An introduction to **Java 9**

How can your applications benefit from Java 9?

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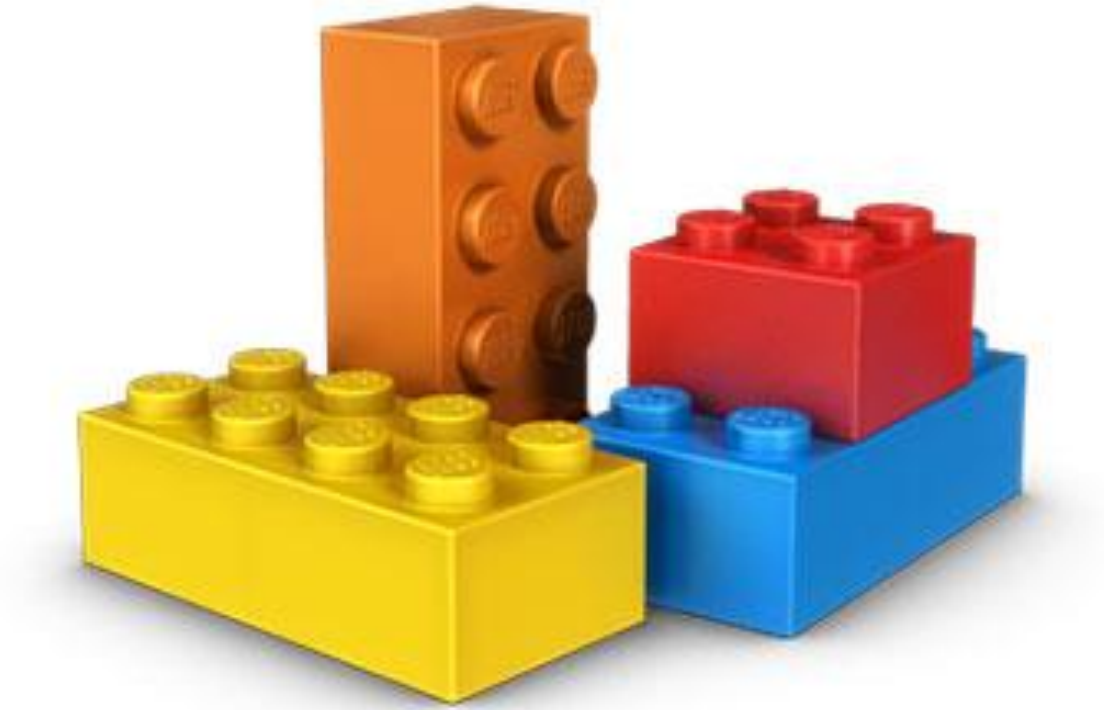
Java 9

The most important feature:

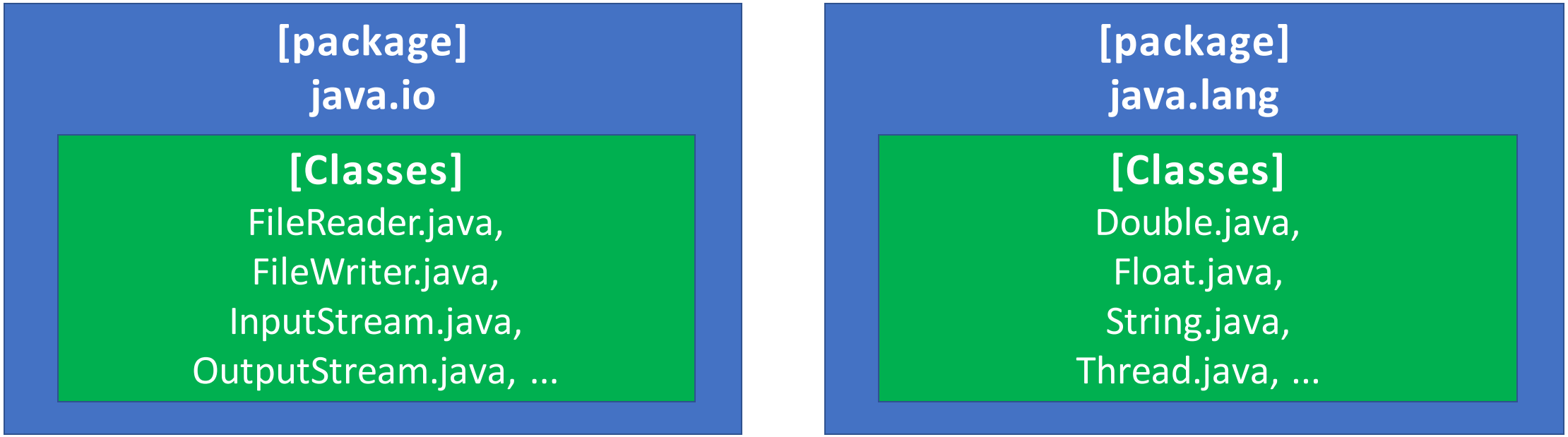
Modules!



What is a **package**?

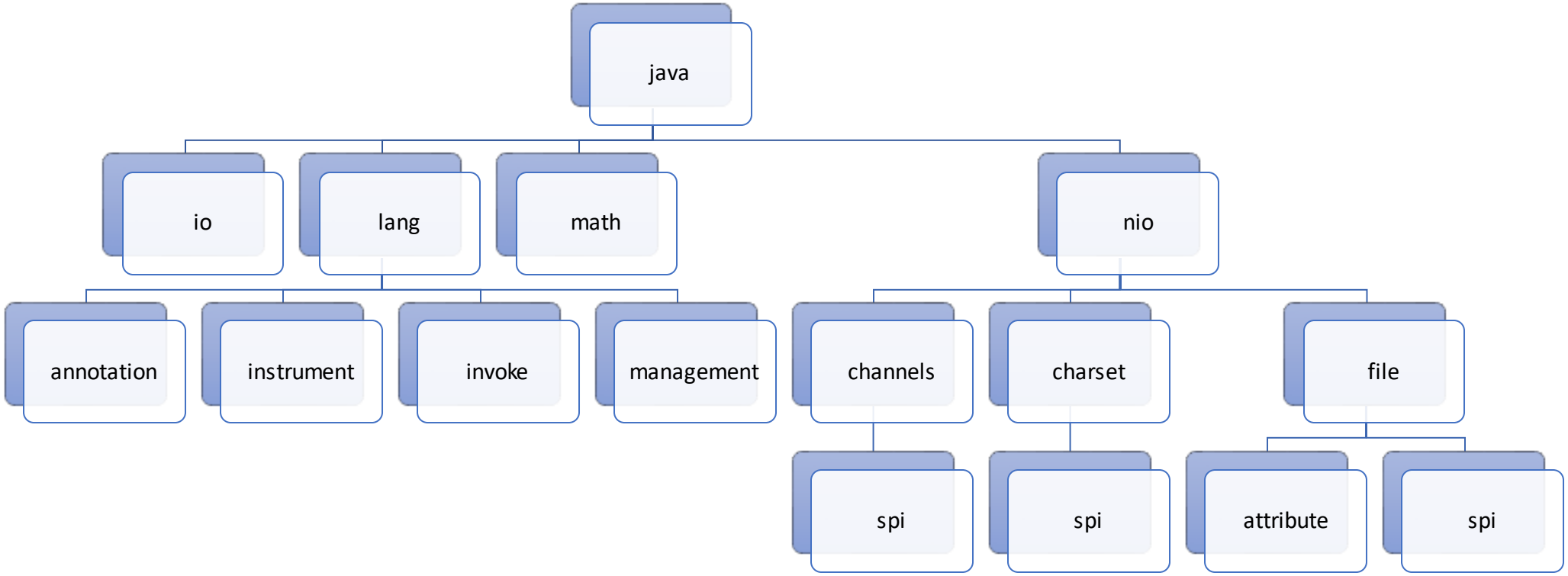
A package is a set of classes

- **Packages** are used to organize **classes** & **interfaces**



Quiz: How many **packages** does **JDK 8** have?

A. 67 B. 117 **C. 217**

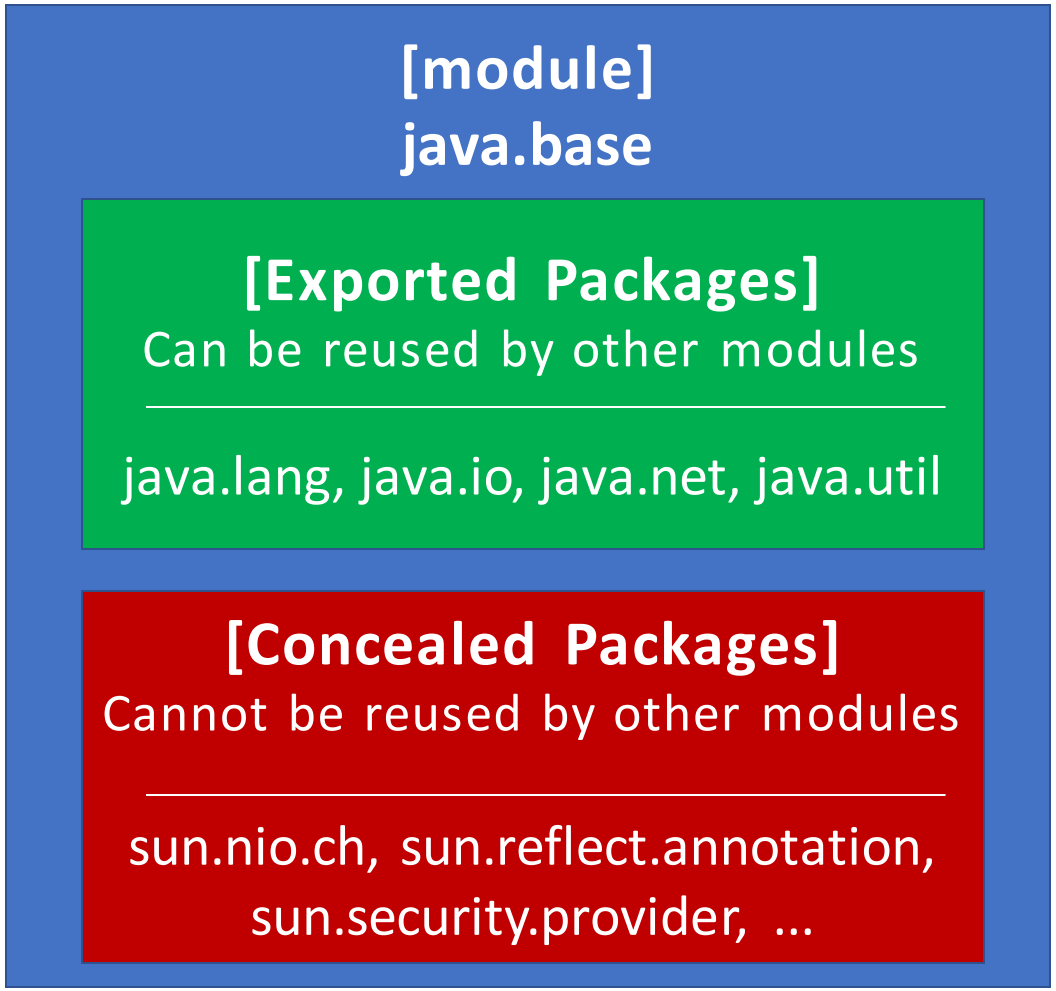


Challenges faced by Java engineers

- How do the classes of those 217 packages *interact* between them?
  - A public class is *accessible* by every other class, in any other package.
  - *Tight coupling* makes it too difficult to introduce changes, resulting in increased development & testing costs.

- Can we create *groups of packages*, controlling how they *interact* between them?

Java 9: What is a **module**?

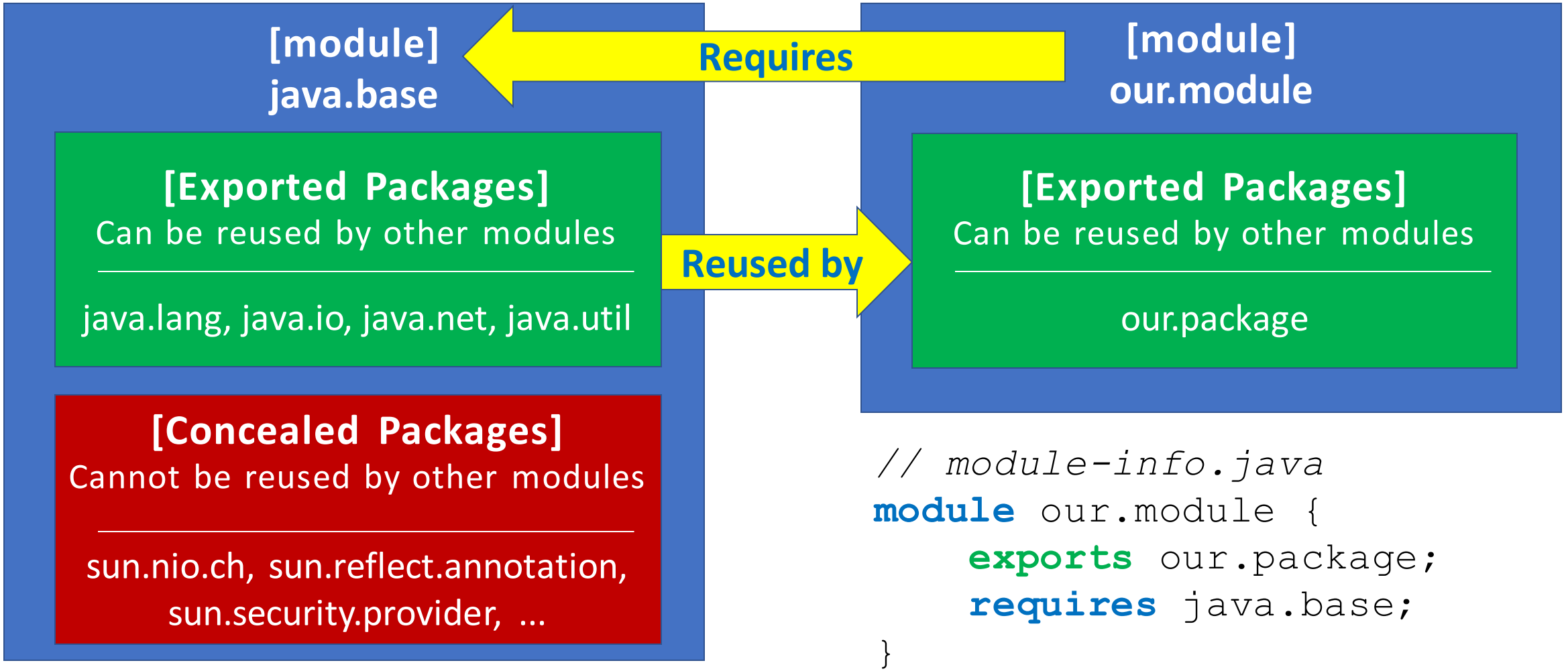


A module is a set of packages

… designed for reuse

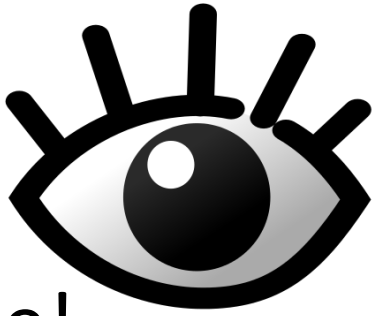
```
// module-info.java
module java.base {
    exports java.lang;
    exports java.io;
    exports java.net;
    exports java.util;
}
```

Reusing packages from another **module**




```
// module-info.java
module our.module {
    exports our.package;
    requires java.base;
}
```

Using modules to **control access**



- In Java 9, a public class may not be *visible* to everyone!

- A public class in *our.package* may be:

```
module our.module {
  exports our.package;
}
```

Accessible to everyone

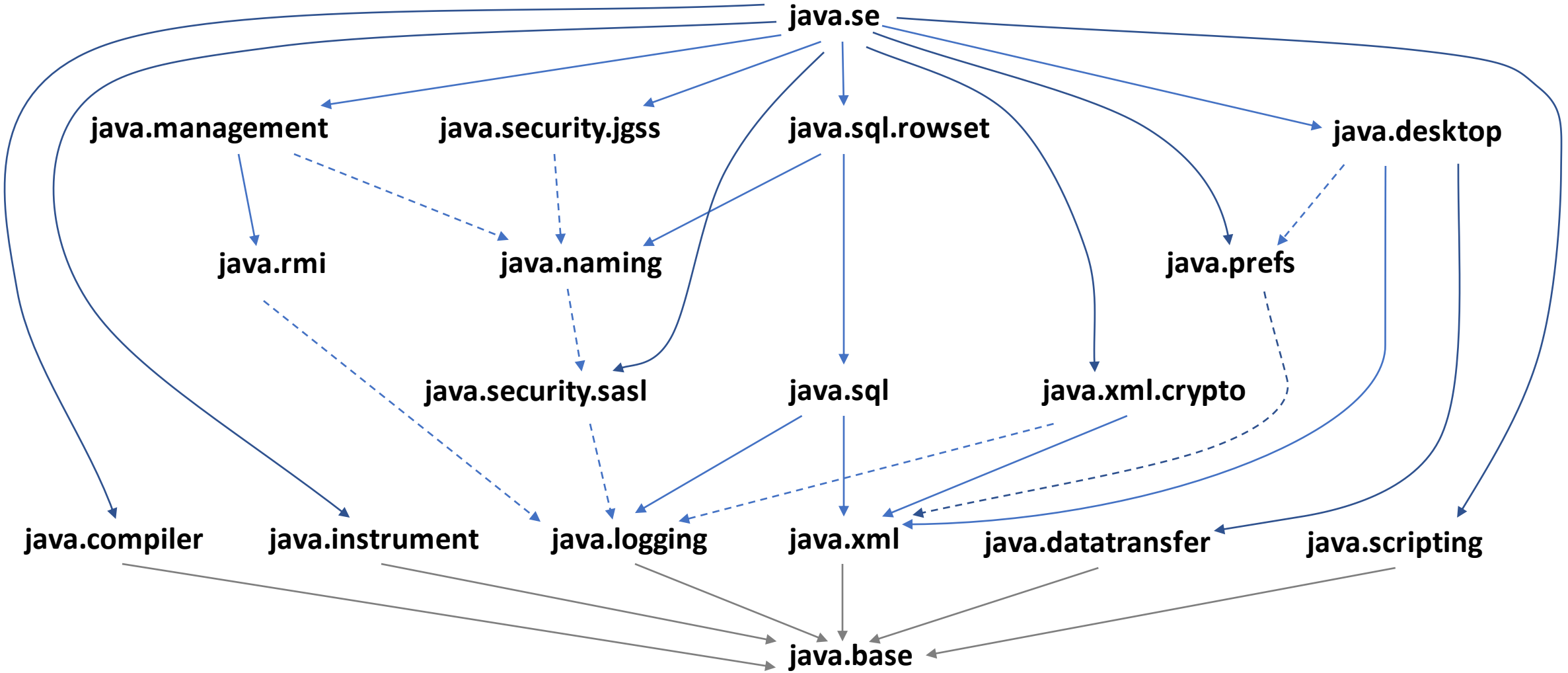
```
module our.module {
  exports our.package
    to friend.module;
}
```

Accessible to other classes in our module & a friend module

```
module our.module {
}
```

Accessible only to other classes in our module

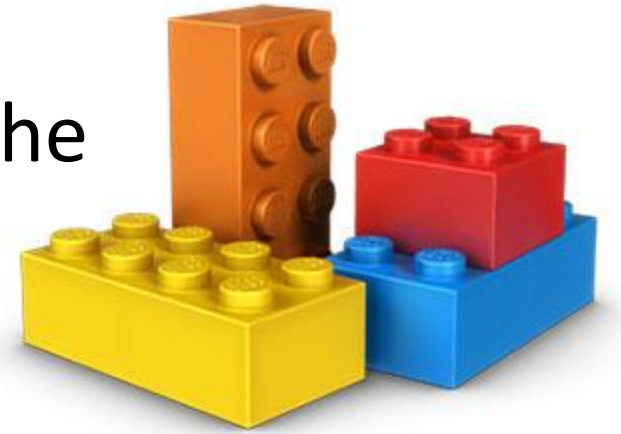
Modularizing Java 9



Tailoring the JRE to fit **our** needs

- Are you worried about the **size** of the JRE?
- Are you building:
  - Embedded, or
  - Containerized applications?
- If yes, then *you* can **minimize** *your* JRE:
  - By deploying **only** the JRE modules that **you** need!

Using the **Java Linker** to minimize our JRE



- Let's suppose that our application needs only the **java.base** module:

```
jlink --module-path /opt/jdk-9/jmods
      --add-modules java-base
      --output /out/jdk-9-base
```

- As demonstrated here, the size of a Docker image of Alpine Linux & JRE 9 is reduced:
  - From: 356MB (JRE with all modules)
  - To: 37MB (JRE with **java.base** module only)

How can your apps benefit from modules?

- Enhanced security, through *strong encapsulation*.

- Performance is improved:
  - only the required JRE modules may be loaded.
  - the classloader does not have to linearly search through all the JARs in the classpath, in order to find a class.

Creating collections made easy in Java 9!

- How would you create a small, unmodifiable collection?

```
Set<String> set = new HashSet<>();
set.add("a");
set.add("b");
set.add("c");
set = Collections.unmodifiableSet(set);
```

≤ Java 8

- *List*, *Map*, and *Set* interfaces are enhanced in Java 9 with static factory methods *"of"*:

```
Set<String> set = Set.of("a", "b", "c");
```

Java 9

Creating collections made easy in Java 9!

- More examples:

```
List<String> list = List.of("m", "e", "s");
Map<String, Integer> map = Map.of("e", 5, "s", 1);
```

Collections are immutable!

- What about *Maps* with more than 10 elements?

```
Map<String, Integer> map = Map.ofEntries(
                                entry("a", 1),
                                entry("b", 2),
                                    …
                                entry("z", 26));
```

… cannot add/delete elements

- For *Sets*, and *Maps* the iteration order is randomized!

Java 9: Changes to Garbage Collectors (GC)

- ***Garbage-First (G1)*** becomes the **default** Garbage Collector.
  - Previously, the default one was the **Parallel** GC.
- *Concurrent Mark Sweep (CMS) GC* becomes deprecated.
- How will those changes affect your existing application?

What does your application aim for?

- Low Latency: Responding *quickly*, in *short periods of time*.
  - e.g. when serving a web page, or returning a database query.

  or

- High Throughput: Maximizing the *amount of work* done in a given time frame.
  - e.g. number of database queries completed in 1 hour.

Tuning the performance of your application

- As Java programmers, we don't need to manage memory:
  - We *allocate* memory for an object with *new*:

```
String meetup = new String("jhug");
```

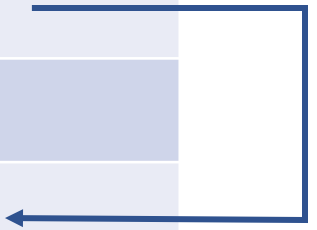
  - This memory will be *automatically deallocated* by the Garbage Collector, when it is no longer in use.

- How do we tune the *performance* of an application?
  - Heap: by properly sizing the heap (the memory area where all the object data is stored).
  - Garbage Collector: by choosing the most appropriate GC, usually optimized for *Low Latency* or *High Throughput*.

Moving to a Low-Latency Garbage Collector

- Garbage Collectors in Java 9:

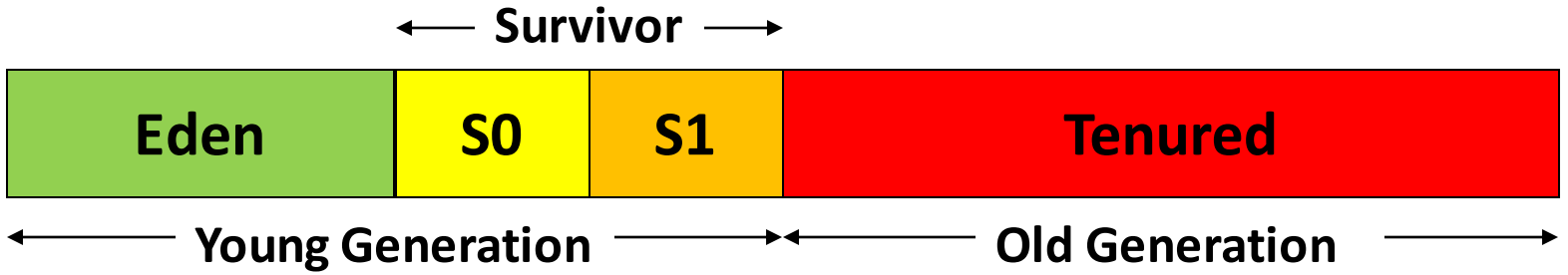
Java 9	Garbage Collector	Optimized for
	Serial	Memory footprint
(Ex-Default)	Parallel	High Throughput
Deprecated	Concurrent Mark Sweep	Low Latency
Default	Garbage First / G1	Low Latency



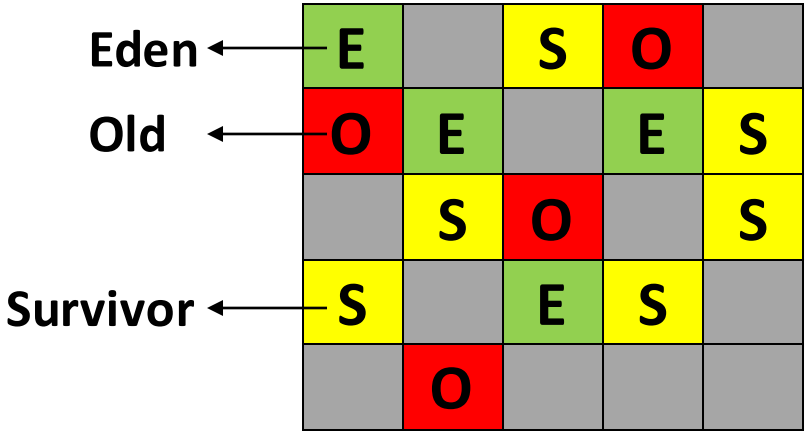
- Moving from a *Throughput-oriented* GC (Parallel) to a *Low-Latency* GC (Garbage First/G1).

G1 Garbage Collector

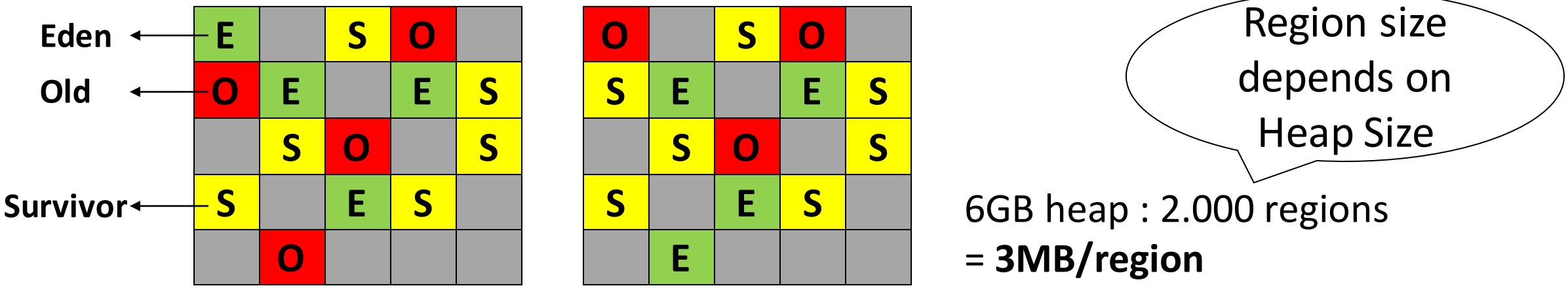
- In Serial/Parallel/CMS GC, the Heap is divided into ***2 regions*** (=Young & Old Generation) of ***fixed*** size.



- In G1 GC, the Heap is divided into ***multiple, smaller regions***.

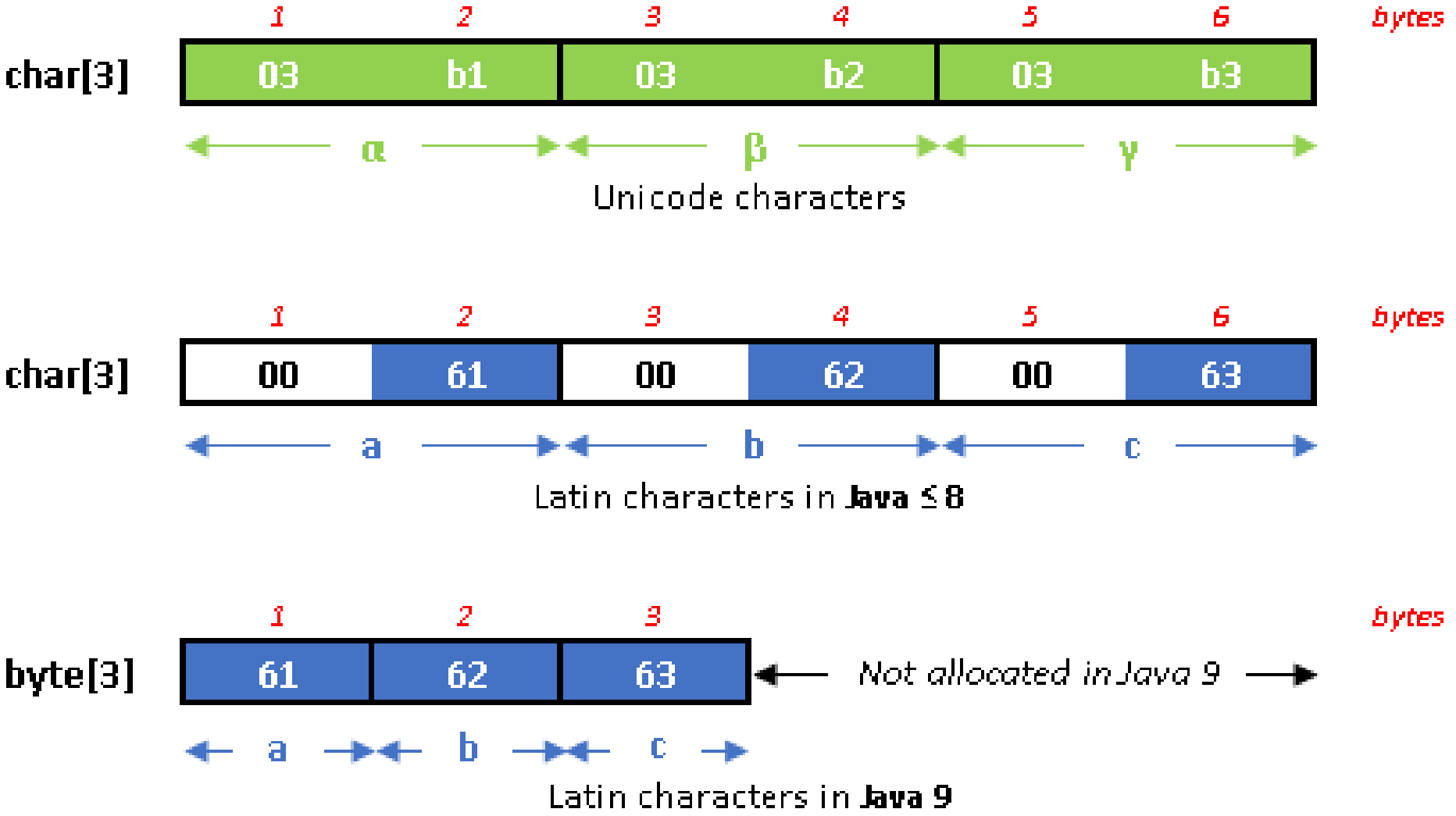


G1 Garbage Collector



- The heap is partitioned into *2.000 equal-sized **regions***:
  - Achieving a finer granularity on how much garbage to collect at each GC pause.
- Default pause goal = *200msec*
  - May be adjusted, to achieve lower latency or higher throughput.

Compact Strings (JEP 254)



Compact Strings - Will your apps run *faster*?

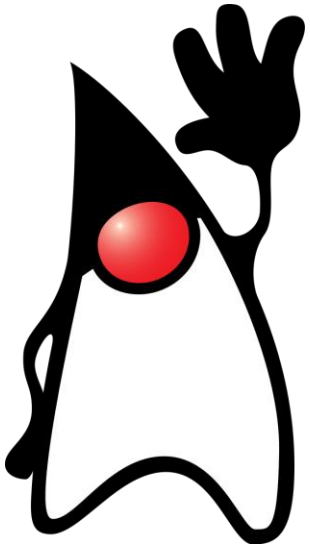
- *Allocation rate:* the amount of memory allocated per time unit, measured in MB/sec.

- Strings now have a *reduced memory footprint*, resulting in:
  → lower memory allocation rate,
  → the GC is called less frequently to clean the memory,
  → a decrease in the frequency and/or duration of pauses during GC cleanup.

- Performance improvements of *up to 10%* have been measured, as stated here.

Controlling native processes

- Ever had to control native processes from your Java app?
  - Executed OS commands (like: *'ps –ef'*), and parsed their output?



- Java 9 makes it a "piece of cake" to:
  - Get the native id of the current process:

```
long processId = ProcessHandle.current().pid();
```

  - Check if a process is currently running.
  - Retrieve information (like: start/total time) for a process.
  - Wait for termination of a process, and trigger dependent actions :

```
process.onExit().thenRun(()-> System.out.println("Done"););
```

HTTP/2 Client API

- Until Java 8, we used the `HttpURLConnection` API to establish an HTTP 1.1 connection. However:
  - It works only in blocking mode (=1 thread per request/response).
  - It is hard to use, with many undocumented behaviors.

- **Java 9** introduces a new HTTP client that supports:
  - HTTP 1.1 and **HTTP/2**,
  - a synchronous/blocking mode, and an asynchronous/non-blocking mode.

- Delivered as an *incubator* module
  - A non-final API, provided for experimentation.
  - May be finalized (or even removed!) in an upcoming Java version.

Security related enhancements

- Improved performance for *GHASH* and *RSA* cryptographic operations (JEP 246).
  - By leveraging SPARC and Intel x64 CPU instructions.
- Support for SHA-3 hash algorithms (JEP 287).
- TLS Application-Layer Protocol Negotiation (JEP244)
  - Provides the means to negotiate an application protocol over TLS.
  - Required by HTTP/2.
- OCSP Stapling for TLS (JEP 249).
  - Improves performance of TLS, by reducing the performance bottleneck of the OCSP responder.

Java Shell: Read-Evaluate-Print Loop (REPL)

- REPL - an interactive programming tool, that:
  - Loops, continuously reading user input,
  - Evaluates the input,
  - Prints the value of the input.

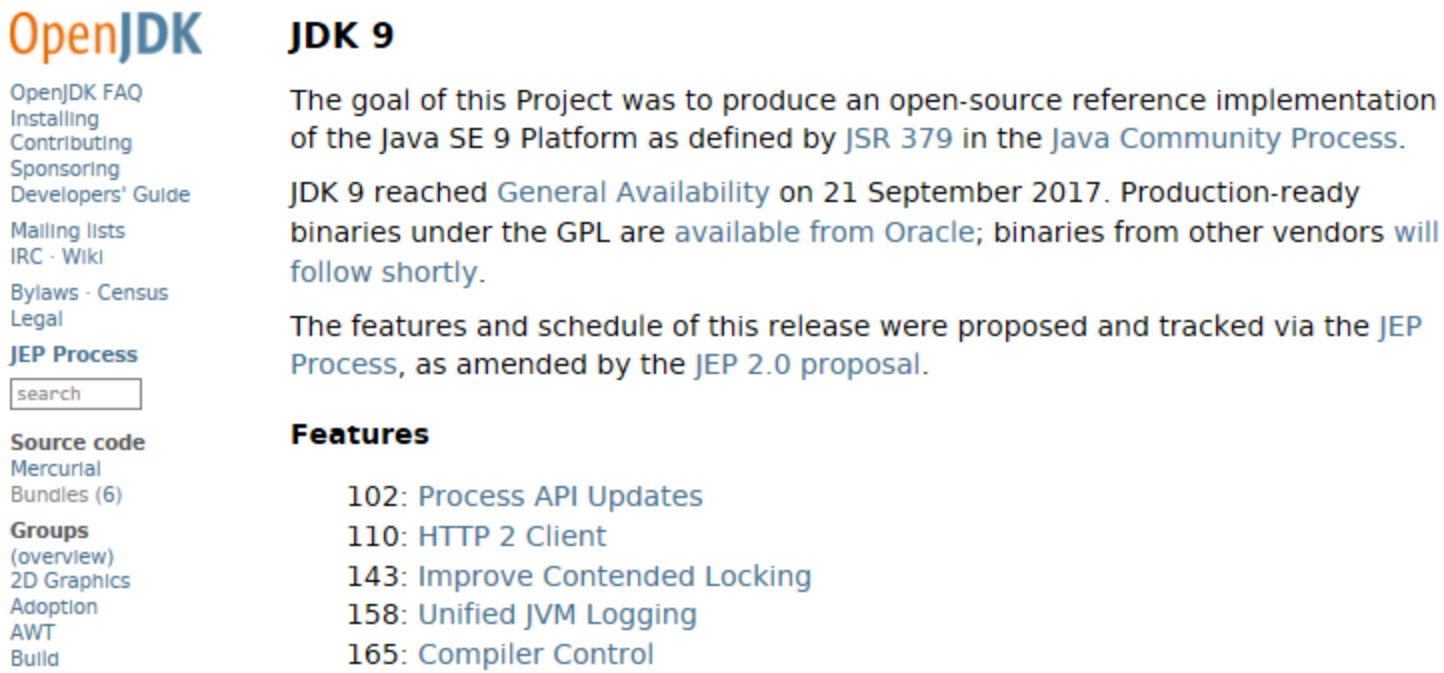
- Expected to help students learn Java, without having to *edit*, *compile*, and *execute* code.

- As developers, we can benefit from JShell by quickly:
  - Exploring new APIs or language features,
  - Prototyping something complex.

Wish to learn more about Java 9?

- For more details, check the **JEP**s (Java Enhancement Proposals) implemented in Java 9:

  http://openjdk.java.net/projects/jdk9/



References

1. JDK 9 Features
2. “Modular Development with JDK 9”, Alex Buckley, Devoxx United States
3. “Java in a World of Containers”, Paul Sandoz
4. “The G1 GC in JDK 9”, Erik Duveblad
5. “JShell is Here”, Robert Field