

Tools for Measuring System and Application Performance



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 - Introduction
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gdb

Debugging

Native and Java Code



Quick, Sampling-based Profiling with gdb

Enabling Remote Support

gdb Introduction

- **Gnu Debugger**
 - Official name is wdb – Wildebeest Debugger (www.hp.com/go/wdb)
 - Wildebeest is another name for the Gnu - *Connochaetes taurinus*
- New version of gdb supports unwind of Java 1.3.1
 - Interpreter frames
 - Java run-time compiler compiled frames
 - Adapters:
 - i2c – interpreted to compiled
 - c2i – compiled to interpreted
 - Java entry frame
- Available at: pdlweb.cup.hp.com/jcs/jdebug

gdb

Goals

- We will learn how to use gdb with Java 1.3.1:
 - Debugging Java
 - How to start up
 - Skip the first signal
 - Debugging a running Java application
 - Where am I? The threads in the Java process
 - Looking at native instructions generated by the runtime compiler
 - Interpreting a SIGBUS
 - Reading the stack traces in a core file
 - **Enabling remote diagnosis of problems**
- Key to highlights in the text:
 - Comments and explanations
 - **Commands to enter**
 - Highlights which you should notice

`gdb`

Summary of Commands Used

<code>r [args]</code>	run program with <i>args</i> as arguments
<code>set args</code>	set the arguments for the run command
<code>thr</code>	print thread number
<code>thr #</code>	change to thread <i>#</i>
<code>info thr</code>	list all threads in the process
<code>thread apply all bt</code>	generate backtrace of <i>all</i> threads or can specify individual threads or range, <i>1-10</i>
<code>bt</code>	generate back trace of current thread
<code>c</code>	continue
<code><Control-c></code>	stop the running process
<code>quit</code>	exit the debugger

`gdb`

Summary of Commands Used

- `b` set breakpoint at current location
- `info break` display all breakpoint information
- `x/16i $pc-32` examine *16* words formatted as *i* instructions from current *PC minus 32* bytes
- `set redirect-file file` specify *file* to which to send gdb output
- `set redirect-mode append` set mode {overwrite | *append*}
- `set redirect on` send output to a file {*on*|off}
- `set pagination off` set state of pagination {on|*off*}
- `handle signal nostop noprint pass` ignore *signal*

gdb: Start-up

Specify Java Unwind Library Location

- gdb support supplied as a shared library
 - The library supporting Java unwind must be specified
 - Set the environment variable:
GDB_JAVA_UNWINDLIB
 - For example:
`export GDB_JAVA_UNWINDLIB=<path>/libjunwind.sl`
 - For this presentation we will put the library in /tmp:
export GDB_JAVA_UNWINDLIB=/tmp/libjunwind.sl

`gdb` Files Required

- `gdb`
 - Debugger
- `libjvmonwind.sl`
 - Library with support for unwinding Java programs

gdb: Start-up

Four Methods for Debugging Java

Four methods:

1. **Modify application** launch script's java command
 - + Often the easiest approach – uses `DEBUG_PROG`
2. **Modify** the `/opt/java1.3/bin/.java_wrapper` script
 - + Easy to pass command line arguments
 - Need to have special JDK if many java processes
3. Use built-in **DEBUG_PROG** environment variable
 - + Easy to set for the process
 - Hard to pass in large numbers of command line arguments
4. **Attach** to a running Java program
 - + Easy to do

`gdb`

Starting Java from `gdb`: Modify app

Modify Application

`gdb`

Starting Java from `gdb`: Modify app

- Easiest method
- Example
 - Change command line in a script such as:

```
exec "$prog" -Xmn500m -ms1024m -mx1024m  
COM.volano.Mark -port 8000 -count 5000 -rooms 5
```
 - To:

```
export GDB_JAVA_UNWINDLIB=/tmp/libjunwind.sl  
export DBG_ARGS="-Xmn500m -ms1024m -mx1024m  
COM.volano.Mark -port 8000 -count 5000 -rooms 5"  
export DEBUG_PROG=/opt/langtools/bin/gdb  
exec "$prog"
```
 - Start scripts as normal – `gdb` will start:

```
(gdb) r $DBG_ARGS
```

`gdb`

Starting Java from gdb: Modify wrap

Modify Wrapper

`gdb`

Starting Java from `gdb`: Modify `wrap`

The second method to invoke the debugger requires you to modify:

```
/opt/java1.3/bin/.java_wrapper
```

At the end of the file you have the following commands to start Java:

```
# Run.
```

```
if [ -x "$prog" ]
```

```
then
```

```
    # invoke the VM $args contains arguments which begin with "-", $* contains ...
```

```
    exec $DEBUG_PROG "$prog" "${options[@]}" "$@"
```

```
else
```

```
    echo >&2 "$progname was not found in ${prog}"
```

```
    exit 1
```

```
fi
```

gdb

Starting Java from gdb: Modify wrap

Modify the file in place by adding the text in red:

```
# Run.  
if [ -x "$prog" ]  
then  
    # invoke the VM $args contains arguments which begin with "-", $* contains ...  
    # exec $DEBUG_PROG "$prog" "${options[@]}" "$@"  
    export GDB_JAVA_UNWINDLIB=/tmp/libjunwind.sl  
    export DBG_ARGS="${options[@]} $@"  
    print -R $DBG_ARGS  
    exec gdb "$prog"  
else  
    echo >&2 "$progname was not found in ${prog}"  
    exit 1
```

`gdb`

Starting Java from `gdb`: Modify wrap

- Problem: `/opt/java1.3` directory not write-able
 - Often hard to modify `/opt/java1.3/bin/.java_wrapper`
- Solution: copy the JDK and modify the copy

```
mkdir /tmp/java1.3
cp -r /opt/java1.3/bin /tmp/java1.3/bin
cp -r /opt/java1.3/lib /tmp/java1.3/lib
cp -r /opt/java1.3/jre /tmp/java1.3/jre
```
- Modify the `.java_wrapper` in `/tmp/java1.3/bin`

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Start Java from the Command Line

```
$ /tmp/java1.3/bin/java
```

HP `gdb` 3.0 for PA-RISC 1.1 or 2.0 (narrow), HP-UX 11.00.

Copyright 1986 - 2001 Free Software Foundation, Inc.

Hewlett-Packard Wildebeest 3.0 (based on GDB) is covered by the GNU General Public License. Type "show copying" to see the conditions to change it and/or distribute copies. Type "show warranty" for warranty/support.

..(no debugging symbols found)...

(gdb)

`gdb`

Start the Java Process (no program)

`(gdb) r`

Starting program: `/opt/java1.3/bin/PA_RISC2.0/native_threads/java`

(no debugging symbols found)...(no debugging symbols found)...(...

Program received signal SIGSEGV, Segmentation fault.

`0x6f8e69f0` in `os_init_2 ()` from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

`(gdb)`

- The SIGSEGV signal is normal part of Java Virtual Machine initialization
 - Do a back trace
 - Continue
- To not stop or print signals permanently use a `~/.gdbinit` file with contents:
`handle SIGFPE nostop noprint pass`
 - Can also do the same for SIGSEGV and SIGBUS, if desired

`gdb`

Continue Past the First Signal

(gdb) ***bt***

#0 0x6f8e69f0 in os_init_2 ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#1 0x6f94721c in create_vm__7ThreadsSFP14JavaVMInitArgs ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#2 0x6f852e94 in JNI_CreateJavaVM ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#3 0x4000 in InitializeJVM ()

#4 0x3298 in main ()

(gdb) ***c***

- Generates the same help information as `java` command without parameters normally does:

Usage: `java [-options] class [args...]`

(to execute a class)

or `java -jar [-options] jarfile [args...]`

(to execute a jar file)

`gdb`

Starting Java from `gdb`: `DEBUG_PROG`

Use of `DEBUG_PROG` Environment Variable

`gdb`

Starting Java from `gdb`: `DEBUG_PROG`

- Built-in mechanism available in `.java_wrapper` for 1.3.1
 - Set `DEBUG_PROG` in your shell:
`export DEBUG_PROG=/opt/langtools/bin/gdb`
`export GDB_JAVA_UNWINDLIB=/tmp/libjunwind.sl`
 - Problem using arguments to the `java` command
 - You need to remove arguments else you get:
`/opt/langtools/bin/gdb: unrecognized option '-Xmn500m'`
- Proceed as with modified `.java_wrapper` method
 - Type in all of the arguments:
`(gdb) r -Xmn500m -Xms1024m -Xmx1024m`
`COM.volano.Mark -port 8000 -count 5000 -rooms 5`
 - Can be cumbersome with large numbers of arguments
 - Alternatively, use the “`set args`” feature in your `~/.gdbinit` file

`gdb`

Starting Java from gdb: Attach

Attaching to a Java Process

`gdb`

Starting Java from `gdb`: Attach

```
export DEBUG_PROG=/opt/langtools/bin/gdb  
export GDB_JAVA_UNWINDLIB=/tmp/libjunwind.sl  
/opt/java1.3/bin/java
```

HP `gdb` 3.0 for PA-RISC 1.1 or 2.0 (narrow), HP-UX 11.00.

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..(no debugging symbols found)...

(`gdb`) **`attach 24037`**

Attaching to program: `/opt/java1.3/bin/PA_RISC2.0/native_threads/java`, process 24037

Reading symbols from `/opt/java1.3/bin/PA_RISC2.0/native_threads/java`...(no debugging symbols found)...done.

Reading symbols from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`...(no debugging symbols found)...done.

gdb

Starting Java from gdb: Attach

Reading symbols from /usr/lib/libpthread.1...(no debugging symbols found)...
done.

Reading symbols from /usr/lib/libm.2...(no debugging symbols found)...done.

Reading symbols from /usr/lib/libc1.2...(no debugging symbols found)...done.

Reading symbols from /usr/lib/libisamstub.1...(no debugging symbols found)...
done.

Reading symbols from /usr/lib/libCsup.2...(no debugging symbols found)...done.

Reading symbols from /usr/lib/libc.2...(no debugging symbols found)...done.

Reading symbols from /usr/lib/libdld.2...(no debugging symbols found)...done.

Reading symbols from

 /opt/java1.3/jre/lib/PA_RISC2.0/native_threads/libhpi.sl...(no debugging symbols
found)...done.

Reading symbols from /opt/java1.3/jre/lib/PA_RISC2.0/libverify.sl...(no debugging
symbols found)...done.

gdb

Starting Java from gdb: Attach

Reading symbols from /opt/java1.3/jre/lib/PA_RISC2.0/libzip.sl...(no debugging symbols found)...done.

Reading symbols from /opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl...(no debugging symbols found)...done.

Reading symbols from /usr/lib/libnss_dns.1...done.

Reading symbols from /usr/lib/libnss_nis.1...done.

Reading symbols from /usr/lib/libnsl.1...done.

Reading symbols from /usr/lib/libxti.2...done.

warning: reading `r3' register: No data - limitation in gdb with pre-release

0xc01f28d0 in __ksleep () from /usr/lib/libc.2

`gdb`

Starting Java from `gdb`: Attach

(`gdb`) ***bt***

```
#0 0xc01f28d0 in __ksleep () from /usr/lib/libc.2
#1 0xc15c8298 in _lwp_cond_timedwait () from /usr/lib/libpthread.1
#2 0xc15c7fd4 in pthread_cond_wait () from /usr/lib/libpthread.1
#3 0xc40de384 in ObjectMonitor::wait ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#4 0xc41182ac in ObjectSynchronizer::wait ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#5 0xc4059d30 in JVM_MonitorWait ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#6 0x6575c in interpreted frame: java/lang/Object::wait {(J)V} ()
#7 0x617fc in interpreted frame: java/lang/Object::wait {( )V} ()
#8 0x617fc in interpreted frame: COM/volano/mbv::úÀ {( )Z} ()
#9 0x6176c in interpreted frame: COM/volano/Mark:: {(Ljava/util/Vector;)Z}
#10 0x6176c in interpreted frame: COM/volano/Mark::main {( [Ljava/lang/String;)V}
#11 0x6ffbf1b8 in Java entry frame ()
```

gdb: Start-up Summary

Four methods:

1. **Modify application** launch script's java command
 - + Often the easiest approach – uses `DEBUG_PROG`
2. **Modify** the `/opt/java1.3/bin/.java_wrapper` script
 - + Easy to pass command line arguments
 - Need to have special JDK if many java processes
3. Use built-in **DEBUG_PROG** environment variable
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`gdb` Running an Application

Running and Debugging an Application

Analysis of Threads in the JVM Process

`gdb`

Running an Application

- Use VolanoMark as a sample application
 - Many threads
 - Easy to run

`gdb`

Running an Application - Volano

\$ ***runVolano***

Starting volano client...

- Print the `DBG_ARGS` from the `.java_wrapper`:

```
-Xmn500m -ms1024m -mx1024m COM.volano.Mark -port 8000 -count 5000 -rooms 5
```

HP `gdb` 3.0 for PA-RISC 1.1 or 2.0 (narrow), HP-UX 11.00.

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Hewlett-Packard Wildebeest 3.0 (based on GDB) ...

(gdb) ***r \$DBG_ARGS***

```
Starting program: /opt/java1.3/bin/PA_RISC2.0/native_threads/java -Xmn500m -Xms1024m -Xmx1024m COM.volano.Mark -port 8000 -count 5000 -rooms 5
```

(no debugging symbols found)...(no debugging symbols found)...

Program received signal SIGSEGV, Segmentation fault.

0x6f8e69f0 in `os_init_2` ()

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

(gdb) ***c***

Running an Application - Volano

Continuing.

(no debugging symbols found)...(no debugging symbols found)...

VolanoMark(TM) Benchmark Version 2.1.2

Copyright (C) 1996-1999 Volano LLC. All rights reserved.

Creating room number 1 ...

20 connections so far.

Creating room number 2 ...

40 connections so far.

Creating room number 3 ...

60 connections so far.

Creating room number 4 ...

80 connections so far.

Creating room number 5 ...

100 connections so far.

Running the test ...

`gdb` Stopping the Java Process

Control-c

Program received signal SIGINT, Interrupt.

[Switching to thread 11 (system thread 27173)]

0x6ffad8d0 in __ksleep () from /usr/lib/libc.2

(gdb)

gdb

Where am I? All Threads

(gdb) **info threads**

```
12 system thread 26778 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
11 system thread 27173 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
10 system thread 26775 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
 9 system thread 26774 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
 8 system thread 26773 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
 7 system thread 26772 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
 6 system thread 26771 0x6ffb1a98 in _nanosleep_sys () from
   /usr/lib/libc.2
 5 system thread 26770 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
 4 system thread 26769 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
 3 system thread 26768 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
 2 system thread 26767 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
 1 system thread 26762 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
```

gdb

Where am I? All Threads

Let's look at each of the Java Virtual Machine Threads:

1. Base Thread
2. Thread Helper
3. Timer Thread
4. Reference Handler Thread
5. Finalizer Thread
6. Watcher Thread
7. Suspend Checker Thread
8. Signal Handler Thread
9. Compiler Thread 1
10. Compiler Thread 2
11. User Threads ...
12. Stubs to transition between native and Java code

`gdb`

Where am I? Base Thread, Part 1

(gdb) ***thr 1***

(gdb) ***bt***

Thread 1 (system thread 26762):

#0 0x6ffad8d0 in `__ksleep ()` from `/usr/lib/libc.2`

#1 0x6fc73298 in `_lwp_cond_timedwait ()` from `/usr/lib/libpthread.1`

#2 0x6fc72fd4 in `pthread_cond_wait ()` from `/usr/lib/libpthread.1`

#3 0x6f8de384 in `ObjectMonitor::wait ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#4 0x6f9182ac in `ObjectSynchronizer::wait ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#5 0x6f859d30 in `JVM_MonitorWait ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#6 0xc8b7c in **interpreted frame**: `java/lang/Object::wait {(J)V} ()`

#7 0xc4c1c in **interpreted frame**: `java/lang/Object::wait {()V} ()`


#8 0xc4c1c in **interpreted frame**: `COM/volano/mbv::Çi {()Z} ()`

gdb

Where am I? Base Thread, Part 2

Thread 1 (system thread 26762):

```
#9 0xc4b8c in interpreted frame: COM/volano/Mark::Ä □ {(Ljava/util/Vector;)Z} ()
#10 0xc4b8c in interpreted frame: COM/volano/Mark::main {([Ljava/lang/String;)V}
#11 0x6fe911b8 in Java entry frame ()
#12 0x6f827a48 in JavaCalls::call_helper ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#13 0x6f8e6394 in os::os_exception_wrapper ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#14 0x6f827748 in JavaCalls::call ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#15 0x6f83129c in jni_invoke ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#16 0x6f84417c in jni_CallStaticVoidMethod ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#17 0x3870 in main ()
```



Volano Mark main()

`gdb` Where am I? Thread Helper

(gdb) ***thr 2***

(gdb) ***bt***

Thread 2 (system thread 26767):

#0 0x6ffad8d0 in `__ksleep ()` from `/usr/lib/libc.2`

#1 0x6fc73298 in `_lwp_cond_timedwait ()` from `/usr/lib/libpthread.1`

#2 0x6fc72fd4 in `pthread_cond_wait ()` from `/usr/lib/libpthread.1`

#3 0x6f8e8328 in `thread_helper ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#4 0x6fc74db0 in `__pthread_create_system ()` from `/usr/lib/libpthread.1`

`gdb`

Where am I? Timer Thread

Thread 3 (system thread 26768):

#0 0x6ffad8d0 in `__ksleep ()` from `/usr/lib/libc.2`

#1 0x6fc73298 in `_lwp_cond_timedwait ()` from `/usr/lib/libpthread.1`

#2 0x6fc730c4 in `pthread_cond_timedwait ()` from `/usr/lib/libpthread.1`

#3 0x6f8d5c64 in `Monitor::wait ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#4 0x6f960924 in `VMThread::loop ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#5 0x6f9603a8 in `VMThread::run ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#6 0x6f8e89b4 in `_start ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#7 0x6fc74db0 in `__pthread_create_system ()` from `/usr/lib/libpthread.1`

gdb

Where am I? Reference Handler, 1

Thread 4 (system thread 26769):

#0 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2

#1 0x6fc73298 in _lwp_cond_timedwait () from /usr/lib/libpthread.1

#2 0x6fc72fd4 in pthread_cond_wait () from /usr/lib/libpthread.1

#3 0x6f8de384 in ObjectMonitor::wait ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#4 0x6f9182ac in ObjectSynchronizer::wait ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#5 0x6f859d30 in JVM_MonitorWait ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#6 0xc8b7c in **interpreted frame**: java/lang/Object::wait {(J)V} ()

#7 0xc4c1c in **interpreted frame**: java/lang/Object::wait {()V} ()

#8 0xc4c1c in **interpreted frame**: java/lang/ref/Reference\$ReferenceHandler::run
{()V} ()

#9 0x6fe911b8 in **Java entry frame** ()

gdb

Where am I? Reference Handler, 2

Thread 4 (system thread 26769):

```
#9 0x6fe911b8 in Java entry frame ()
#10 0x6f827a48 in JavaCalls::call_helper ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#11 0x6f8e6394 in os::os_exception_wrapper ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#12 0x6f826bf4 in JavaCalls::call_virtual ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#13 0x6f867ea8 in thread_entry ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#14 0x6f944210 in JavaThread::run ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#15 0x6f8e89b4 in _start ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#16 0x6fc74db0 in __pthread_create_system () from /usr/lib/libpthread.1
```

gdb

Where am I? Reference Handler, 2

Thread 4 (system thread 26769):

```
#9 0x6fe911b8 in Java entry frame ()  
#10 0x6f827a48 in JavaCalls::call_helper ()  
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl  
#11 0x6f8e6394 in os::os_exception_wrapper ()  
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl  
#12 0x6f826bf4 in JavaCalls::call_virtual ()  
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl  
#13 0x6f867ea8 in thread_entry ()  
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl  
#14 0x6f944210 in JavaThread::run ()  
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl  
#15 0x6f8e89b4 in _start ()  
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl  
#16 0x6fc74db0 in __pthread_create_system () from /usr/lib/libpthread.1
```

**Same Thread
Stack Base
For Most
Java Threads**

gdb

Where am I? Reference Handler, 2

Thread 4 (system thread 26769):

#9 0x6fe911b8 in **Java entry frame** ()

In future stack traces:

Only show to Java entry frame()

#10 0x6f827a48 in **JavaCalls::call_helper** ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#11 0x6f8e6394 in **os::os_exception_wrapper** ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#12 0x6f826bf4 in **JavaCalls::call_virtual** ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#13 0x6f867ea8 in **thread_entry** ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#14 0x6f944210 in **JavaThread::run** ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#15 0x6f8e89b4 in **_start** ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#16 0x6fc74db0 in **__pthread_create_system** () from /usr/lib/libpthread.1

`gdb`

Where am I? Finalizer, 1

Thread 5 (system thread 26770):

- #0 0x6ffad8d0 in `__ksleep ()` from `/usr/lib/libc.2`
- #1 0x6fc73298 in `_lwp_cond_timedwait ()` from `/usr/lib/libpthread.1`
- #2 0x6fc72fd4 in `pthread_cond_wait ()` from `/usr/lib/libpthread.1`
- #3 0x6f8de384 in `ObjectMonitor::wait ()`
from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`
- #4 0x6f9182ac in `ObjectSynchronizer::wait ()`
from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`
- #5 0x6f859d30 in `JVM_MonitorWait ()`
from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`
- #6 0xc8b7c in **interpreted frame**: `java/lang/Object::wait {(J)V} ()`
- #7 0xc4c1c in **interpreted frame**: `java/lang/ref/ReferenceQueue::remove {(J)Ljava/lang/ref/Reference;} ()`
- #8 0xc4b68 in **interpreted frame**: `java/lang/ref/ReferenceQueue::remove {(())Ljava/lang/ref/Reference;} ()`

Where am I? Finalizer, 2

Thread 5 (system thread 26770):

#9 0xc4b68 in **interpreted frame**:

java/lang/ref/Finalizer\$FinalizerThread::run {()V} ()

#10 0x6fe911b8 in **Java entry frame** ()

gdb

Where am I? Watcher Thread

Thread 6 (system thread 26771):

#0 0x6ffb1a98 in `_nanosleep_sys ()` from `/usr/lib/libc.2`

#1 0x6ffbad10 in `nanosleep ()` from `/usr/lib/libc.2`

#2 0x6f8e7b50 in `os_sleep ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#3 0x6f8e7bd4 in `os::sleep ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#4 0x6f9432e8 in `WatcherThread::run ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#5 0x6f8e89b4 in `_start ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#6 0x6fc74db0 in `__pthread_create_system ()` from
`/usr/lib/libpthread.1`

`gdb`

Where am I? Suspend Checker

Thread 7 (system thread 26772):

#0 0x6ffad8d0 in `__ksleep ()` from `/usr/lib/libc.2`

#1 0x6fc73298 in `_lwp_cond_timedwait ()` from `/usr/lib/libpthread.1`

#2 0x6fc72fd4 in `pthread_cond_wait ()` from `/usr/lib/libpthread.1`

#3 0x6f8d5944 in `Monitor::wait ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#4 0x6f943790 in `SuspendCheckerThread::run ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#5 0x6f8e89b4 in `_start ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#6 0x6fc74db0 in `__pthread_create_system ()` from
`/usr/lib/libpthread.1`

gdb

Where am I? Signal Handler

Thread 8 (system thread 26773):

#0 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2

#1 0x6fc73298 in _lwp_cond_timedwait () from /usr/lib/libpthread.1

#2 0x6fc72fd4 in pthread_cond_wait () from /usr/lib/libpthread.1

#3 0x6f8d5ad0 in Monitor::wait ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#4 0x6f8e9bd4 in os::signal_wait ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#5 0x6f8e2d74 in **signal_thread_entry** ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#6 0x6f944210 in JavaThread::run ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#7 0x6f8e89b4 in _start ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#8 0x6fc74db0 in __pthread_create_system () from /usr/lib/libpthread.1

gdb

Where am I? Compiler Thread 1

Thread 9 (system thread 26774):

```
#0 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
#1 0x6fc73298 in _lwp_cond_timedwait () from /usr/lib/libpthread.1
#2 0x6fc72fd4 in pthread_cond_wait () from /usr/lib/libpthread.1
#3 0x6f8d5ad0 in Monitor::wait ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#4 0x6f97cc48 in CompileBroker::compiler_thread_loop ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#5 0x6f947070 in compiler_thread_entry ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#6 0x6f944210 in JavaThread::run ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#7 0x6f8e89b4 in _start ()
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#8 0x6fc74db0 in __pthread_create_system () from /usr/lib/libpthread.1
```

gdb

Where am I? Compiler Thread 2

Thread 10 (system thread 26775):

#0 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2

#1 0x6fc73298 in _lwp_cond_timedwait () from /usr/lib/libpthread.1

#2 0x6fc72fd4 in pthread_cond_wait () from /usr/lib/libpthread.1

#3 0x6f8d5ad0 in Monitor::wait ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#4 0x6f97cc48 in **CompileBroker::compiler_thread_loop ()**

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#5 0x6f947070 in compiler_thread_entry ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#6 0x6f944210 in JavaThread::run ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#7 0x6f8e89b4 in _start ()

from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl

#8 0x6fc74db0 in __pthread_create_system () from /usr/lib/libpthread.1

gdb

Where am I? Volano Thread 1, 1

Thread 11 (system thread 27173):

- #0 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
- #1 0x6fc73298 in _lwp_cond_timedwait () from /usr/lib/libpthread.1
- #2 0x6fc72fd4 in pthread_cond_wait () from /usr/lib/libpthread.1
- #3 0x6f8de384 in ObjectMonitor::wait ()
from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
- #4 0x6f9182ac in ObjectSynchronizer::wait ()
from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
- #5 0x6f859d30 in JVM_MonitorWait ()
from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
- #6 0xc8b7c in **interpreted frame**: java/lang/Object::wait {(J)V} ()
- #7 0xc4c1c in **interpreted frame**: java/lang/Object::wait {()V} ()
- #8 0xc4c1c in **interpreted frame**: COM/volano/mcf::Ä€
{()[Ljava/lang/Object; } ()
- #9 0xc4b68 in **interpreted frame**: COM/volano/mca::run {()V} ()

`gdb`

Where am I? Volano Thread 1, 2

Thread 11 (system thread 27173):

#10 0xc4dcc in **interpreted frame**: java/lang/Thread::run {()V} ()

#11 0x6fe911b8 in **Java entry frame** ()

`gdb`

Where am I? Volano Thread 2, 1

Thread 12 (system thread 26778):

#0 0x6ffad8d0 in `__ksleep ()` from `/usr/lib/libc.2`

#1 0x6fc77bb0 in `pthread_mutex_lock ()` from `/usr/lib/libpthread.1`

#2 0x6f8d488c in `Mutex::lock ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#3 0x6f91a9d8 in `SystemDictionary::find ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#4 0x6f91a530 in

`SystemDictionary::resolve_instance_class_or_null ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#5 0x6f91987c in `SystemDictionary::resolve_or_fail ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#6 0x6f85b558 in `JVM_FindClassFromClassLoader ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

gdb

Where am I? Volano Thread 2, 2

Thread 12 (system thread 26778):

#7 0x6fc1d6b8 in Java_java_lang_Class_forName0 ()
from /opt/java1.3/jre/lib/PA_RISC2.0/libjava.sl

- **Transition to native code (c2native)**

#8 0x6d41428c in **compiled frame**: java/lang/Class::forName0
{(Ljava/lang/String;ZLjava/lang/ClassLoader;)Ljava/lang/Class;} ()

#9 0x6d4123a4 in **compiled frame**: COM/volano/mby::Æ°
{()Ljava/lang/Object;} ()

#10 0x6d40517c in **i2c_adapter frame** ()

- **Transition to compiled Java code: Interpreted To Compiled (i2c)**

#11 0xc4b68 in **interpreted frame**: COM/volano/mby::run {}()V} ()

#12 0xc4dcc in **interpreted frame**: java/lang/Thread::run {}()V} ()

#13 0x6fe911b8 in Java entry frame ()

`gdb`

Compiled Java Frames

- Continue the program and then interrupt with Control-c again

(gdb) **c**

- Program runs

Control-c

Program received signal SIGINT, Interrupt.

[Switching to thread 80 (system thread 26912)]

0x6ffaf6a0 in `_read_sys ()` from `/usr/lib/libc.2`

(gdb) **bt**

#0 0x6ffaf6a0 in `_read_sys ()` from `/usr/lib/libc.2`

#1 0x6ffbb664 in `read ()` from `/usr/lib/libc.2`

#2 0x6f866ce0 in `JVM_Read ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#3 0x6fbca100 in `socketReadWork ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl`

gdb

Compiled Java Frames

- #4 0x6fbca328 in socketReadOnStack ()
from /opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl
- #5 0x6fbca394 in Java_java_net_SocketInputStream_socketRead ()
from /opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl
- #6 0x6d4134d8 in compiled frame: java/net/SocketInputStream::socketRead
{([BII)]} ()
- #7 0x6d413c44 in compiled frame: java/io/BufferedInputStream::fill {()V} ()
- #8 0x6d408ee8 in compiled frame: java/io/BufferedInputStream::read {()I} ()
- #9 0x6d40bdc8 in compiled frame: java/io/DataInputStream::readUnsignedShort
{()I} ()
- #10 0x6d4056d8 in compiled frame: java/io/DataInputStream::readUTF
{(Ljava/io/DataInput;)Ljava/lang/String;} ()
- #11 0x6d41237c in compiled frame: COM/volano/mby::Æ° {(Ljava/lang/Object);} ()
- #12 0x6d40517c in i2c adapter frame () - interpreted to compiled adapter
- #13 0xc4b68 in interpreted frame: COM/volano/mby::run {()V} ()
- #14 0xc4dcc in interpreted frame: java/lang/Thread::run {()V} ()
- #15 0x6fe911b8 in Java entry frame ()

HotSpot Compiler Examples

Transitions: i2c, c2i and i2native

#11 0xc4dcc in interpreted frame: java/lang/Thread::run {()V} ()



#12 0x6fe911b8 in Java entry frame ()

HotSpot Compiler Examples

Transitions: i2c, c2i and i2native

#10 0xc4b68 in interpreted frame: COM/volano/mca::run {}(V) ()

#11 0xc4dcc in interpreted frame: java/lang/Thread::run {}(V) ()

#12 0x6fe911b8 in Java entry frame ()

HotSpot Compiler Examples

Transitions: **i2c**, c2i and i2native

#9 0x6d40517c in **i2c adapter frame** () - **interpreted to compiled adapter**

#10 0xc4b68 in **interpreted frame**: COM/volano/mca::run {()V} ()

#11 0xc4dcc in **interpreted frame**: java/lang/Thread::run {()V} ()

#12 0x6fe911b8 in Java entry frame ()

HotSpot Compiler Examples

Transitions: i2c, c2i and i2native

- #8 0x6d41a1b8 in compiled frame: COM/volano/mcf::Ä€ {}([Ljava/lang/Object; } ()
- #9 0x6d40517c in i2c adapter frame () - **interpreted to compiled adapter**
- #10 0xc4b68 in interpreted frame: COM/volano/mca::run {}(V} ()
- #11 0xc4dcc in interpreted frame: java/lang/Thread::run {}(V} ()
- #12 0x6fe911b8 in Java entry frame ()

HotSpot Compiler Examples

Transitions: i2c, **c2i** and i2native

- #7 0x6d41aaf4 in c2i adapter frame () - **compiled to interpreted adapter**
- #8 0x6d41a1b8 in compiled frame: COM/volano/mcf::Ä€ {}([Ljava/lang/Object;] ())
- #9 0x6d40517c in i2c adapter frame () - **interpreted to compiled adapter**
- #10 0xc4b68 in interpreted frame: COM/volano/mca::run {}(V) ()
- #11 0xc4dcc in interpreted frame: java/lang/Thread::run {}(V) ()
- #12 0x6fe911b8 in Java entry frame ()

HotSpot Compiler Examples

Transitions: i2c, c2i and i2native

- #6 0xc8b7c in interpreted frame: java/lang/Object::wait {(J)V} ()
- #7 0x6d41aaf4 in c2i adapter frame () - **compiled to interpreted adapter**
- #8 0x6d41a1b8 in compiled frame: COM/volano/mcf::Ä€ {(())[Ljava/lang/Object;} ()
- #9 0x6d40517c in i2c adapter frame () - **interpreted to compiled adapter**
- #10 0xc4b68 in interpreted frame: COM/volano/mca::run {(V)} ()
- #11 0xc4dcc in interpreted frame: java/lang/Thread::run {(V)} ()
- #12 0x6fe911b8 in Java entry frame ()

`gdb`

Transitions: `i2c`, `c2i` and **`i2native`**

```
#5 0x6f859d30 in JVM_MonitorWait ()  
    from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl  
#6 0xc8b7c in interpreted frame: java/lang/Object::wait {(J)V} ()  
#7 0x6d41aaf4 in c2i adapter frame () - compiled to interpreted adapter  
#8 0x6d41a1b8 in compiled frame: COM/volano/mcf::Ä€  
    {()[Ljava/lang/Object;} ()  
#9 0x6d40517c in i2c adapter frame () - interpreted to compiled adapter  
#10 0xc4b68 in interpreted frame: COM/volano/mca::run {()V} ()  
#11 0xc4dcc in interpreted frame: java/lang/Thread::run {()V} ()  
#12 0x6fe911b8 in Java entry frame ()
```

HotSpot Compiler Examples

Transitions: i2c, c2i and i2native

- #0 0x6ffad8d0 in __ksleep () from /usr/lib/libc.2
- #1 0x6fc73298 in _lwp_cond_timedwait () from /usr/lib/libpthread.1
- #2 0x6fc72fd4 in pthread_cond_wait () from /usr/lib/libpthread.1
- #3 0x6f8de384 in ObjectMonitor::wait ()
from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
- #4 0x6f9182ac in ObjectSynchronizer::wait ()
from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
- #5 0x6f859d30 in JVM_MonitorWait ()
from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
- #6 0xc8b7c in **interpreted frame**: java/lang/Object::wait {(J)V} ()
- #7 0x6d41aaf4 in **c2i adapter frame** () - **compiled to interpreted adapter**
- #8 0x6d41a1b8 in **compiled frame**: COM/volano/mcf::Ä€ {(())[Ljava/lang/Object;} ()
- #9 0x6d40517c in **i2c adapter frame** () - **interpreted to compiled adapter**
- #10 0xc4b68 in **interpreted frame**: COM/volano/mca::run {(V)} ()
- #11 0xc4dcc in **interpreted frame**: java/lang/Thread::run {(V)} ()
- #12 0x6fe911b8 in Java entry frame ()

gdb

Where am I? Summary

- We have seen what's going on in each of the threads in the JVM
- gdb with Java/Native support is a powerful tool
 - Understand what's going on in the JVM
 - What are the native libraries that do the work?
 - What is the overhead of using a certain Java feature?
 - Diagnose problems

`gdb`

Set a Breakpoint in Compiled Code

Set a Breakpoint in Compiled Code

`gdb`

Set a Breakpoint in Compiled Code

- Breakpoint usage to examine the instructions generated for:
 - Interpreted code
 - Compiled code

gdb

Set a Breakpoint in Compiled Code

- ***Easy, direct method:***

- If you want to set breakpoint at a specific address:

0x6d4142c4 in compiled frame: java/io/BufferedInputStream::fill {()V}

(gdb) ***b *0x6d4142c4***

gdb

Set a Breakpoint in Compiled Code

- Can also go to the frame to set the breakpoint
 - Navigate to the correct thread and frame
 - Set the breakpoint
 - We will cover the detailed steps subsequently
- Subsequent steps:
 - Continue after setting the breakpoint
 - Examination of instructions using **x** command

gdb

Set a Breakpoint in Compiled Code

- **Setting a breakpoint in `BufferedInputStream::fill` – go to the frame:**

(gdb) ***thr***

[Current thread is 11 (system thread 5485)]

(gdb) ***bt***

#0 0x6ffaf6a0 in `_read_sys ()` from `/usr/lib/libc.2`

#1 0x6ffbb664 in `read ()` from `/usr/lib/libc.2`

#2 0x6f866ce0 in `JVM_Read ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#3 0x6e219100 in `socketReadWork ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl`

#4 0x6e219328 in `socketReadOnStack ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl`

#5 0x6e219394 in `Java_java_net_SocketInputStream_socketRead ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl`

`gdb`

Set a Breakpoint in Compiled Code

- #6 0x6e410b58 in **compiled frame**: java/net/SocketInputStream::socketRead
{([BII)I} ()
- Call to java/net/SocketInputStream::read() has been inlined in fill()
- #7 0x6e411d04 in **compiled frame**: java/io/BufferedInputStream::fill {()V} ()
- #8 0x6e408ee8 in **compiled frame**: java/io/BufferedInputStream::read {()I} ()
- #9 0x6e40c308 in **compiled frame**: java/io/DataInputStream::readUnsignedShort
- #10 0x6e4056d8 in **compiled frame**: java/io/DataInputStream::readUTF
{(Ljava/io/DataInput;)Ljava/lang/String;} ()
- #11 0x6e40fcf8 in **compiled frame**: COM/volano/mby::óα {(Ljava/lang/Object);} ()
- #12 0x6e40517c in i2c_adapter frame ()
- #13 0x61748 in interpreted frame: COM/volano/mby::run {()V} ()
- #14 0x619ac in interpreted frame: java/lang/Thread::run {()V} ()
- #15 0x6fe911b8 in Java entry frame ()

gdb

Set a Breakpoint in Compiled Code

(gdb) **up 7** - goes to frame #7

#7 **0x6e411d04** in compiled frame: java/io/BufferedInputStream::fill {()V}
()

(gdb) **b** - sets a breakpoint at the return PC in
BufferedInputStream::fill

Breakpoint 1 at 0x6e411d04

(gdb) **info break** - verify

Num	Type	Disp	Enb	Address	What
1	breakpoint	keep	y	0x6e411d04	

`gdb`

Continue Execution

(gdb) **c**

Continuing.

[Switching to thread **18** (system thread 5473)]

Breakpoint 1, **0x6e411d04** in compiled frame: java/io/BufferedInputStream::fill {()V}

(gdb) **bt**

#0 **0x6e411d04** in compiled frame: java/io/BufferedInputStream::fill {()V} ()

#1 0x6e40b96c in compiled frame: java/io/BufferedInputStream::read1 {([BII)I}

#2 0x6e409978 in compiled frame: java/io/DataInputStream::readFully {([BII)V}

#3 0x6e4057a4 in compiled frame: java/io/DataInputStream::readUTF
{(Ljava/io/DataInput;)Ljava/lang/String;} ()

#4 0x6e40be54 in compiled frame: COM/volano/mas::á¿
{(Ljava/io/DataInputStream;)V} ()

#5 0x6e40fdf0 in compiled frame: COM/volano/mby::ó¤ {(L)Ljava/lang/Object;} ()

#6 0x6e40517c in i2c_adapter frame ()

#7 0x61748 in interpreted frame: COM/volano/mby::run {()V} ()

#8 0x619ac in interpreted frame: java/lang/Thread::run {()V} ()

#9 0x6fe911b8 in Java entry frame ()

gdb

Examine Instructions at Breakpoint

```
(gdb) x/16i $pc-32 - inlined java/net/SocketInputStream::read() code
0x6e411ce4:  cmpib,=,n 0,%r9,0x6e411d20 ; if r9 (length) == 0 branch
0x6e411ce8:  nop
0x6e411cec:  copy %r7,%r26 ; load the argument registers
0x6e411cf0:  copy %r5,%r25
0x6e411cf4:  copy %r8,%r24
0x6e411cf8:  copy %r9,%r23
0x6e411cfc:  b,l,n 0x6e410a60,%rp ; java/net/SocketInputStream::socketRead
0x6e411d00:  nop
0x6e411d04:  ldw -0xa0(%sp),%r22
0x6e411d08:  ldw 0x14(%r22),%r21
0x6e411d0c:  add,l %r21,%ret0,%r22
0x6e411d10:  cmpib,>=,n 0,%ret0,0x6e411dfc ; check return value from Read
0x6e411d14:  nop
0x6e411d18:  ldw -0xa0(%sp),%r21
0x6e411d1c:  stw %r22,0x10(%r21)
0x6e411d20:  ldw -0x64(%sp),%r4
```

`gdb`

Set a Breakpoint in Compiled Code

- Easy to set breakpoint interpreted or compiled code:
 - Direct:
(gdb) **`b *0x6d4142c4`**
 - Go to the frame to set the breakpoint:
(gdb) **`up #`** - *go to frame #*
(gdb) **`b`**
- Demonstrated subsequent steps:
 - Continue after setting the breakpoint
 - Examination of instructions using **`x`** command

gdb

SIGBUS when Debugging, 1

- For this example, send a SIGBUS to the Java process identifier
- Signal will be caught by the debugger
 - Can query the state of the Java process
- Signal passed to the Java process
 - Information displayed describing location
 - Java Stack Trace
 - Libraries loaded
 - Information also written to a log file

`gdb` SIGBUS when Debugging, 2

- Send a kill `-10 <pid>` to the Java process from another window

Program received signal SIGBUS, Bus error.

[Switching to thread 33 (system thread 27266)]

0x6ffb0988 in `_sigsetstatemask ()` from `/usr/lib/libc.2`

(gdb) *bt*

#0 0x6ffb0988 in `_sigsetstatemask ()` from `/usr/lib/libc.2`

#1 0x6ffb919c in `sigsetjmp ()` from `/usr/lib/libc.2`

#2 0x6f866c1c in `JVM_Read ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#3 0x6fbc5100 in `socketReadWork ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl`

#4 0x6fbc5328 in `socketReadOnStack ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl`

gdb

SIGBUS when Debugging, 3

- Remember method names below to compare with the Java Stack Trace
- ```
#5 0x6fbc5394 in Java java net SocketInputStream socketRead ()
 from /opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl
#6 0x6d413dd8 in compiled frame:
 java/net/SocketInputStream::socketRead {([BII)]}
#7 0x6d4142c4 in compiled frame: java/io/BufferedInputStream::fill {()V} ()
#8 0x6d408ee8 in compiled frame: java/io/BufferedInputStream::read {()I} ()
#9 0x6d40c308 in compiled frame:
 java/io/DataInputStream::readUnsignedShort {()I} ()
#10 0x6d4056d8 in compiled frame: java/io/DataInputStream::readUTF
 {(Ljava/io/DataInput;)Ljava/lang/String;} ()
#11 0x6d40fe7c in compiled frame: COM/volano/mby::Æ° {()Ljava/lang/Object;} ()
#12 0x6d40517c in i2c_adapter frame ()
#13 0x66c68 in interpreted frame: COM/volano/mby::run {()V} ()
#14 0x66ecc in interpreted frame: java/lang/Thread::run {()V} ()
#15 0x6fe911b8 in Java entry frame ()
```

# `gdb` SIGBUS when Debugging, 4

```
[Switching to thread 12 (system thread 27222)]
0x6ffb2390 in sched_yield () from /usr/lib/libc.2
(gdb) c
Continuing.
```

```
Program received signal SIGBUS, Bus error.
[Switching to thread 43 (system thread 27284)]
0x6ffaf6a0 in _read_sys () from /usr/lib/libc.2
(gdb) c
Continuing.
```

```
Unexpected Signal : 10 occurred at PC=0x6f94ef74
Function name=
 copy_array__14typeArrayKlassFP12arrayOopDesciT1N22P6Thread
Library=
 /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
```

# gdb SIGBUS when Debugging, 5

- Here is the Java Stack Trace that you can compare with the previous Native Current Java thread:

```
"Receiver-17" prio=6 tid=0x002c6238 nid=43 lwp_id=27284 runnable
[0x667de000..0x667de478]
```

```
at java.net.SocketInputStream.socketRead(Native Method)
at java.net.SocketInputStream.read(Unknown Source)
at java.io.BufferedInputStream.fill(Unknown Source)
at java.io.BufferedInputStream.read(Unknown Source)
- locked <0x6bc276b0> (a java.io.BufferedInputStream)
at java.io.DataInputStream.readUnsignedShort(Unknown Source)
at java.io.DataInputStream.readUTF(Unknown Source)
at java.io.DataInputStream.readUTF(Unknown Source)
at COM.volano.mby.Æ°(Unknown Source)
at COM.volano.mby.run(Unknown Source)
at java.lang.Thread.run(Unknown Source)
```

# `gdb` SIGBUS when Debugging, 6

Dynamic libraries:

`/opt/java1.3/bin/PA_RISC2.0/native_threads/java`

text:0x00001000-0x000066cc data:0x00007000-0x00007324

`/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

text:0x6f400000-0x6fbbd000 data:0x6fde7000-0x6fe9c000

`/usr/lib/libpthread.1`

text:0x6fc6b000-0x6fc81000 data:0x6fc68000-0x6fc6b000

`/usr/lib/libm.2`

text:0x6fc82000-0x6fcae000 data:0x6fc81000-0x6fc82000

`/usr/lib/libcl.2`

text:0x6fcce000-0x6fda5000 data:0x6fcb0000-0x6fcce000

`/usr/lib/libisamstub.1`

text:0x6fcaf000-0x6fcb0000 data:0x6fcae000-0x6fcaf000

`/usr/lib/libCsup.2`

text:0x6fda8000-0x6fdc3000 data:0x6fda5000-0x6fda8000

# `gdb` SIGBUS when Debugging, 7

Dynamic libraries (cont):

`/usr/lib/libc.2`

`text:0x6febb000-0x6ffe6000 data:0x6fea4000-0x6febb000`

`/usr/lib/libdld.2`

`text:0x6fe9d000-0x6fea0000 data:0x6fe9c000-0x6fe9d000`

`/opt/java1.3/jre/lib/PA_RISC2.0/native_threads/libhpi.sl`

`text:0x6fc57000-0x6fc68000 data:0x6fc56000-0x6fc57000`

`/opt/java1.3/jre/lib/PA_RISC2.0/libverify.sl`

`text:0x6fc35000-0x6fc45000 data:0x6fc34000-0x6fc35000`

`/opt/java1.3/jre/lib/PA_RISC2.0/libjava.sl`

`text:0x6fc08000-0x6fc34000 data:0x6fc03000-0x6fc08000`

`/opt/java1.3/jre/lib/PA_RISC2.0/libzip.sl`

`text:0x6fbf0000-0x6fc03000 data:0x6fbee000-0x6fbf0000`

`/opt/java1.3/jre/lib/PA_RISC2.0/libnet.sl`

`text:0x6fbbe000-0x6fbc7000 data:0x6fbbd000-0x6fbbe000`

# `gdb` SIGBUS when Debugging, 8

Dynamic libraries (cont):

`/usr/lib/libnss_dns.1`

text:0x6d21c000-0x6d220000 data:0x6d21b000-0x6d21c000

`/usr/lib/libnss_nis.1`

text:0x6d215000-0x6d21b000 data:0x6d214000-0x6d215000

`/usr/lib/libnsl.1`

text:0x6c704000-0x6c77f000 data:0x6c6ef000-0x6c704000

`/usr/lib/libxti.2`

text:0x6c6da000-0x6c6ef000 data:0x6d20d000-0x6d212000

# `gdb` SIGBUS when Debugging, 9

```
Local Time = Mon Oct 8 20:09:10 2001
```

```
Elapsed Time = 6927
```

```
#
```

```
HotSpot Virtual Machine Error : 10
```

```
Please report this error to HP customer support.
```

```
#
```

```
Java VM: Java HotSpot(TM) Server VM (1.3.1 1.3.1.01-release-010816-
13:34-PA_RISC2.0 PA2.0 mixed mode)
```

```
#
```

```
An error report file has been saved as hs_err_pid19019.log.
```

```
Please refer to the file for further information.
```

```
#
```

# `gdb`

## SIGBUS when Debugging, Summary

- `gdb` stack traces (Java and Native)
  - Enable you to distinguish problems that are in:
    - Interpreted code
    - Runtime compiled code
    - Native code
  - Give additional information about the native code executed
    - Which instruction was being executed
  - Permit you to look at the other threads in the process

# `gdb` Debugging a Core File

## Debugging a Core File

# gdb

## Debugging a Core File, 1

- For remote analysis
  - Need to reproduce environment
    - Correct versions of all libraries
- Easy to look at the core file where generated
  - All of the libraries are already in place
- Remote problem analysis
  - Use gdb to generate a preliminary report
    - Stack traces can be used to compare with known problems
- In the example that follows:
  - Core file generated by the 1.3.1.01 JVM
  - Signal sent in this case to generate the core

# `gdb`

## Debugging a Core File, 2

```
$ export GDB_JAVA_UNWINDLIB=/tmp/libjunwind.sl
```

```
$ gdb /opt/java1.3/bin/PA_RISC2.0/native_threads/java --core=core
```

- Need to:
  - Specify correct path to executable
    - Might be installed elsewhere
    - Could be a 1.0 machine (PA\_RISC in the path above)
  - Have correct libraries (including system libraries) on the system
    - Can use `gdb`'s `GDB_SHLIB_PATH` environment variable

HP `gdb` 3.0 for PA-RISC 1.1 or 2.0 (narrow), HP-UX 11.00.

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Hewlett-Packard Wildebeest 3.0 (based on GDB) is covered by the GNU General Public License. Type "show copying" to see the conditions to change it and/or distribute copies. Type "show warranty" for warranty/support.

..(no debugging symbols found)... **Ignore these**

Core was generated by `java'.

# `gdb` Debugging a Core File, 3

```
#0 0xc01f4000 in kill () from /usr/lib/libc.2
```

```
(gdb) bt
```

```
#0 0xc01f4000 in kill () from /usr/lib/libc.2
```

```
#1 0xc0191358 in raise () from /usr/lib/libc.2
```

```
#2 0xc01d198c in abort_C () from /usr/lib/libc.2
```

```
#3 0xc01d19e4 in abort () from /usr/lib/libc.2
```

```
#4 0xc40eacd0 in os::abort ()
```

```
 from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
```

```
#5 0xc40e4598 in os::handle_unexpected_exception ()
```

```
 from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
```

```
#6 0xc40ecdac in os::Hpx::JVM_handle_hpux_signal ()
```

```
 from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
```

```
#7 0xc40e9f94 in os::Hpx::signalHandler ()
```

```
 from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
```

```
#8 <signal handler called>
```

# `gdb` Debugging a Core File, 4

(gdb) ***thr 10*** - Example to show that you can look at other threads

[Switching to thread 10 (system thread 28979)]

#0 0xc01f28d0 in `__ksleep ()` from `/usr/lib/libc.2`

(gdb) ***bt***

#0 0xc01f28d0 in `__ksleep ()` from `/usr/lib/libc.2`

#1 0xc15c8298 in `_lwp_cond_timedwait ()` from `/usr/lib/libpthread.1`

#2 0xc15c7fd4 in `pthread_cond_wait ()` from `/usr/lib/libpthread.1`

#3 0xc40d5ad0 in `Monitor::wait ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#4 0xc4160f54 in `VMThread::execute ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#5 0xc4106678 in `Scavenge::invoke_and_allocate ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

#6 0xc41561dc in `Universe::clear_allocate_local ()`

from `/opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl`

# gdb

## Debugging a Core File, 5

```
#7 0xc414e6dc in typeArrayKlass::allocate ()
 from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#8 0xc40e0540 in oopFactory::new_typeArray ()
 from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#9 0xc4304c48 in OptoRuntime::new_typeArray_C ()
 from /opt/java1.3/jre/lib/PA_RISC2.0/server/libjvm.sl
#10 0x6ec00c8c in JVM runtime stub frame ()
#11 0x6ec06d80 in compiled frame: java/lang/String::<init> {([CII)V} ()
#12 0x6ec05960 in compiled frame: java/io/DataInputStream::readUTF
 {(Ljava/io/DataInput;)Ljava/lang/String;} ()
#13 0x6ec100f8 in compiled frame: COM/volano/mby::Æ° {()Ljava/lang/Object;} ()
#14 0x6ec0517c in i2c_adapter frame ()
#15 0x61748 in interpreted frame: COM/volano/mby::run {()V} ()
#16 0x619ac in interpreted frame: java/lang/Thread::run {()V} ()
#17 0x6ffbf1b8 in Java entry frame ()
```

# **gdb**

## Debugging a Core File, 6

- Use following command to view all thread stacks:

(gdb) ***set pagination off***

(gdb) ***thread apply all bt***

- **Remote analysis**

- Direct the output to a file using:

(gdb) ***set redirect-file <filename>***

(gdb) ***set redirect on***

(gdb) ***thread apply all bt***

- To return the display to the debugger:

(gdb) ***set redirect off***

`gdb`

## Debugging a Core File, Summary

- Java/Native core file analysis
  - Powerful tool for problem diagnosis
  - Enables quick remote diagnosis of problems

# **gdb** **Native + Java Support: Summary**

## **gdb** **Native + Java Support**

# gdb

## Native + Java Support: Summary

- Powerful tool for problem diagnosis
  - Debugging problems
    - Correctness
    - To answer question – What's going on in the JVM?
      - Hung processes
      - Curious phenomena that occur during execution
- **ENABLED**: *Fast* remote diagnosis of problems
  - Redirect output to a file
  - gdb is another diagnostic tool that complements
    - Xverbosegc
    - Xeprof/HPjmeter