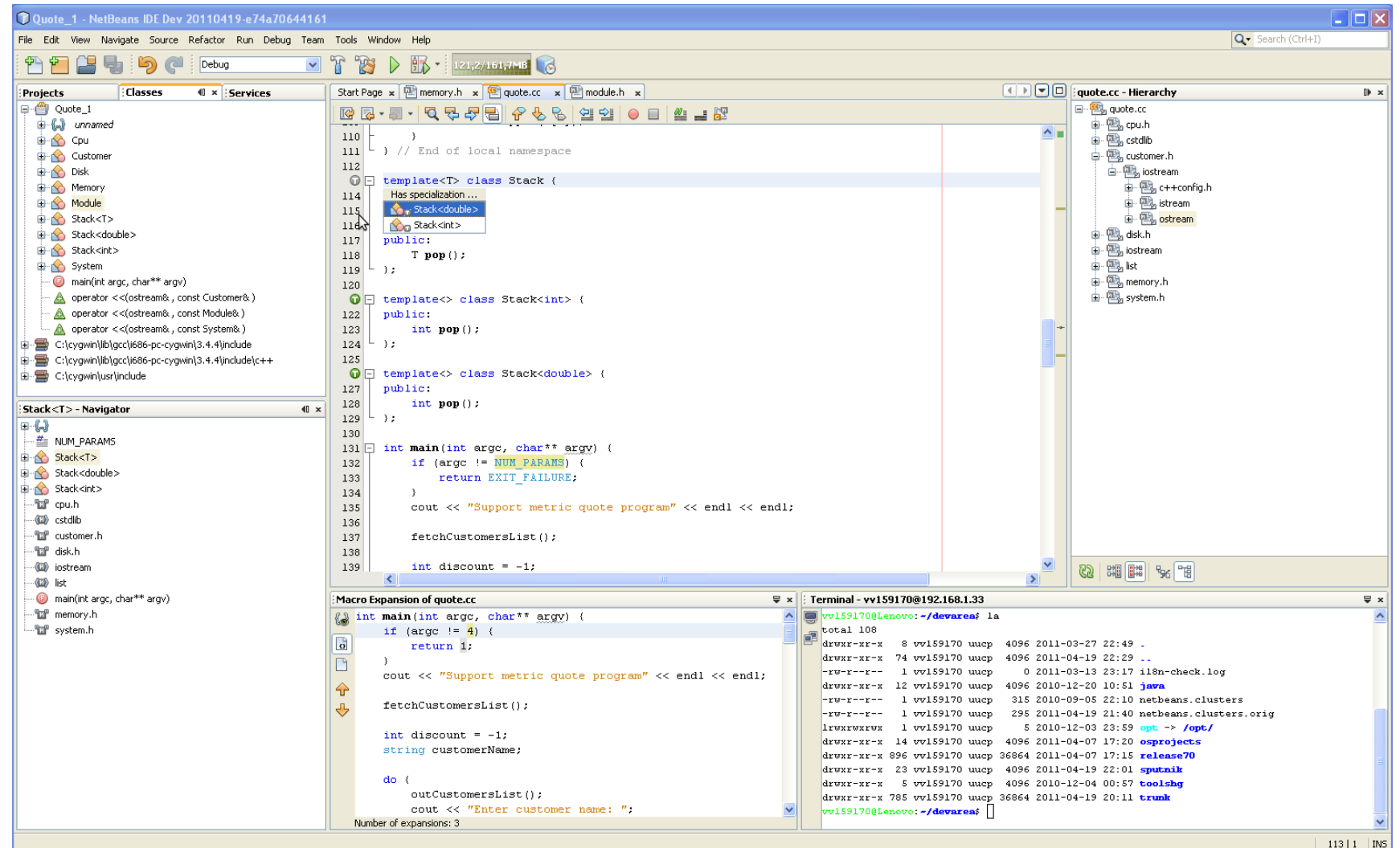


Backup deck

More about Studio IDE and other Studio Tools

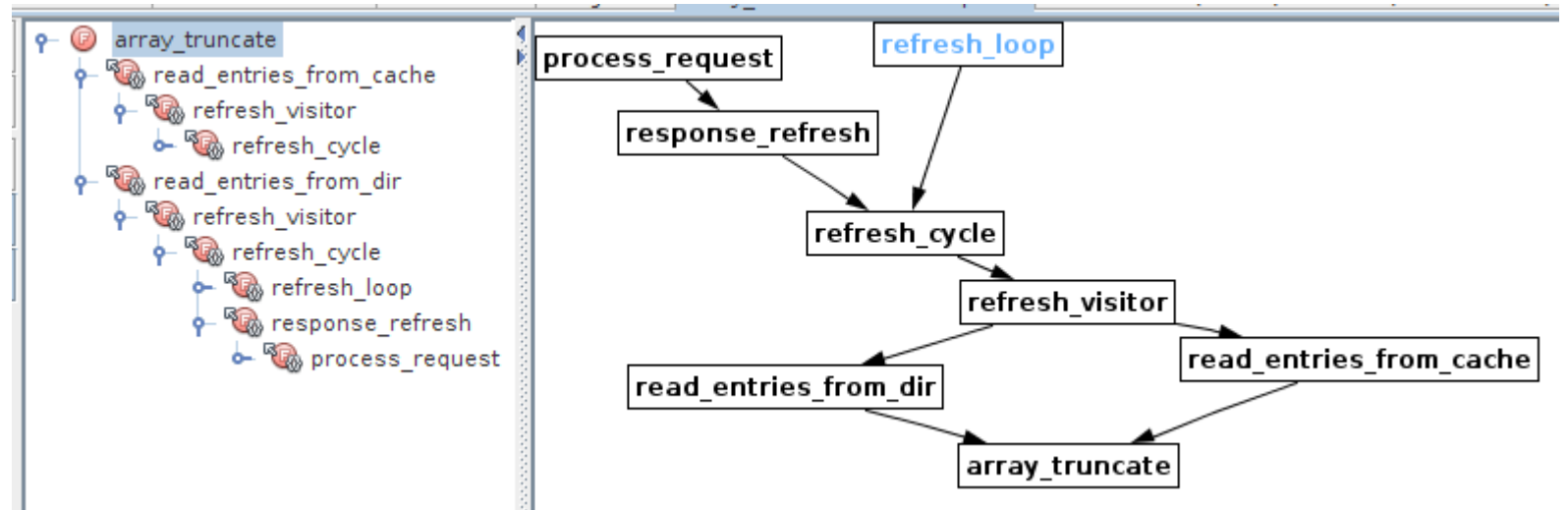
IDE – More Highlights

- Code editor
 - Code Generation
 - Highlighting
 - Folding
 - Navigation
 - Formatting



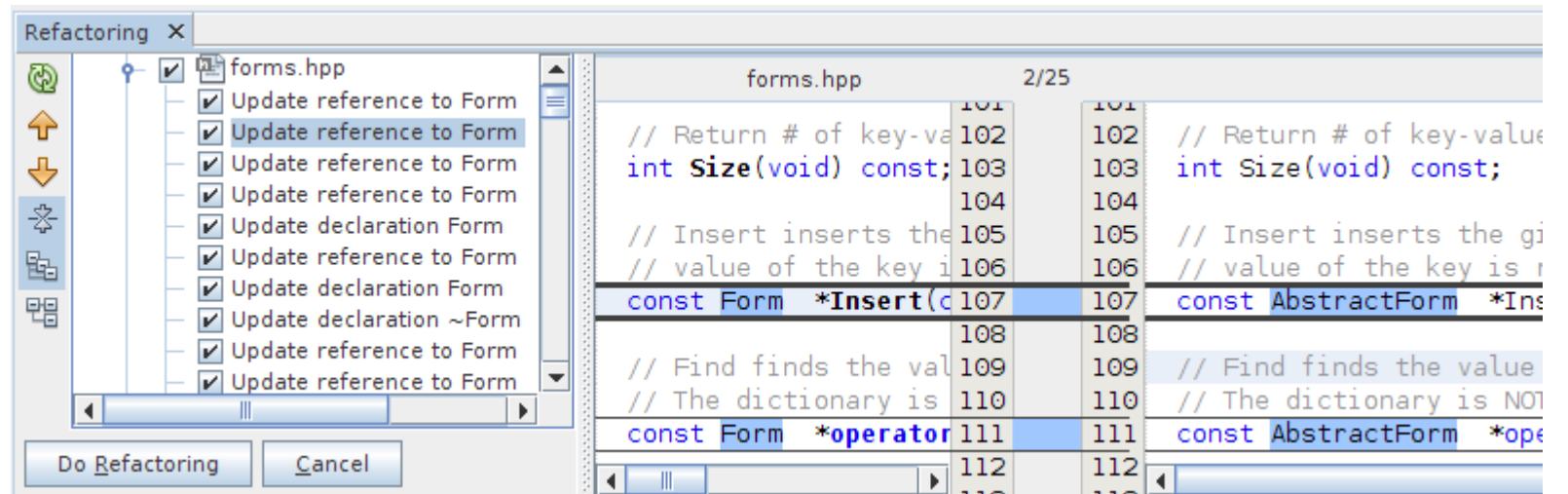
IDE – More Highlights

- Rich reverse engineering capabilities
 - Find Usages
 - Call Graph
 - Macro View
 - Include Hierarchy
 - Class Hierarchy



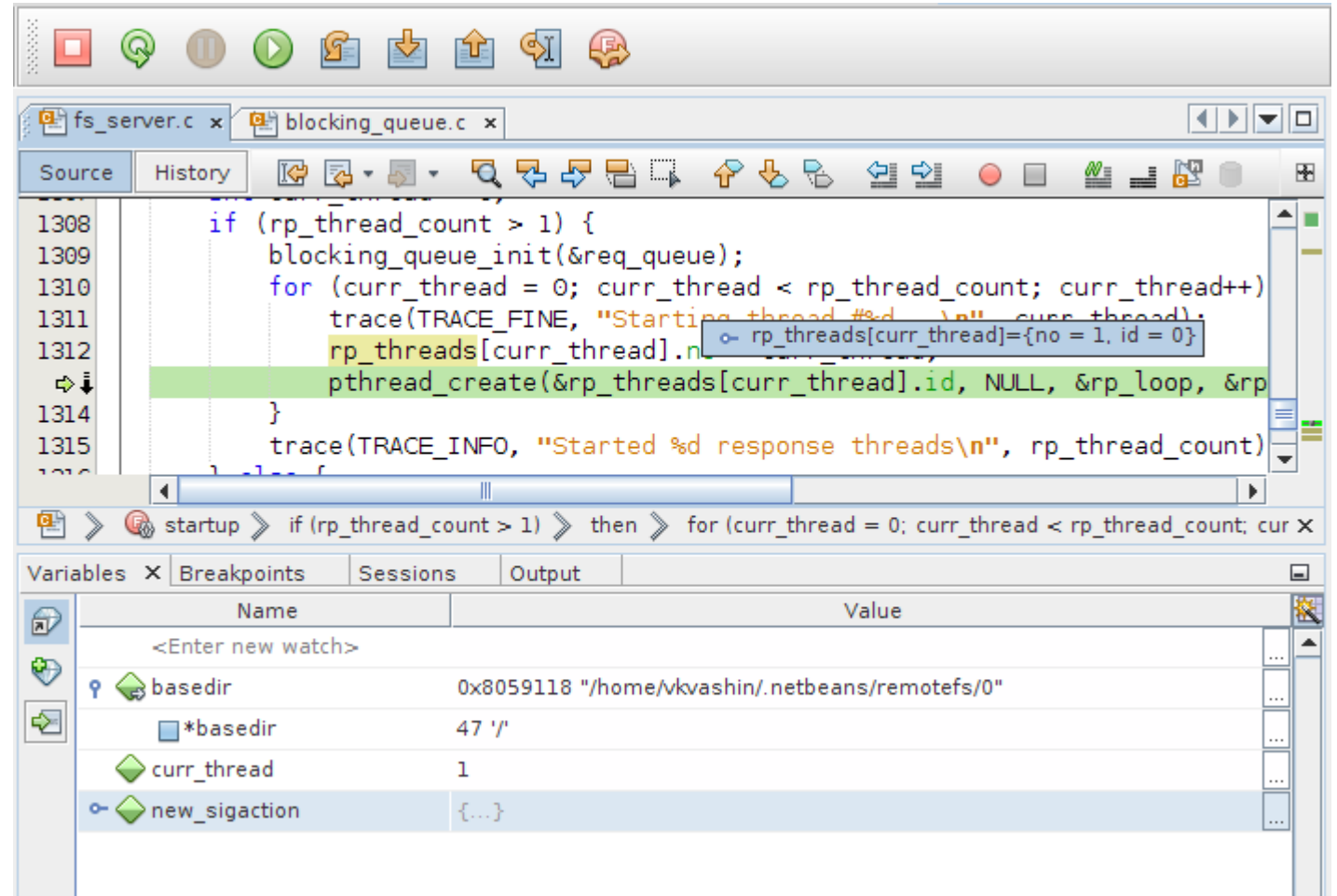
IDE – More Highlights

- Code Refactoring support



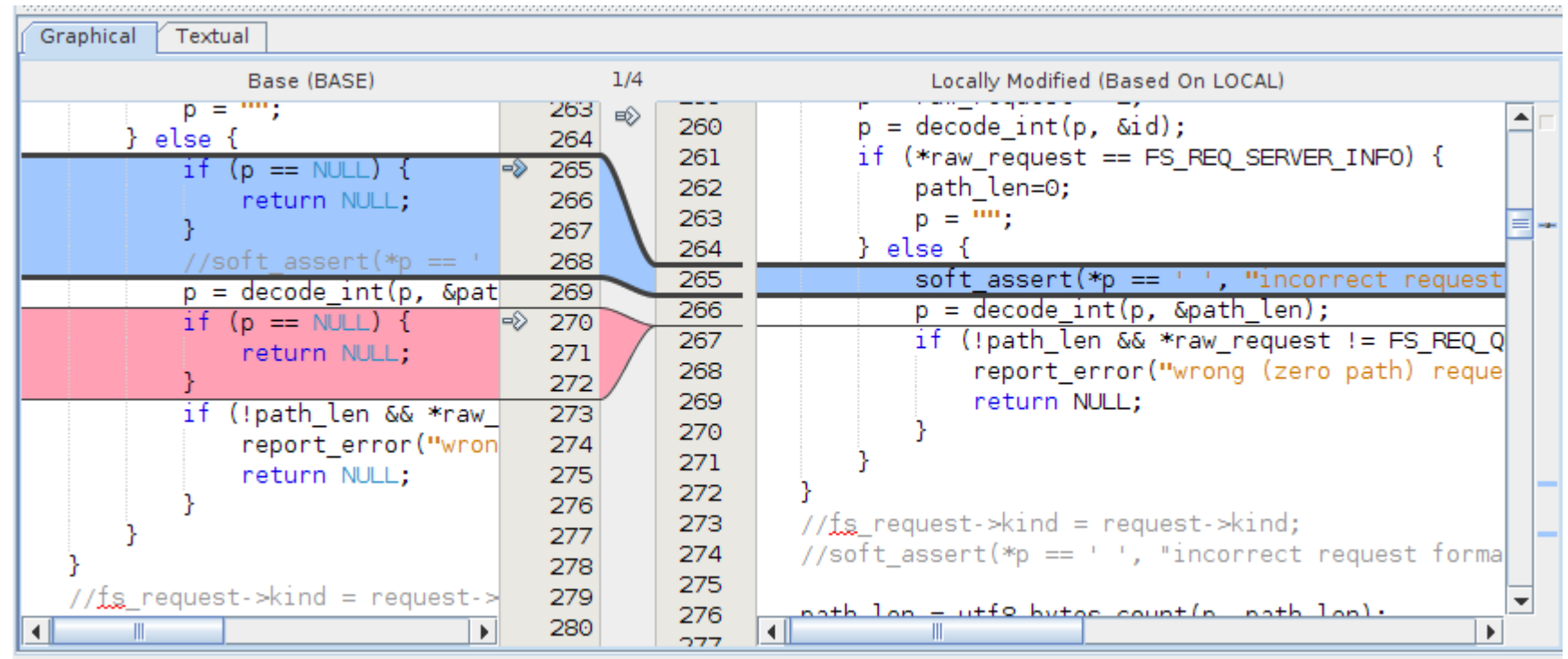
IDE – More Highlights

- Visual Debugging



IDE – More Highlights

- Smooth Integration with popular VCS tools
 - GIT
 - Mercurial
 - Subversion



IDE – More Highlights

- Integration with static and dynamic analysis tools
 - Code Analyzer
 - Performance Analyzer
 - Thread Analyzer

The screenshot displays an IDE interface with several panels. The top-left panel, titled 'Data Races and Deadlocks...', shows the results of a static analysis: 'Analysis complete, see results below', '1 deadlock detected' (with a 'details' link), and 'No dataraces'. Below this is a 'Thread Usage' graph showing the number of threads (green area) and lock waits (orange area) over time. The x-axis represents time from 0.0 to 0.15, and the y-axis represents the count from 0 to 2. The graph shows two threads running, with one thread holding a lock while the other waits. The bottom-left panel, 'thread1(void* arg) - Navigator', shows a list of variables: main(), mutex1, mutex2, thread1(void* arg) (selected), var1, and var2. The main editor window shows the source code of 'potential_deadlock.cpp', which includes two mutexes and a thread function 'thread1' that acquires a lock and sleeps. The bottom-right panel, 'Thread Analysis Tool', shows a detailed view of the detected deadlock, including the lock held (8061c40) and the lock requested (8061c28), along with the stack traces for the threads involved.

```
13 int var1 = 0;
14 int var2 = 0;
15 pthread_mutex_t mutex1 = PTHREAD_MUTEX_INITIALIZER;
16 pthread_mutex_t mutex2 = PTHREAD_MUTEX_INITIALIZER;
17
18 extern "C" void *thread1(void *arg) {
19     int* p = (int*)arg;
20
21     if (*p == 1) {
22         pthread_mutex_lock(&mutex1);
23         var1 = 1;
24         sleep(1); // or some big code
```

Output Thread Analysis Tool

Potential deadlock

- Lock held: 8061c40
 - thread1 at potential_deadlock.cpp:22
 - thread_hj_start_routine in thread_h
 - _thrp_setup in _thrp_setup
 - _lwp_start in _lwp_start
- Lock requested: 8061c28
 - thread1 at potential_deadlock.cpp:25
 - thread_hj_start_routine in thread_h
 - _thrp_setup in _thrp_setup
 - _lwp_start in _lwp_start
- Lock held: 8061c28
 - thread1 at potential_deadlock.cpp:30
 - thread_hj_start_routine in thread_h

Studio IDE – Cloud Development Support

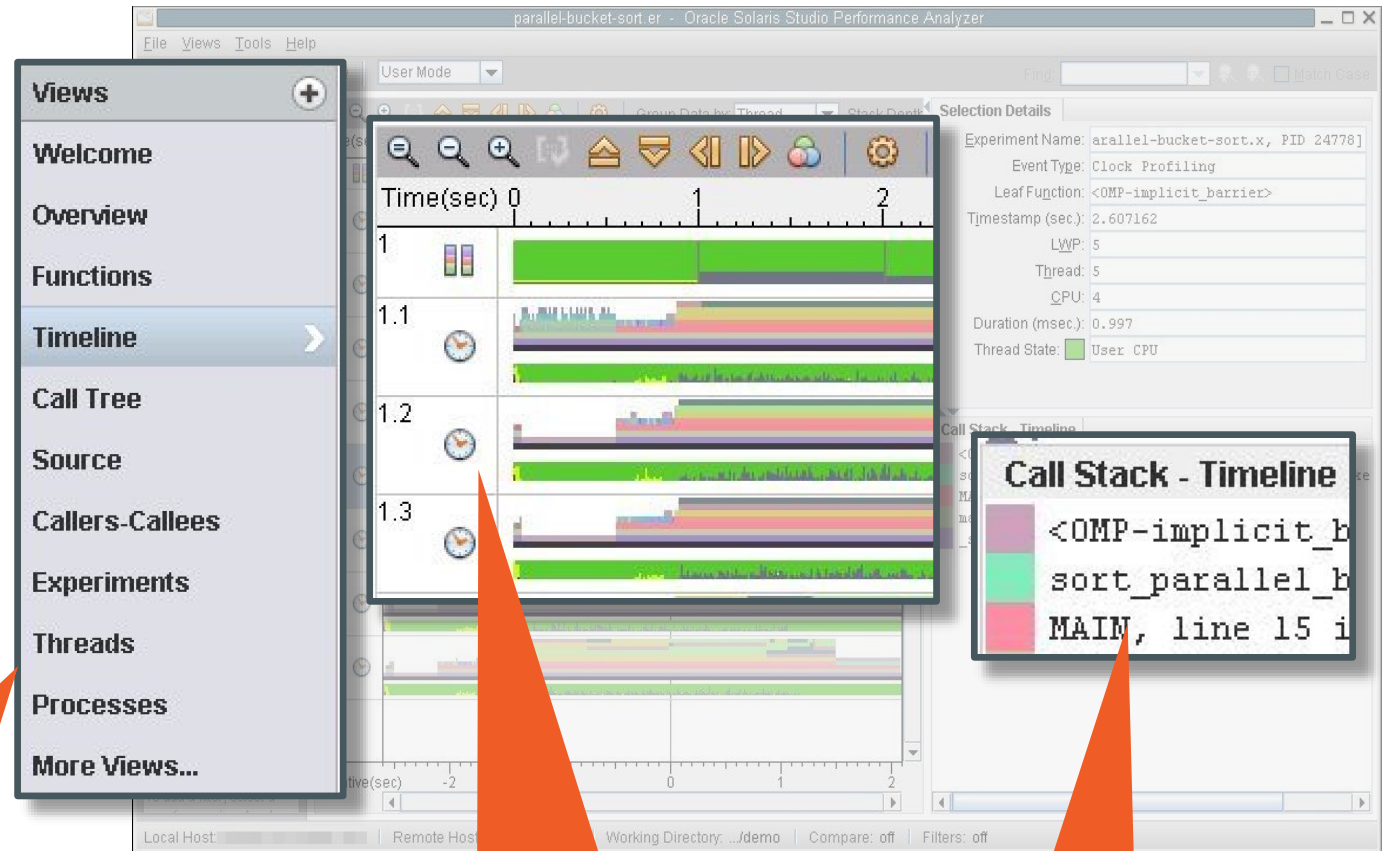
- Everything is moving towards Web and Cloud development
- Studio/NetBeans IDE provides:
 - Web languages support
 - HTML5, JS
 - Frameworks
 - Node.js is available, Docker is in the plans
 - Web IDE
 - Java and Web languages are available
 - C/C++ is in the plans
 - Both for Public and on-premises clouds



Performance Analyzer

Optimize Application Performance

- Quick identification of bottlenecks with intuitive UI
- Rich set of performance metrics
- Easy profiling with remote and cross-platform analysis
- Supports C, C++, Fortran, Java and OpenMP



Data organized by a variety of Views

Visualize time spent across multiple threads

Call stack for selected event

Studio 12.4 Code Analysis Tools

Previser

Source code analysis

- Beyond array bounds access
- Freed memory
- Memory leaks
- No change to the executable

```
int a[5];  
...  
for (i=0; i<=5; i++)  
    printf ("%d\n", a[i]);
```

Discoverer

Memory corruption detection

- Uninitialized memory and beyond array bounds access
- Heap, stack, globals
- Points to allocation&free code
- Memory leak APIs

```
char *z = (char *) malloc(1)  
...  
free (z);  
...  
z = 'a';
```

Uncoverer

Code coverage

- Source line granularity
- Orders functions by priority
- No recompilation
- Accumulates coverage over multiple runs

```
if (unmet_condition)  
    *y = 'a';  
...  
printf ("*y = %c\n", *y);
```

Code Analyzer

Ensure Application Reliability

- Synthesizes results from static, dynamic and coverage analysis tools
- Advanced error filtering and sorting
- Source code viewing and hyperlinks

The screenshot displays the 'Code Analyzer pythia' application window. The 'Issues' tab is active, showing a list of bugs. A specific bug is highlighted, showing its details in the 'Details Window'. The bug is of type 'ABR' (Beyond Array Bounds Read) and is located in the file `/export/sheldon/openssl/openssl-1.0.1f/ssl/t1_lib.c` at line 2586. The code snippet shows a `memcpy` operation. The bug details also indicate the memory allocation source: `default_malloc_ex` at `mem.c:79` and `CRYPTO_malloc` at `mem.c:308`.

Error Type

Error Location

Memory allocation

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