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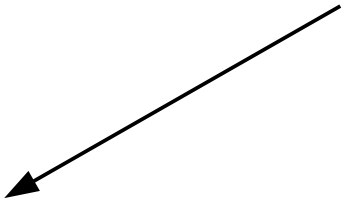
The Bright Future of OpenJDK

Deepak Bhole
Supervisor [Java Group], Red Hat
June 13th 2013

Agenda

Persistent index will always show current point



What is OpenJDK
- Overview
- Components

Red Hat's focus
- Our goals
- Specific areas of focus
  - Support
  - Bridge the gap with proprietary
    - Deployment
    - Serviceability
  - Performance improvements
  - Architectural expansion
    - Zero
    - ARM32
    - AARCH64

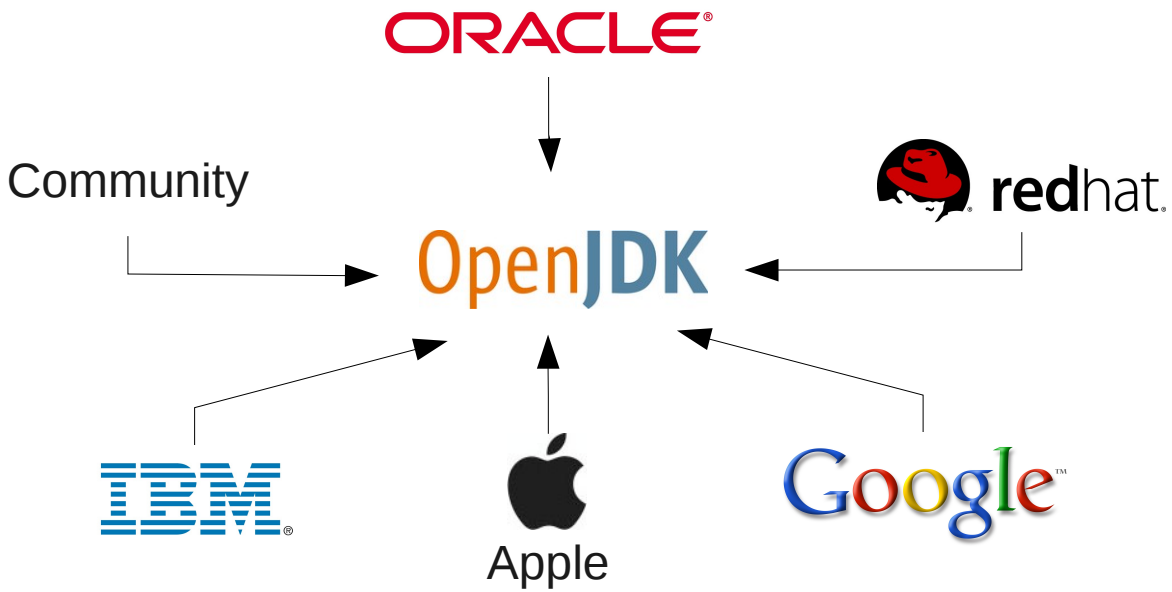
Upcoming features
- OpenJDK 8
  - Lambda
  - Bulk data operations
  - Java type annotations
  - Parameter name access
  - Parallel array sorting
  - Perm-gen removal
  - Date and Time API
  - Nashorn
- OpenJDK 9
  - Jigsaw
  - Other potential features

Questions?

OpenJDK

- The only 100% complete Open Source Java implementation
- Fedora and RHEL versions of OpenJDK 6 and OpenJDK 7 fully pass TCK6 and TCK7 respectively
- Basis of the proprietary Oracle JDK (95% shared code)
- Default Java implementation in Fedora, Red Hat Enterprise Linux, Ubuntu, SuSE and numerous other Linux distributions

OpenJDK Contributors



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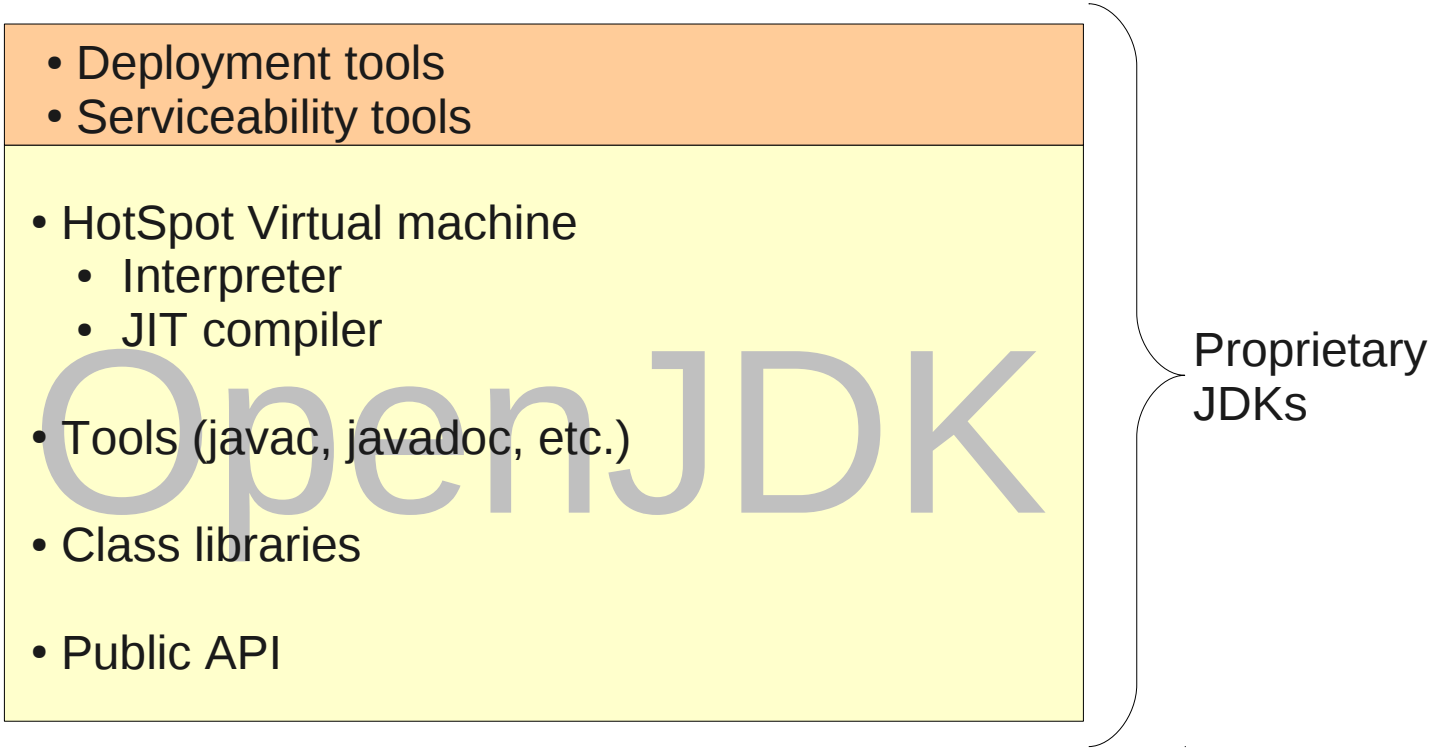
Proprietary JDKs vs OpenJDK



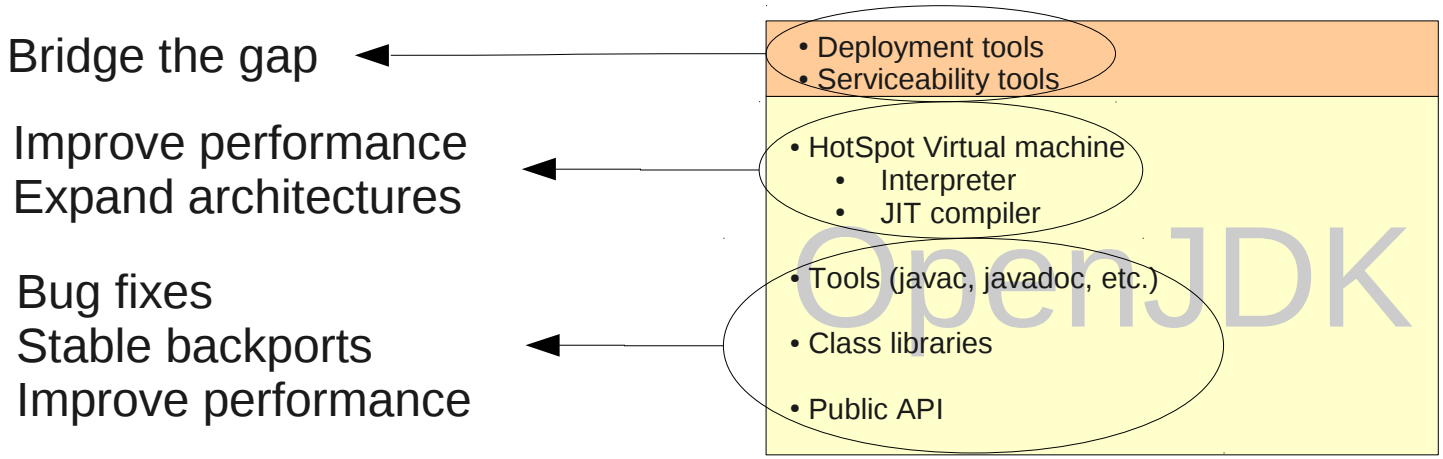
Red Hat and the Java platform

- Heavily invested in OpenJDK
- We want to make OpenJDK one of the top development platforms by means of:
  - Ensuring that customers receive full support for their deployments
  - Ensuring that Java is ready to handle tomorrow's computing needs
  - Ensuring that Java is ready to run on next generation hardware
  - Doing all of the above while balancing security, reliability, and feature set

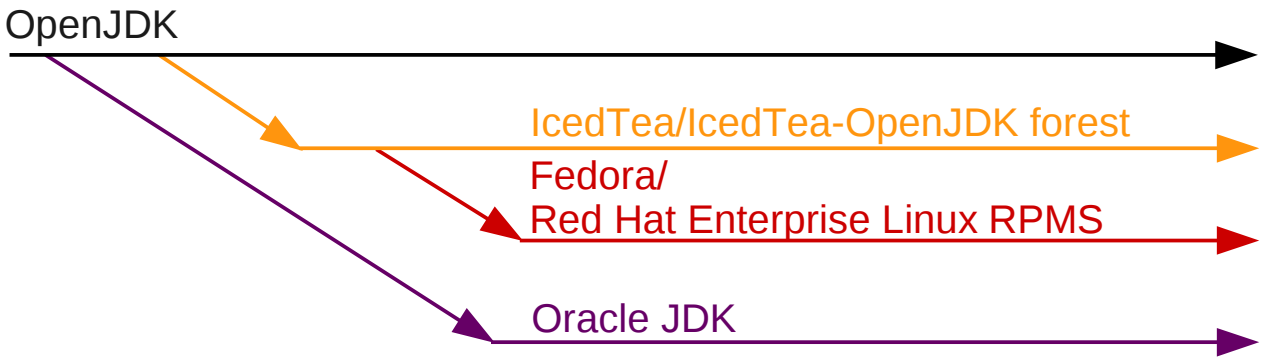
Red Hat's current focus

Support

+



Support (distribution)

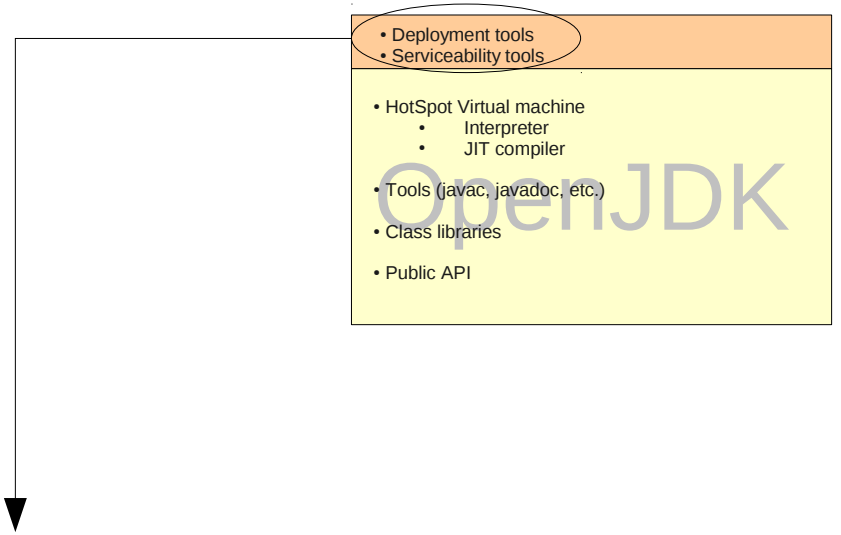


- Red Hat accounts for 80+% contribution to IcedTea/IcedTea-forest (on top of base OpenJDK)
- Red Hat accounts for 100% contribution to Fedora/RHEL packaging
- Early previews: OpenJDK 8 in Fedora 19

Support (OpenJDK 6)

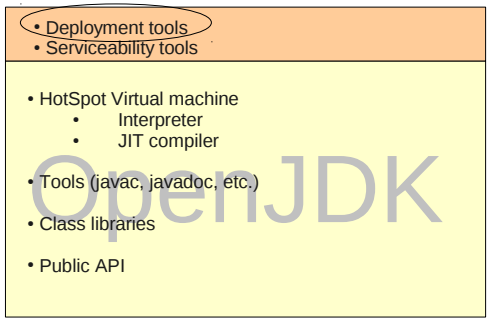
- Red Hat is now the global lead for OpenJDK 6
- Took over after Oracle EOLd it in February 2013
- OpenJDK 6 is in maintenance mode, all security fixes and major bug fixes are applied regularly

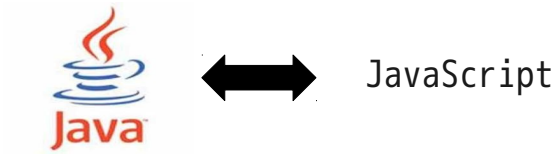
Bridging the gap



Deployment: IcedTea-Web
Serviceability: Thermostat

IcedTea-Web





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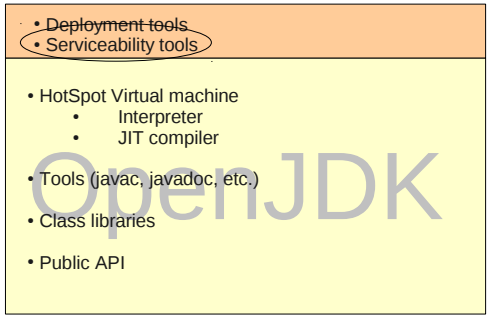
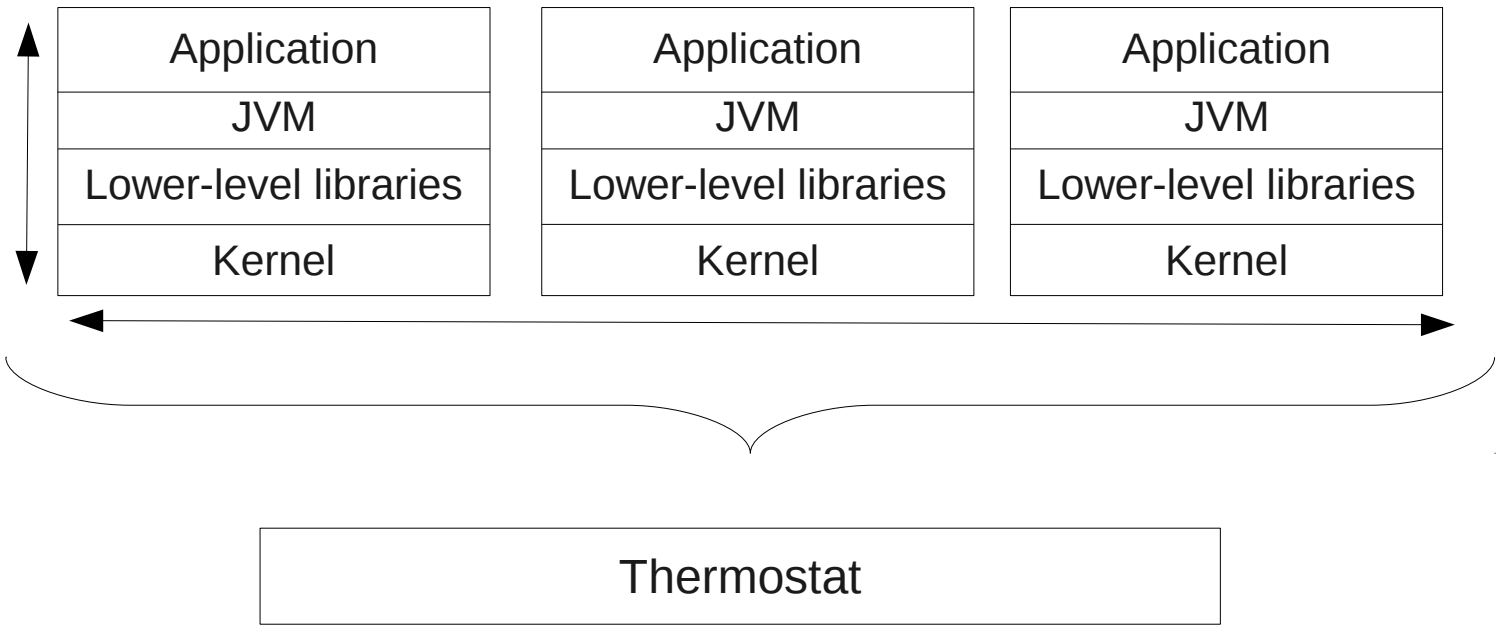
IcedTea-Web

- 1.3 and 1.4 released over the past 12 months
- Numerous bug fixes
- Improved Epiphany and Midori support
- Numerous new features including:
  - Splash screen, with GUI error reporting
  - Bi-directional cookie support
  - Removed GTK reliance
  - Compact download indicator
  - JVM selection option
  - Enhanced security settings dialog
  - And much more...

Thermostat





Thermostat

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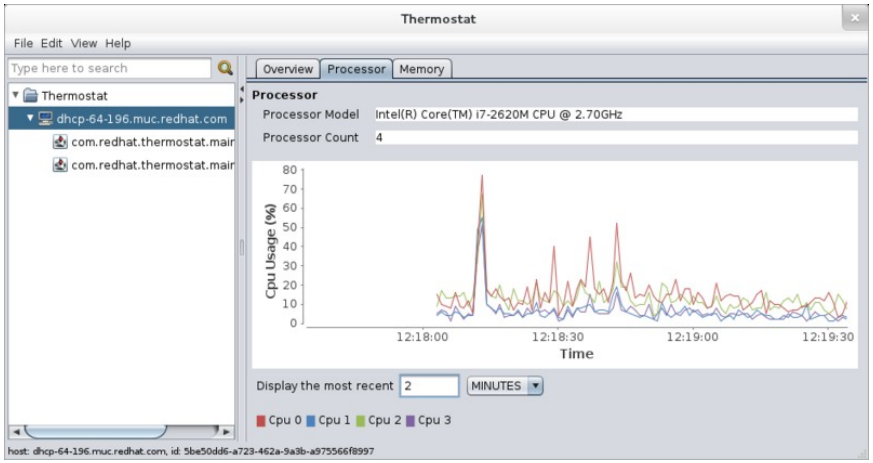

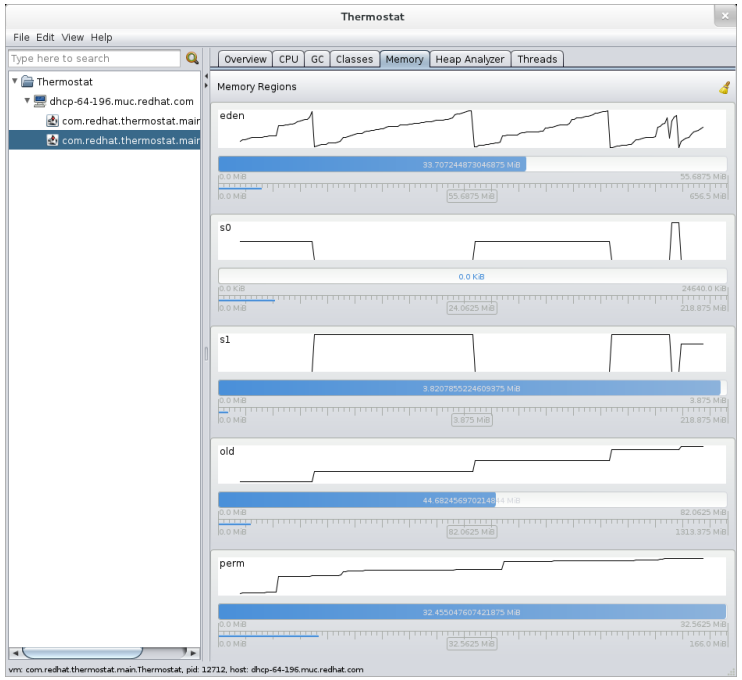

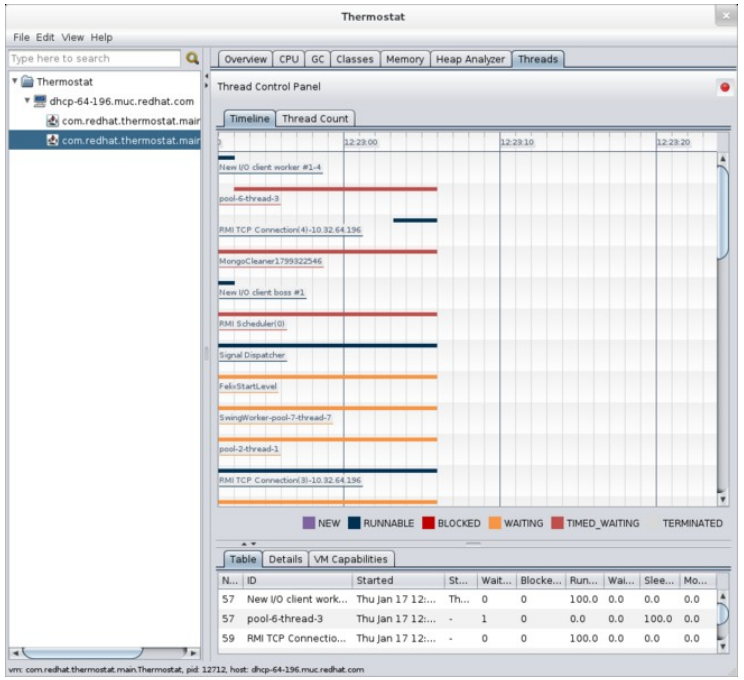

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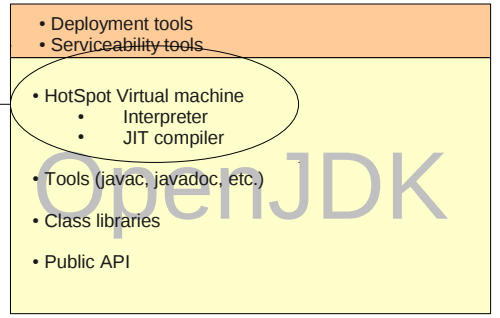
Thermostat

CLI interface for scriptability

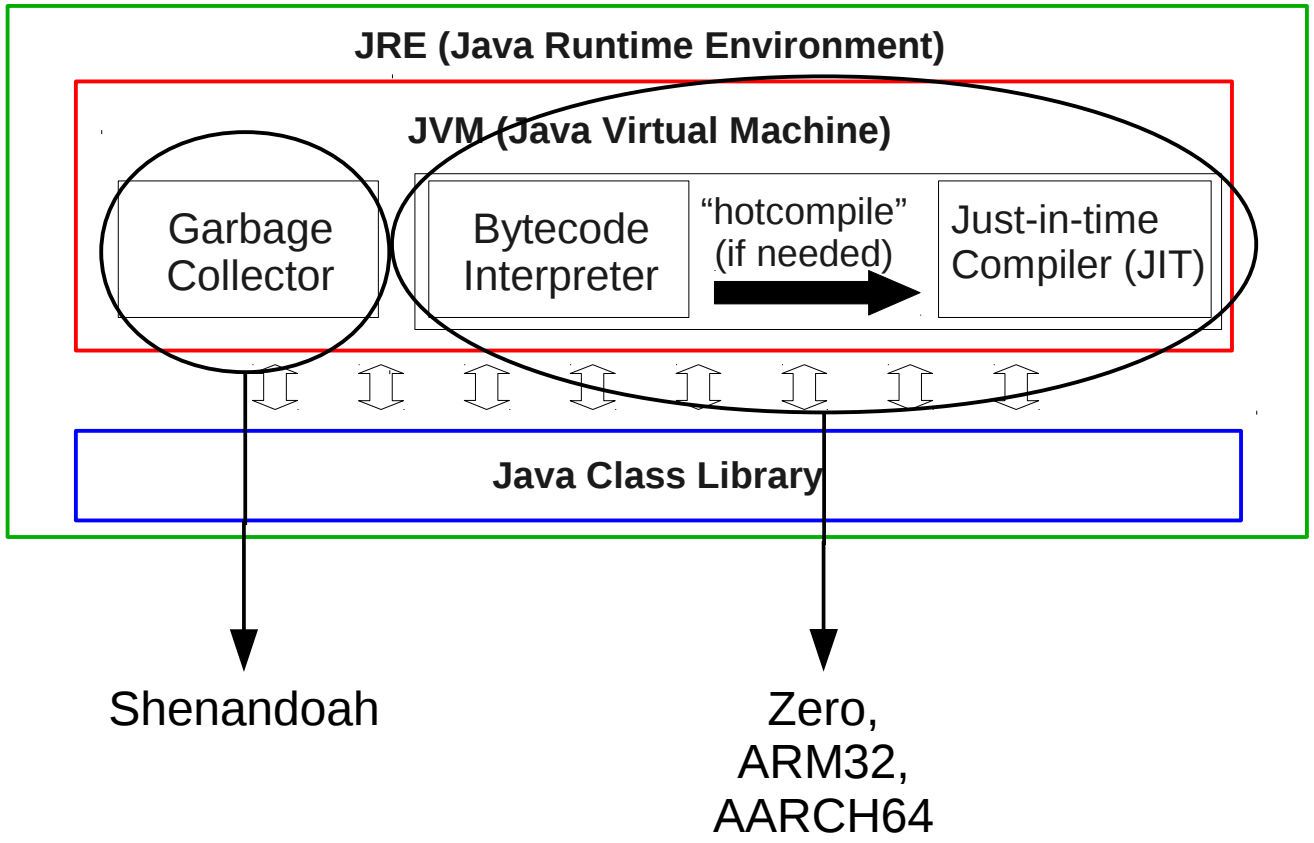
```
Thermostat > object-info --objectId 0x6e5f9dc08 --heapId a952ab0d-2330-46da-a954-
f740361c1cae-2821-1370620094485

Dump file created Fri Jun 07 11:48:13 EDT 2013
Resolving 124623 objects...
Chasing references, expect 24 dots.......................
Eliminating duplicate references.......................
Object ID:      0x6e5f9dc08
Type:           java.net.URL
Size:           104 bytes
Heap allocated: true
References:
                [??] -> java.lang.Class@0x6e5dea4f8
                [field handler] -> sun.net.www.protocol.jar.Handler@0x6e5f62858
                [field path] -> java.lang.String@0x6e5f9dc48
                [field authority] -> java.lang.String@0x6e5c118b8
                [field path] -> java.lang.String@0x6e5f9dc48
                [field authority] -> java.lang.String@0x6e5c118b8
                [field protocol] -> java.lang.String@0x6e5c50360
Referrers:
                sun.misc.URLClassPath$JarLoader@0x6e5f9dbd8 -> [field base]

Thermostat > _
```

Improve performance, Expand architectures

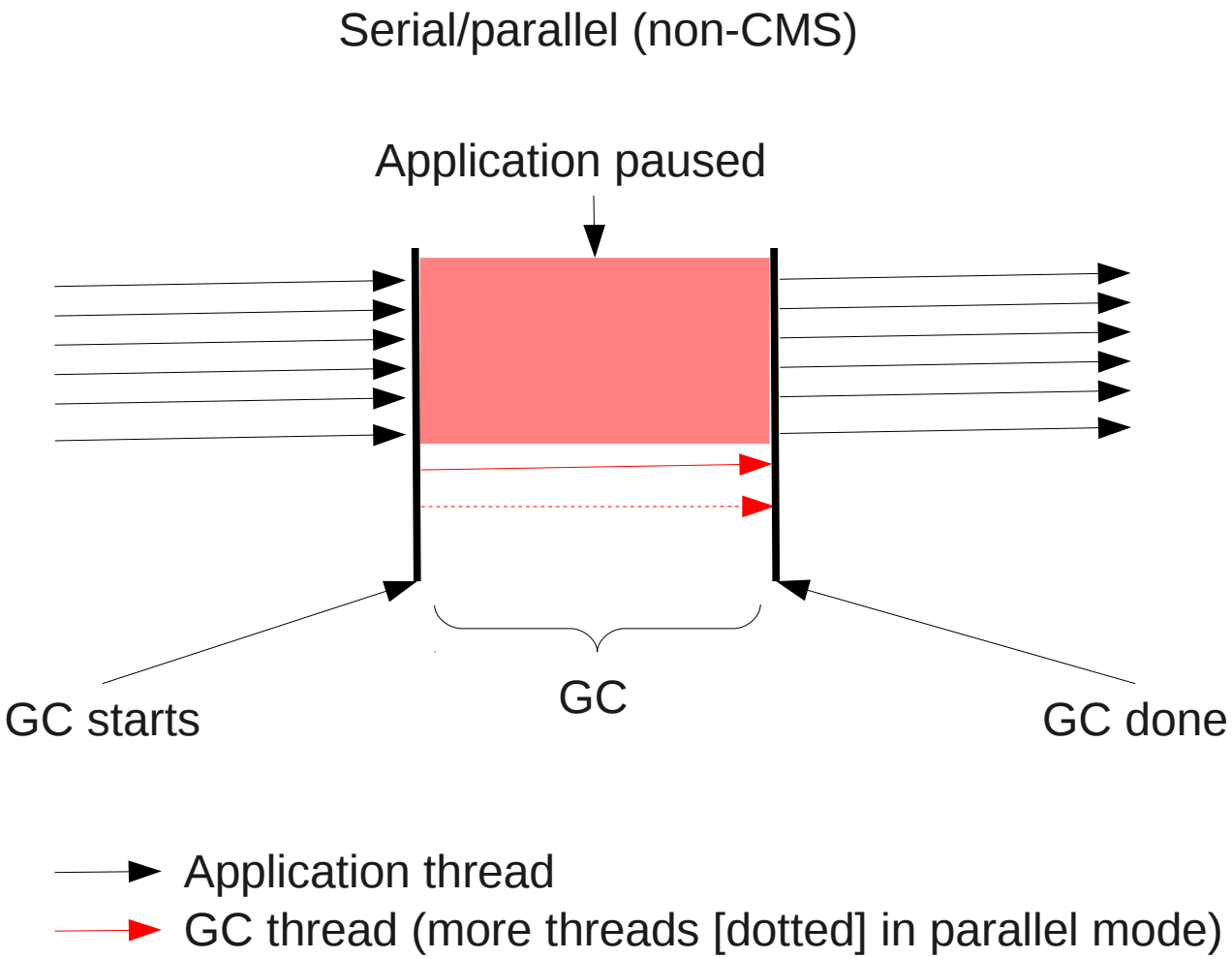


Performance: New GC: Shenandoah
Expand platforms: Zero, ARM32, AARCH64

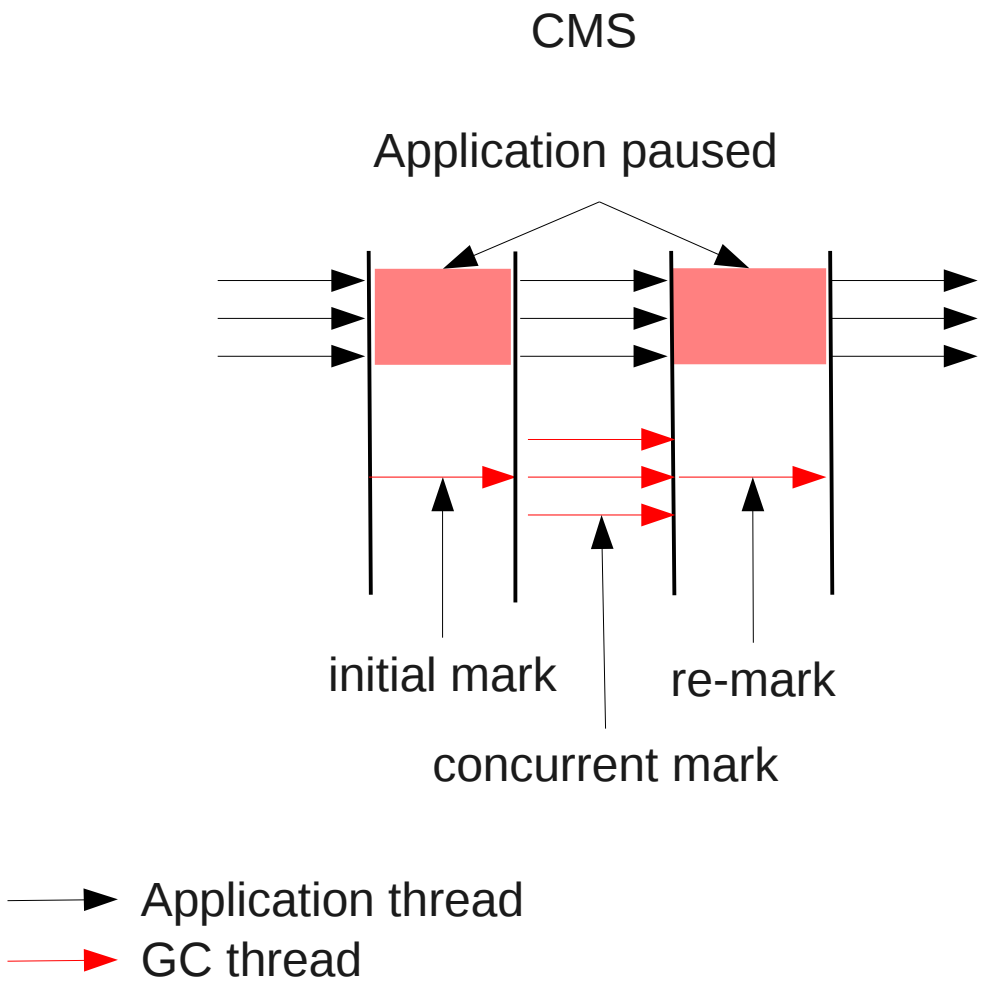
Improve performance, Expand architectures



Current Garbage Collectors



Current Garbage Collectors



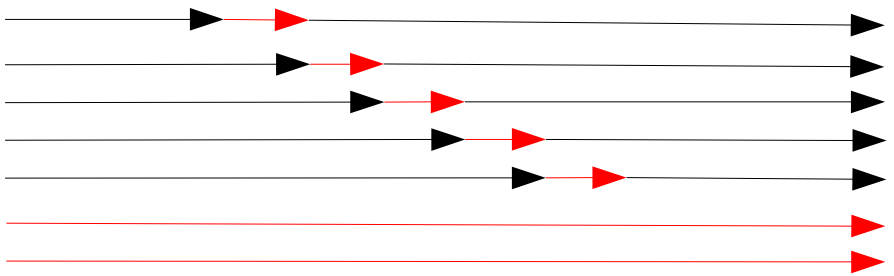
Current Garbage Collectors

G1

- Replacement for CMS
- Parallelizes operations like CMS
- Divides memory into regions and sacrifices some memory (book-keeping) to track region liveness
- Tries to free regions with mostly dead objects
- Performs compaction regularly, unlike CMS
- Like CMS, subject to stop-the-world pauses
- Targets heaps 6+GB, with 500ms pause time*

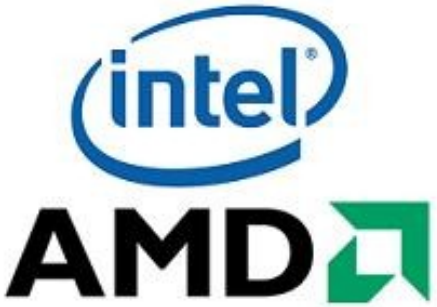
* http://docs.oracle.com/javase/7/docs/technotes/guides/vm/G1.html

Shenandoah



- Currently being developed solely by Red Hat
- Region based
- Parallel, concurrent marking
- Parallel, concurrent evacuation
- Target is 200 GB heaps with a pause time of < 10ms

Multi-arch support via Zero



Java interpreter written in C++, for any platform where GCC is available

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ARM32 JIT

- Based on an older Thumb2 JIT from ARM
- Updated to work with OpenJDK and multiple ARM CPUs by Red Hat

AARCH64

- AARCH64 is still in its infancy
- No hardware available yet
- Very different from current gen ARM (unlike x86_64 vs x86)

http://www.arm.com/images/AARCH64.jpg

AARCH64

- Need a solution in place by the time hardware rolls out
- Red Hat is leading the OpenJDK AARCH64 port
- Template interpreter is reasonably complete*
- C1 core functionality done*
- C2 core operations now working*
- C2 optimization is the next major target

** Since hardware is not yet available, completion is measured against a simulator written based on the official AARCH64 specification*

Upcoming features in Java

Feature ↓ … Java version →	Java 8	Java 9
JSR-335: Lambda	●	●
JSR-335: Bulk Data operations	●	●
JSR-308: Java Type Annotations	●	●
JEP-118: Access to parameter names at runtime	●	●
JEP-103: Parallel Array Sorting	●	●
JEP-122: Perm-gen removal	●	●
JSR-310: Date and Time API	●	●
JEP-174: Nashorn	●	●
JSR-294: Jigsaw		●
Large heap support (Shenandoah?)		●

Java 9 features are subject to change as they are under heavy development

Highlights – Java 8

JSR-335: Project Lambda

- Closures for Java
- Will help get rid of many anonymous classes
- Simple interface that requires no changes to existing declarations
- Non-final variables can be captured
- No more confusion around what "**this**" refers to
- Will also introduce default methods (which will allow interface extension without breaking compatibility)
- Syntax:

```
Runnable r = () -> System.out.println("Hello World");
```

  - Above will initialize an instance of runnable such that its run() method prints "Hello World"

Highlights – Java 8

JSR-335: Bulk data operations

- Will leverage lambda
- Provide new collection methods to parallelize operations
- e.g.

```
Object o = findFirstNotNull(l);
public Object findFirstNotNull(List l) {
      for (Object o: l) {
            if (o != null) {
                  return o;
            }
      }
}
```

```
Object o = findFirstNotNull(l);
public Object findFirstNotNull(List l) {
      l.stream().
            filter(o -> o != null).
            findFirst();
}
```

```
Object o = l.stream().filter(o -> o != null).findFirst();
```

Highlights – Java 8

JSR-308: Type Annotations

- Allows usage of annotations in more places, including generic types. For example:
  - `List<@NotNull String> l = new ArrayList<String>();`
- Backward compatible (by writing annotations in comments)

Highlights – Java 8

JEP-118: Access to parameter names at runtime

- Currently parameter information is available via a fragmented API
- Current API is not reliable
- Goal is to provide a reliable API that provides detailed parameter information

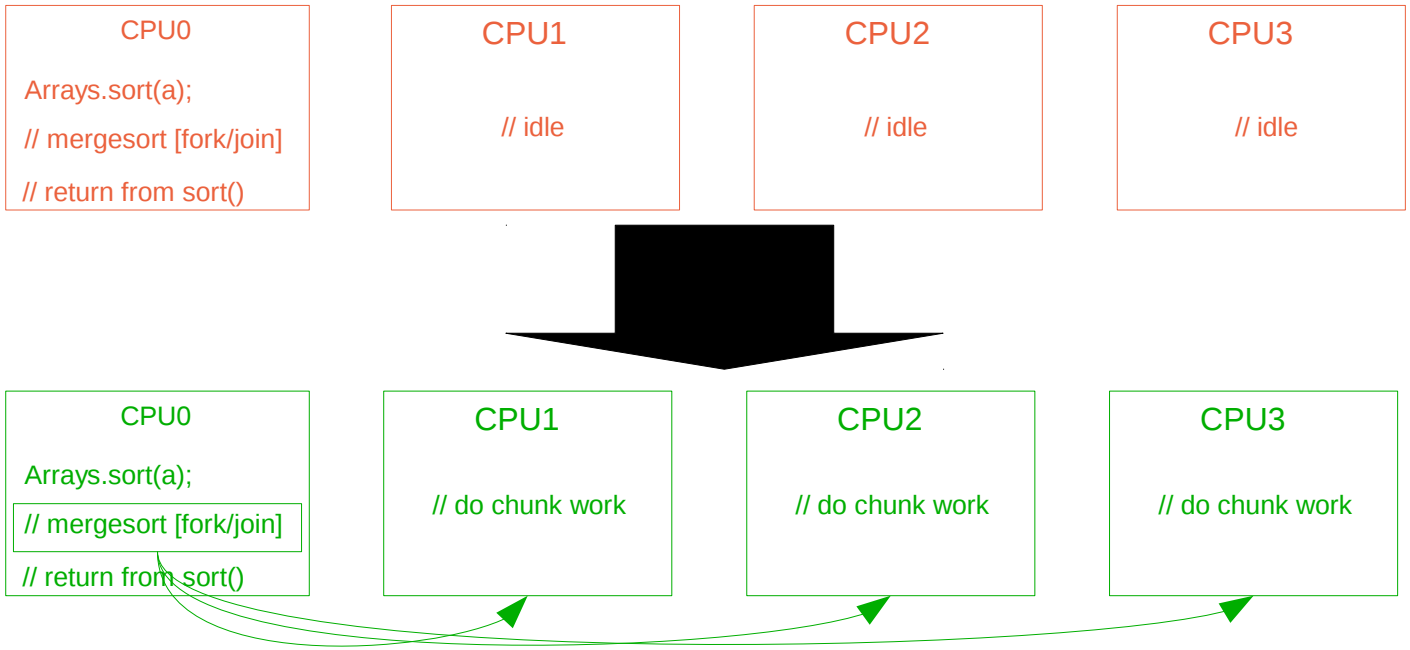
```
public void printParameterInfo(Method m) {
      for (int i=0; i < m.getParameterTypes().length(); i++) {
            // No way to get name
            System.outprintln(m.getParameterTypes()[i]); //type
            for (int j=0; j < m.getParameterAnnotations[i].length(); j++) {
                  System.outprintln(m.getParameterAnnotations[i][j]);
            } // annotations
      }
}
```

```
public void printParameterTypesInfo(Method m) {
      for (Parameter p: m.getParameters()) {
            System.out.println(p.getName()); // name
            System.out.println(p.getType()); // type
            for (Annotation a: p.getAnnotations) {
                  System.outprintln(a);
            } // annotations
      }
}
```

Highlights – Java 8

JEP-103: Parallel Array Sorting

- Current sort method is sequential, doing work in the caller thread
- Currently unable to leverage multi-core CPUs efficiently
- Java 8 will use the new Fork/Join framework to parallelize Array sorting and leverage multiple cores/cpus



Highlights – Java 8

JEP-122: Perm-gen Removal

- Perm-gen stores class metadata
- Once set up during VM initialization, it cannot be expanded
- An issue for VMs that run for a long enough time
- Interned strings moved to heap
- Class metadata and others moved to “metaspace”

Highlights – Java 8

JSR-310: Date/Time API

- A comprehensive API to handle Date/Time related functionality
- Flexible representations of various combinations of Date/Time:
  - Date and Time
  - Date only
  - Time only
- Instants
- Durations
- Clearer representation of Timezone's, UTC offsets, etc.
- And much more!

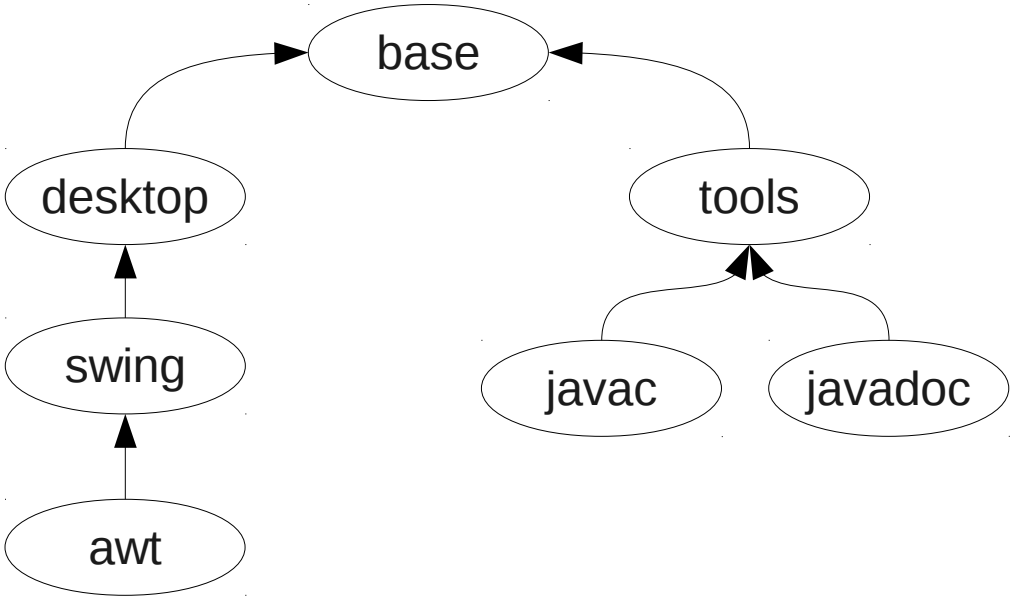
Highlights – Java 8

JEP-174: Nashorn

- JavaScript (JS) engine for the JVM that leverages JSR-292
- Will allow JS access through Java code
- Significantly improved performance over Rhino
- New tool (`jjs`) to allow command-list scripting/script launching
- Supports JSR-223 (javax.script/Scripting Engine for Java)

Highlights – Java 9

JSR-294: Jigsaw



Example to illustrate how Jigsaw can potentially break down components

Highlights – Java 9

- Other potential features:
  - Large heap support
  - Multi-tenancy support
  - Tail call optimizations
  - re-ification

Questions?

OpenJDK: http://openjdk.java.net/
IcedTea: http://icedtea.classpath.org/
IcedTea-Web: http://icedtea.classpath.org/wiki/IcedTea-Web
Thermostat: http://icedtea.classpath.org/wiki/Thermostat

IcedTea Bugs: http://icedtea.classpath.org/bugzilla/
RHEL/Fedora bugs: http://bugzilla.redhat.com

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