23. hroug
godišnja konferencija

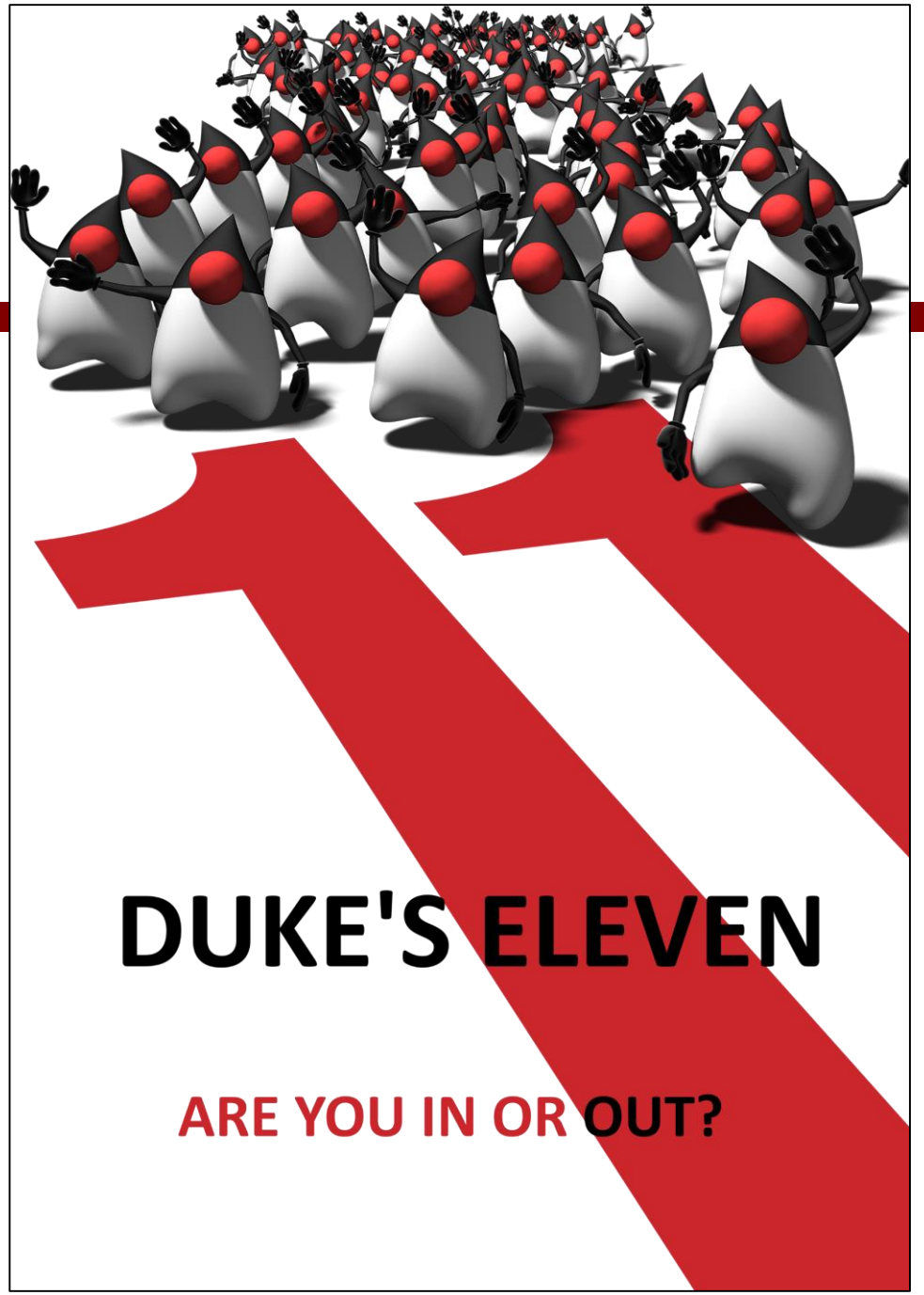
Above and Beyond
Java 9, 10, 11, 12…

dr. sc. **Branko Mihaljević**

and

dr. sc. **Martin Žagar**

HUJAK



A bit of Sentimental Journey

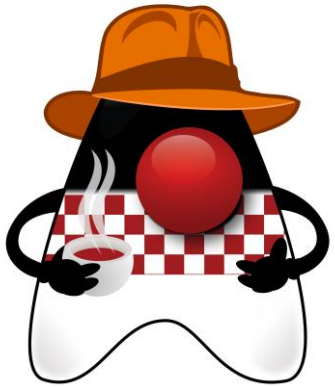
- **HUJAK** founded in **2011**
- Interested in **meetups**
  - Well, more drinkups ☺
- No one dreamed about **organizing conferences** ☺
- However, we've got some **help**… ☺

- ***… the beginning of a beautiful friendship …***

JavaCro conferences – 2012-2018

Javantura conferences – 2014-2018

Javantura



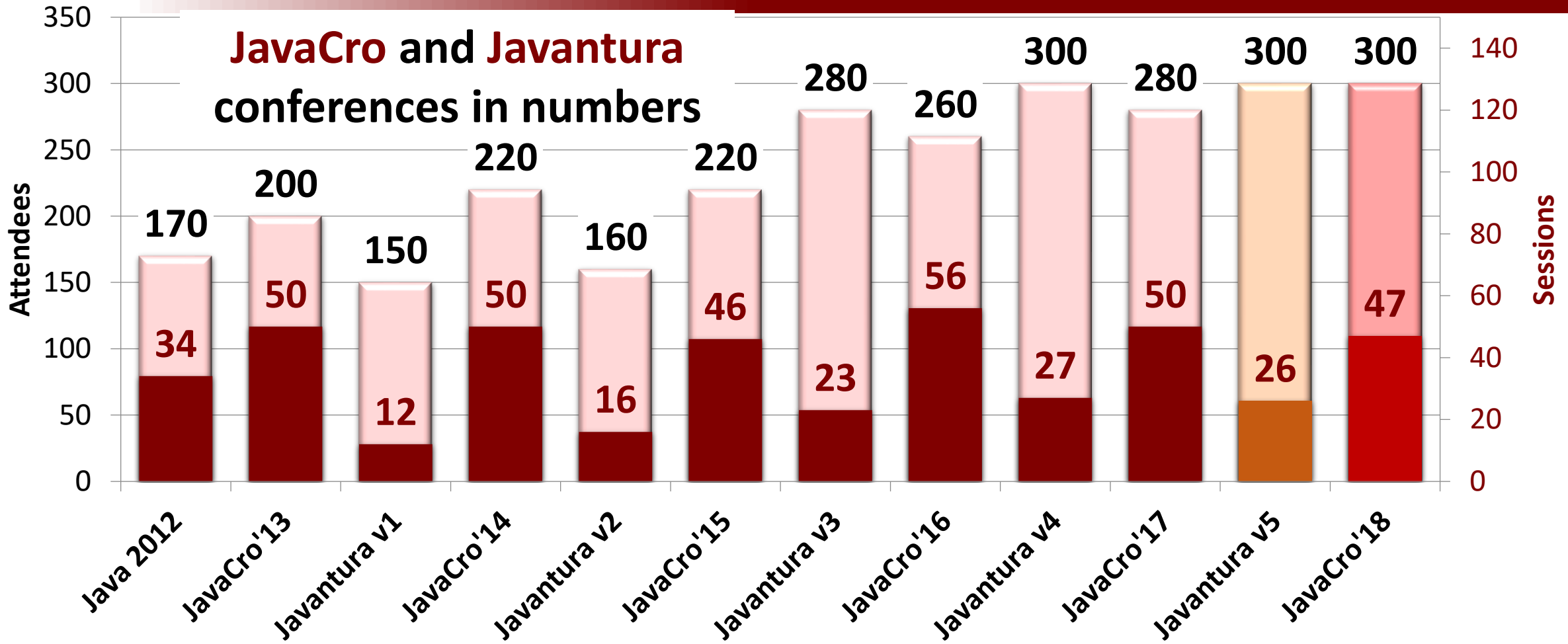
Java-related Conferences in Croatia

Conference	Location	Date	Sessions	Tracks	Attendees	Countries
JavaCro'18	Rovinj	7.-9.5.2018.	47	5	300	15
Javantura v5	Zagreb	17.2.2018.	26	3	300	-
JavaCro'17	Rovinj	10.-12.5.2017.	50	5	280	15
Javantura v4	Zagreb	11.2.2017.	27	3	300	-
HrOUG 2016	Rovinj	18.-22.10.2016.	7 (od 96)	1 (od 9)	450	11
JavaCro'16	Rovinj	18.-20.5.2016.	56	5	260	15
Javantura v3	Zagreb	20.2.2016.	23	-	300	-
JavaCro'15	Rovinj	10.-12.5.2015.	46	5	200	11
Javantura v2	Zagreb	15.11.2014.	16	-	160	-
JavaCro'14	Poreč	11.-13.5.2014.	50	5	220	11
Javantura v1	Zagreb	22.2.2014.	12	-	150	-
WebCamp 2013						-
HrOUG 2013						12
JavaCro'13						-
HrOUG 2012						13
WebCamp 2012						-
Java 2012	Tuhelj	29.-30.5.2012.	34	7	170	-
HrOUG 2011	Rovinj	18.-22.10.2011.	12 (od 96)	1 (od 9)	460	11

This is our 19th conference!!! ☺

#Javantura #JavaCro #HrOUG #proud

And we are still there ☺



OK, but let's talk about Java! ☺

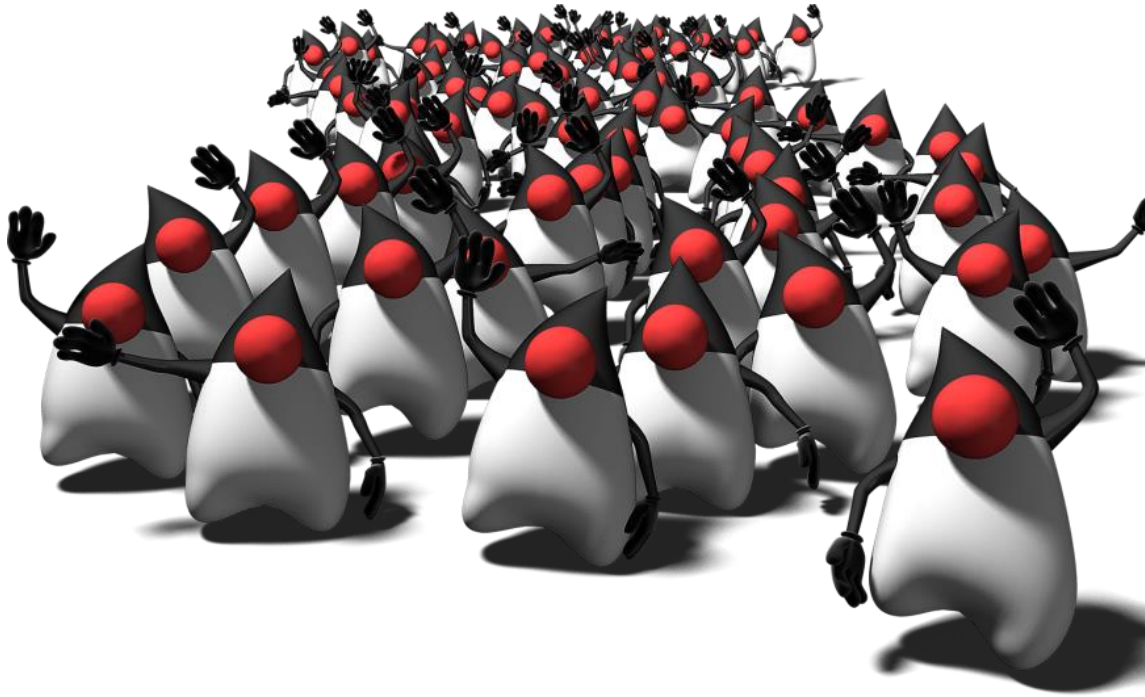
- *Before we start – some interesting facts:*
- Java does **not** stand for **Just Another Vague Acronym** ☺
- Invented almost **by accident**
  - They were building a new language for set-top box as a "cleaned up" C++ version
- Originally designed for **interactive TV** and **remote handheld devices**
  - Unfortunately, it was ahead of time
- Called **Oak** at the beginning
  - Later changed to Java because of **copyright** issues
- Java was named after a **coffee cup** slang word
  - Coffee imported from Indonesian **island** of Java (**Jawa**)

Some other interesting facts ☺

- **0xCAFEBABE** in class files is a tribute to the café
  - Where the **Green team** from **Project Stealth** went for coffee every day
- **James Gosling**, "the Father of Java", joined Amazon Web Services (AWS) team in 2017
  - After **Sun Microsystems**, Google (short), and Liquid Robotics
- **Joe Palrang**, the guy who created the Duke, also worked later on famous cartoon movies
  - The Simpsons, Shrek, Antz, Flushed Away, and Over the Hedge movies
- **JavaScript** got its name after Java
  - But only as a "marketing scam" just to make it more **popular**

So, what is… Java?

- **#1 Development Platform**
  - **Cloud**, **Microservices**, and **IoT**
- **Continued growth of Java** for **23 years**
- **A few Billion Devices** run Java
- **10 Million Java Developers** in the world
  - Many have **Java Certificates**
    - **OCA**, **OCP** & **OCM** for Java SE
    - **OCE** & **OCM** for Java EE
- **90%** of the **Fortune 500 companies** use **Java**
- But not only Java – **50+ JVM languages**
  - including Clojure, Groovy, Scala, JRuby, Jython, Fantom, Kotlin, Ceylon, Xtend, X10, LuaJ, Golo, Frege, Mirah, Eta… and JavaScript



Some Terminology

- **Java Platform, Standard Edition (Java SE)**
  - Specification of Java language, JVM, and core libraries
- **Java Development Kit (JDK)**
  - Tested (binary) implementation of Java SE
- **OpenJDK**
  - Open source reference implementation of Java SE
- **OpenJDK binary**
  - JDK built from OpenJDK source code

Current State of Java

- Are you still using Java **8**?
- Or you switched to Java **9** / **10**?
- Or the latest **Java 11**?
- What about Java **EE**?
- Well… let's explain

Java Platform today is:

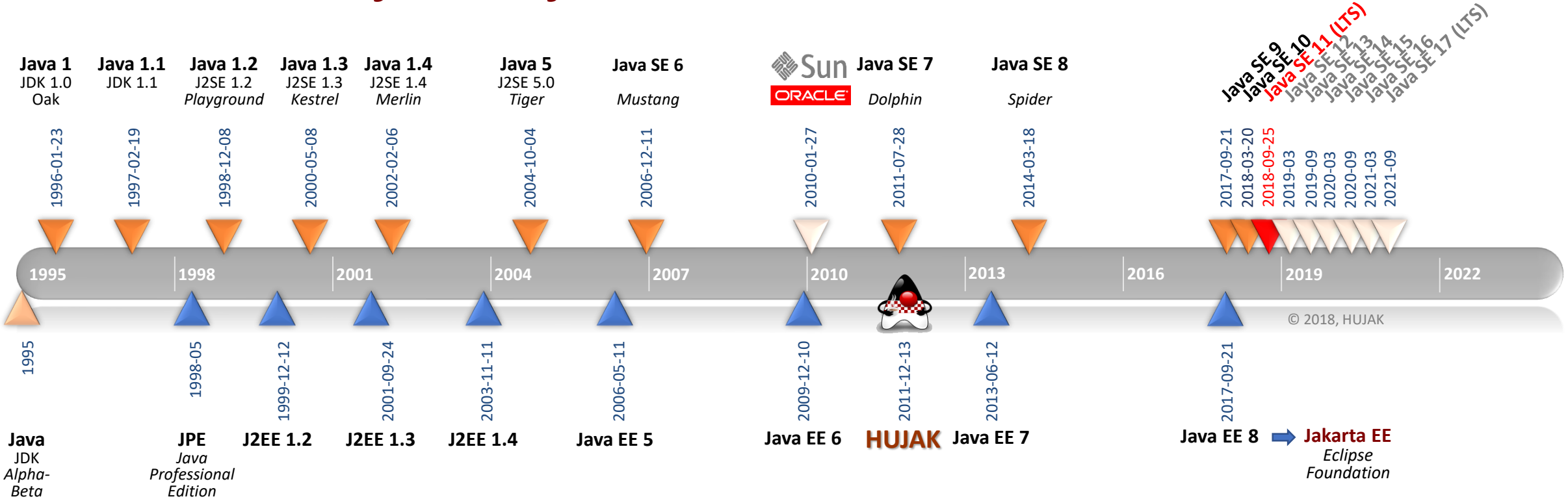
Stable **Secure** **Free** ?

However, commonly choose two out of three ☹

"Moving Java Forward Faster"

- *"For Java to remain competitive it must not just* ***continue to move forward*** *—* ***it must move forward faster****."*

Mark Reinhold



OpenJDK (New) Release Model

- **New Features** included (only) **when ready**
  - Not targeted for specific release, but released when feature **complete**
- **Feature release versions** released **twice a year**
  - Every **six months** in **March** and **September** (from JDK 9)
- **Update releases** will ship **quarterly**
  - in **January**, **April**, **July**, and **October**
- **Long-term support (LTS) feature release** every **three years**
  - Starting in September of 2018 with JDK 11
  - Updates will be available **for at least three years** and quite possibly longer
- **Time-Based Release Versioning** (JEP 322) openjdk.java.net/jeps/322
  - Revise the version-string scheme of the Java SE Platform and the JDK
  - Plans to name it by year and month (JEP 223), i.e. Java 18.3. – abandoned

JDK Version Numbering

- **$FEATURE.$INTERIM.$UPDATE.$EMERG**
  - **$FEATURE** is incremented every six months
    - Previously MAJOR
    - JDK **10** in March 2018, JDK **11** in September 2018, JDK **12** in March 2019…
  - **$INTERIM** is always **zero**, reserved for flexibility and future use
    - Previously MINOR
  - **$UPDATE** is incremented one month after $FEATURE is incremented, and every three months thereafter
    - Previously SECURITY
    - JDK **10.0.1** in April 2018, JDK **10.0.2** in July 2018, JDK **11.0.1** in October 2018…
  - **$PATCH** is emergency patch-release counter
    - Outside of planned schedule, incremented only when it's necessary to fix a critical issue

Available JDKs (and Licenses)

- **Oracle JDK** www.oracle.com/technetwork/java/javase/downloads/ **$$$?**
  - **Oracle Binary Code License (BCL)** with FoU (Field of Use) restrictions
- Many **OpenJDKs:**
- **Oracle OpenJDK** jdk.java.net/11/
  - **GNU General Public License version 2**, with the Classpath Exception (**GPLv2cpe**) with no restrictions
  - Security and bug fix updates every (and only for) **six months** (until next JDK, no overlap)
- **Azul's Zulu OpenJDK** www.azul.com/downloads/zulu/
  - Free, from JDK 6 to JDK 11, wide platform support
- **AdoptOpenJDK's OpenJDK** adoptopenjdk.net
  - Free, from JDK 8 to JDK 11, without commercial support, wide platform support
- **AdoptOpenJDK's OpenJDK based on OpenJ9** adoptopenjdk.net
  - OpenJ9 is former IBM commercial JVM, now open-sourced to Eclipse foundation
- **RedHat's OpenJDK**
- **SAP's SapMachine OpenJDK**
- **Other Linux distribution's OpenJDKs**

Demystifying "Free" Java

- **$free** as in **free beer** (cost) vs
  free as in **free speech** (what can you do)

- For **$free** use **OpenJDK binaries**
- For **free** use **OpenJDK** with **GPLv2+CE license**

- **Updates** refers to **code patches** – typically **$free**
- **Support** means **fixing bugs** and **answering questions** – was **never $free**

Oracle's JDK is (not) "free"

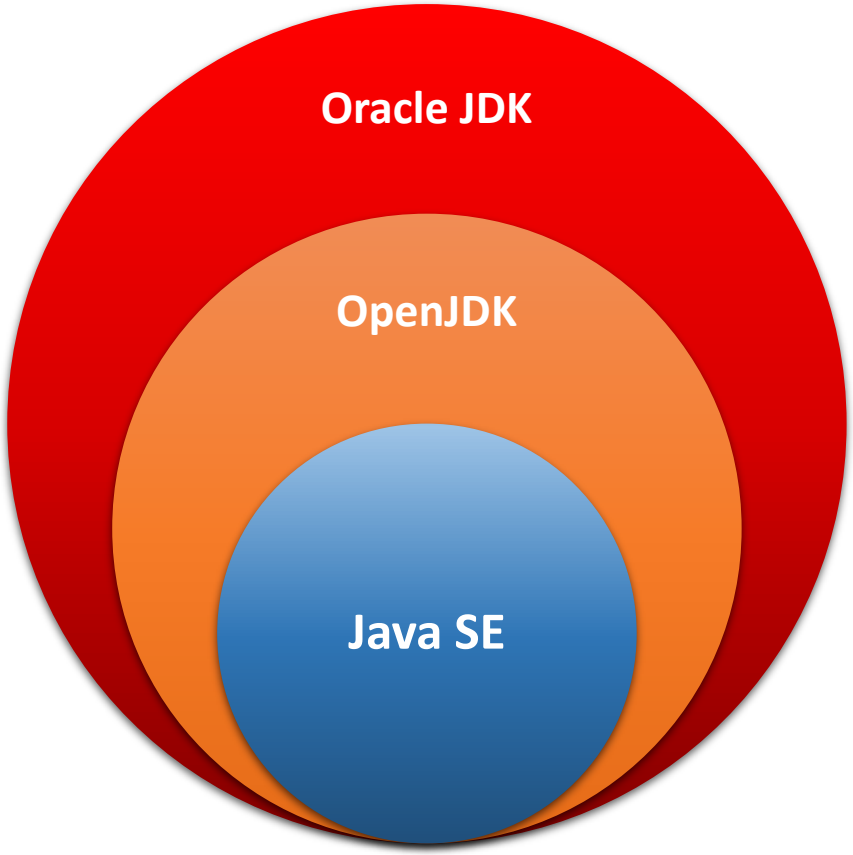
- LTS release **every 3 years** – **does not mean** 3 years of **free updates**
- **Oracle JDK 11** (and onward) can only be used in **production** with **commercial Java SE subscription**
  - Free JDK 11 (and later) are OpenJDK binaries
- **Oracle JDK 8** can be used **indefinitely for free**
  - **Without** any further **security patches** and **bug fixes**
- **Oracle** will lead and contribute to each new JDK (every 6 months)
  - For all JDK (Feature and LTE releases)
  - Will not backport updates, Java community need to do it for LTS release

Open Sourcing and Converged Binaries

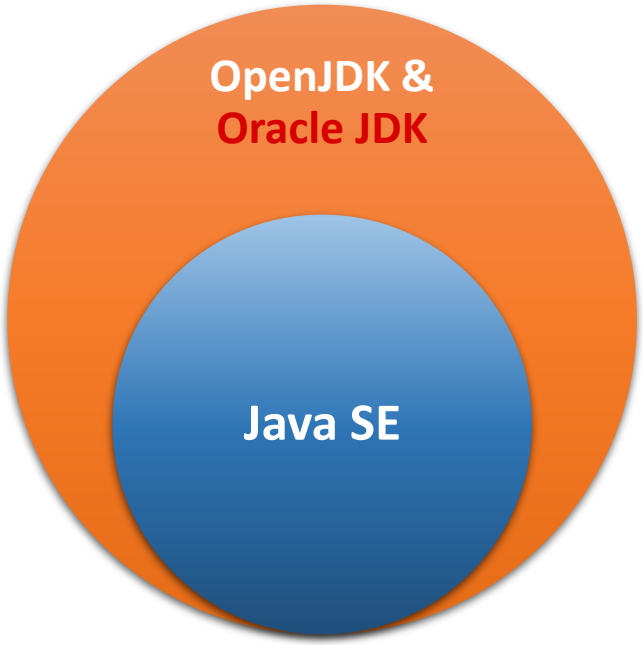
- Goal: **No functional difference** between OpenJDK and Oracle JDK in **JDK 11**
- **Open sourcing** closed-source parts of JDK
  - Flight recorder
  - Mission control
  - …
- **Removing** some closed-source parts
  - Browser Plugin
  - Java Web Start
  - JavaFX
- **Backwards Compatibility** – applications depending on Java SE should work

Converged Binaries

Up to JDK 10

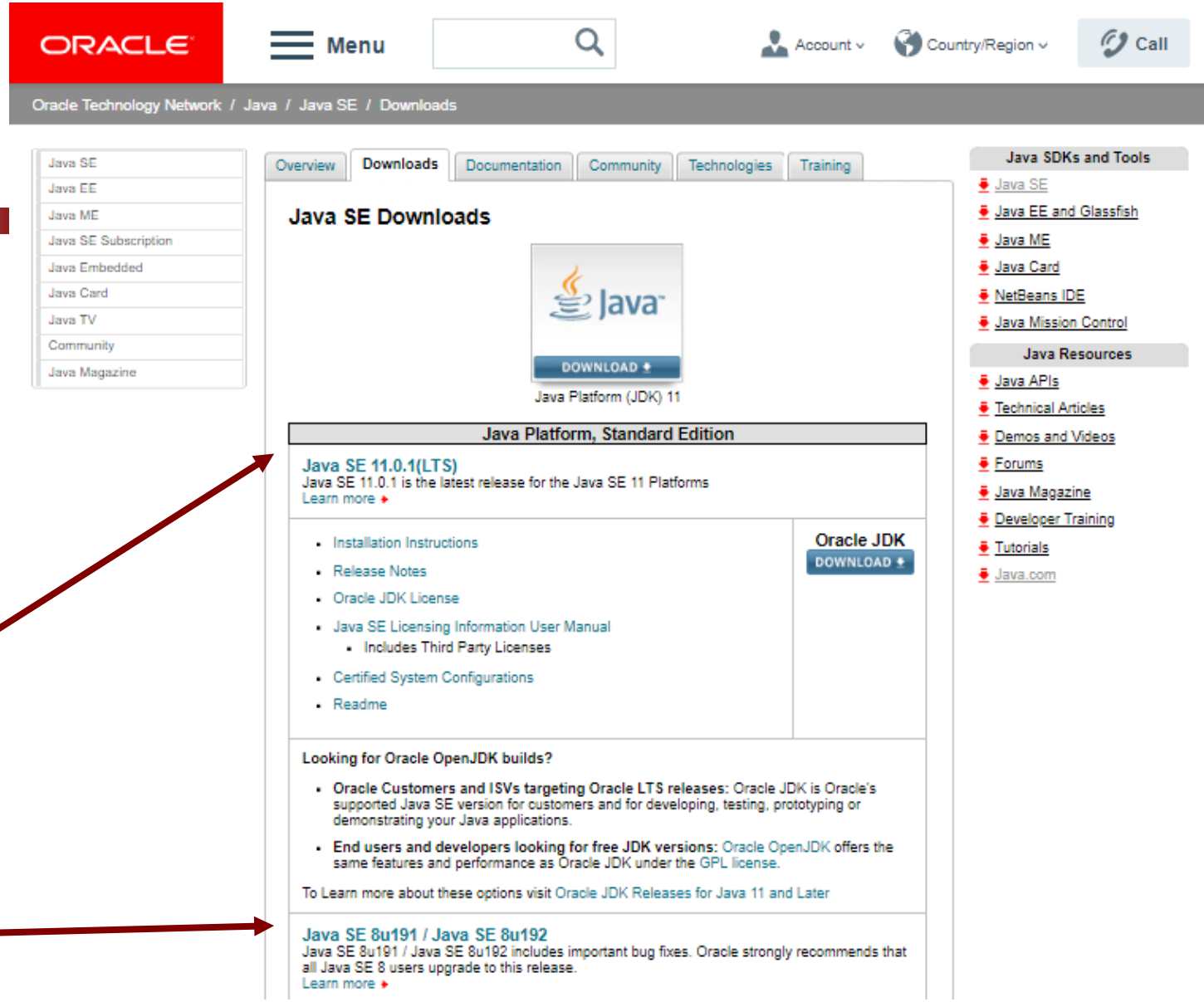


JDK 11 and later



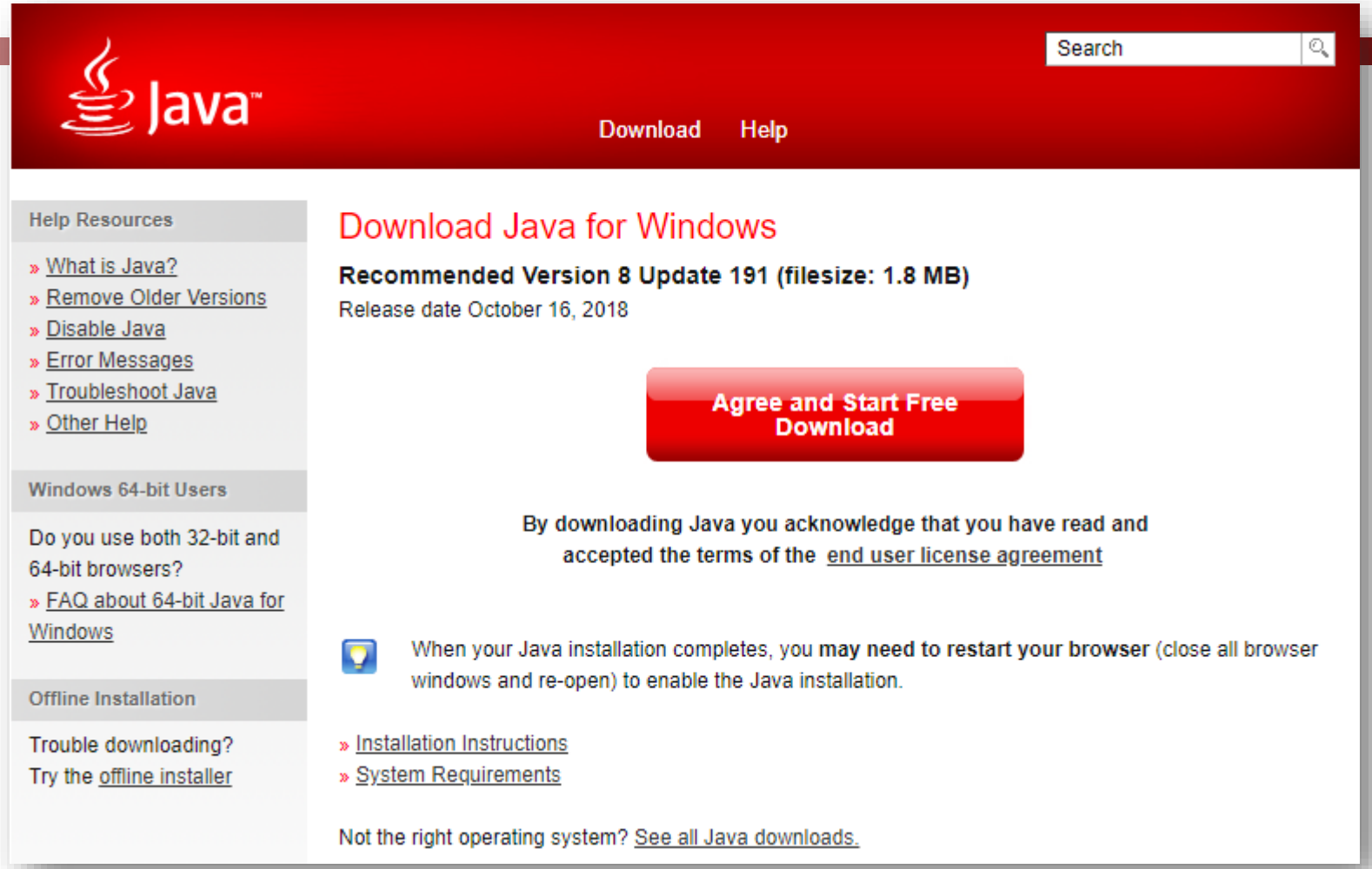
Java Download

- What/where to download **Java today**?
  - **OpenJDK**
  - Oracle **JDK**
  - Some other OpenJDK?
    - **Zulu** (Azul Systems) or **AdoptOpenJDK**
- Currently available downloads of Oracle's JDK:
  - Java SE **11.0.1**
  - Java SE **8u191**



What about www.java.com?

- Well…
  we don't know?!?



(Long Term) Support

- **Long Term Support (LTS)** for all releases is **not practical**
- **One Long Term Support release** every **three years**
  - Starting with **JDK 11** (September 2018), then **JDK 17** (September 2021), then **JDK 23**…
  - For Oracle's **commercial customers** updates available **for at least three years** or longer
- JDK **9** – supported until March 2018 (release of JDK 10)
- JDK **10** – supported until September 2018 (release of JDK 11)
- JDK **11** (September 2018) – supported until March 2019 (JDK 12)
- JDK **12** (March 2019) …
- JDK change every six months?

Public Updates and Support – from 7 till 17

Java SE Version	Public Release	Versions	Oracle Support	Commercial / Personal User End of Public Updates	Oracle's Premier / Extended Support
7	July 2011		Long Term Support (LTS)	-	July 2019 / July 2022
8	March 2014	8u191 – October 2018	Long Term Support (LTS)	January 2019 / December 2020	March 2022 / March 2025
9	September 2017	9.0.4+11 – January 2018	Short Term Support	March 2018	March 2018 / NA
10	March 2018	10.0.0 10.0.1 – April 2018 10.0.2 – July 2018	Short Term Support	September 2018	September 2018 / NA
11	**September 2018**	11.0.0 LTS **11.0.1 – October 2018** 11.0.2 – January 2019	**Long Term Support (LTS)**	*	September 2023 / September 2026
12	March 2019	-	Short Term Support	-	-
13	September 2019	-	Short Term Support	-	-
14	March 2020	-	Short Term Support	-	-
15	September 2020	-	Short Term Support	-	-
16	March 2021	-	Short Term Support	-	-
17	September 2021	-	Long Term Support (LTS)	-	-

* https://blogs.oracle.com/java-platform-group/oracle-jdk-releases-for-java-11-and-later

JDK 9/10 – old news?

- A lot of **significant changes**
- **Java Platform Module System (JPMS)**
  - All core Java libraries become modules (JEP 220)
  - 97 modules: 28 Java SE, 8 JavaFX, 59 JDK, 2 Oracle…
  - Most internal APIs encapsulated (JEP 260)
- **Deprecated APIs removed**
  - 1 package, many classes and methods
- **Redundant features eliminated**
  - Numerous deprecated GC options, jhat tool, TI hprof agent…
- Many **command line changes**
  - Removed 200+ -XX flags

JDK 10

- **JDK 10** was available since **March 20th, 2018**
  - JSR 383 – Oracle, IBM, Red Hat, SAP, Azul…
  - openjdk.java.net/projects/jdk/10/
- **109 new features** and **APIs**
- **JEPs** included
  - 286: Local-Variable Type Inference
  - 296: Consolidate the JDK Forest into a Single Repository
  - 304: Garbage-Collector Interface
  - 307: Parallel Full GC for G1
  - 310: Application Class-Data Sharing
  - 312: Thread-Local Handshakes
  - 313: Remove the Native-Header Generation Tool (javah)
  - 314: Additional Unicode Language-Tag Extensions
  - 316: Heap Allocation on Alternative Memory Devices
  - 317: Experimental Java-Based JIT Compiler
  - 319: Root Certificates
  - 322: Time-Based Release Versioning

Local Variable Type Inference

- **JEP 286** http://openjdk.java.net/jeps/286
- Extending **type inference** to declarations of **local variables** and **initializers**
  - Reducing the ceremony associated with writing Java
  - Maintaining the commitment to static type safety
- Examples:

```
var list = new ArrayList<String>();  // infers ArrayList<String>
var stream = list.stream();          // infers Stream<String>
var m = new HashMap <String, List<BigDecimal>>();
```

- Guidelines:
  - *Restricted to*: **local variables** with initializers, **indexes** in the enhanced for-loop, **locals** declared in a traditional for-loop
  - *Not available for*: **method** parameters, **constructor** parameters, **method return types**, **fields, catch formals** or any other kind of variable declaration
- *Don't blame language features for making developers write sh**y code* – Simon Maple

Garbage Collector Interface

- **JEP 304** http://openjdk.java.net/jeps/304
- Introducing a **clean GC interface** to improve source code isolation of different GCs
  - Better modularity for HotSpot internal GC code
  - Simpler to **add a new GC** to HotSpot without perturbing the current code base
  - Make it easier to **exclude a GC** from a JDK build
- Bits and pieces of GC source files scattered all over the HotSpot sources
  - Becomes an issue when implementing a new garbage collector
- BTW, some of our own experimenting with GCs (Parallel, CMS, G1…)
  - *Comparison of Garbage Collectors in Java Programming Language* at MIPRO 2018

Parallel Full GC for G1

- **JEP 307** http://openjdk.java.net/jeps/307
- **Improving G1 worst-case latencies** by making the **full GC parallel**
  - G1 GC (default GC since JDK 9) designed to avoid full collections
  - When concurrent collections can't reclaim memory fast enough – fall back full GC
  - Previous G1 implementation was using single threaded algorithm
    - Previous default was parallel collector (had parallel full GC)
- To minimize the impact for users experiencing full GCs, the G1 full GC was **made parallel** as well
  - Intends to parallelize the mark-sweep-compact algorithm
    - Use the same number of threads as the Young and Mixed collections do
  - Number of threads controlled by the *-XX:ParallelGCThreads* option
    - It will also affect the number of threads used for Young and Mixed collections

Handshakes, heap allocation, and Unicode

- **Thread-Local Handshakes**
  - **JEP 312** openjdk.java.net/jeps/312
  - Introduces how to execute a **callback on threads**, without performing a global VM safepoint
  - It is both possible and cheap to stop individual threads and not just all threads or none
- **Heap Allocation on Alternative Memory Devices**
  - **JEP 316** openjdk.java.net/jeps/316
  - Allocate Java object **heap** on an **alternative memory device** (e.g. NV-DIMM)
- **Additional Unicode Language-Tag Extensions**
  - **JEP 314** openjdk.java.net/jeps/314
  - Enhance **java.util.Locale** and related APIs to implement additional **Unicode extensions of language tag syntax** (BCP 47)

Some Housekeeping

- **Experimental Java-Based JIT Compiler (Graal)**
  - **JEP 317** openjdk.java.net/jeps/317
  - Performance ☺ – hotspots compiled to native
  - Enable **Graal** (Java-based JIT compiler) to be used as experimental JIT compiler

    ```
    -XX:+UnlockExperimentalVMOptions -XX:+UseJVMCICompiler
    ```
- **Root Certificates**
  - **JEP 319** openjdk.java.net/jeps/319
  - Provide a **default set of root Certification Authority (CA) certificates** in JDK
  - Open source the root certificates in Oracle's Java SE Root CA program
- **Consolidate the JDK Forest into a Single Repository**
  - **JEP 296** openjdk.java.net/jeps/296
  - Combine the various repositories of JDK forest into a **single repository**
  - Simplify and streamline development (FX not included)
- **Remove the Native-Header Generation Tool (*javah*)**
  - **JEP 313** openjdk.java.net/jeps/313
  - Remove the *javah* tool from the JDK, superseded by superior functionality in ***javac***

New APIs

- **73 additional new APIs**
  - **copyOf**(Collection) in List, Set and Map
  - Optional.**orElseThrow**() – get or throw
  - **toUnmodifiable**List/Map/Set
- Some APIs **removed**
  - Based on **Java SE 10 (18.3) (JSR 383) Proposed Final Draft Specification** cr.openjdk.java.net/~iris/se/10/pfd/java-se-10-pfd-spec-01/#APIs-removed
  - Optional annotation element `forRemoval=true` to previously deprecated API elements
  - Remove deprecated methods Runtime.getLocalized{Input,Output}Stream
  - Remove deprecated pre-1.2 SecurityManager methods and fields
  - De-deprecate XMLInputFactory.newFactory()

JDK 11

- **JDK 11** is in **General Availability**
  - JSR 384 – Oracle, IBM, Red Hat, SAP, Azul…
  - openjdk.java.net/projects/jdk/11/
- **90** new features in JDK 11
  - Post by Simon Ritter
  - https://www.azul.com/90-new-features-and-apis-in-jdk-11/
  - Less Developer **Visible** Features
- What is inside?

- **JEPs** included
  - 181: Nest-Based Access Control
  - 309: Dynamic Class-File Constants
  - 315: Improve Aarch64 Intrinsics
  - 318: Epsilon: A No-Op Garbage Collector
  - 320: Remove the Java EE and CORBA Modules
  - 321: HTTP Client (Standard)
  - 323: Local-Variable Syntax for Lambda Parameters
  - 324: Key Agreement with Curve25519 and Curve448
  - 327: Unicode 10
  - 328: Flight Recorder
  - 329: ChaCha20 and Poly1305 Cryptographic Algorithms
  - 330: Launch Single-File Source-Code Programs
  - 331: Low-Overhead Heap Profiling
  - 332: Transport Layer Security (TLS) 1.3
  - 333: ZGC: A Scalable Low-Latency Garbage Collector
  - 335: Deprecate the Nashorn JavaScript Engine
  - 336: Deprecate the Pack200 Tools and API

Local-Variable Syntax for Lambda Parameters

- **JEP 323** http://openjdk.java.net/jeps/323
- Extending **Local-Variable Type Inference** (JEP 286) – but now for **Lambda** expressions
  - Uniformity of local variables and lambdas
- Allow **var** when declaring **formal parameters** of **implicitly typed lambda expressions**

```
(var x, var y) -> x.process(y)
```

- For **all** formal parameters **or none** of them

```
(var x, y) -> x.process(y)      // Can't mix 'var' and 'no var' in implicitly typed lambdas
```

- Explicitly typed lambda expressions continue to use data types for all their formal parameters

```
(var x, int y) -> x.process(y)   // Can't mix 'var' and data types in explicitly typed lambdas
```

- Not compromising the brevity of the shorthand syntax

```
var x -> x.foo()                 // is not allowed
```

Local-Variable Syntax for Lambda Parameters – Example

- Example (by Simon Ritter):

```
list.stream()
    .map((var s) -> s.toLowerCase())
    .collect(Collectors.toList());
```

- Lambda expressions already have type inference so use of var is not necessary:

```
list.stream()
    .map(s -> s.toLowerCase())
    .collect(Collectors.toList());
```

- When **adding an annotation** to Lambda parameter you have to use a (explicit) type, and we can use **var** instead

```
list.stream()
    .map((@Notnull var s) -> s.toLowerCase())
    .collect(Collectors.toList());
```

- Also causes changes to the Java Language Specification (JLS) :
  - Description of the var special identifier, Lambda parameters, Runtime evaluation of Lambda expressions, and Lambda syntax

Launch Single-File Source-Code Programs

- **JEP 330** http://openjdk.java.net/jeps/330
- Run a program supplied as a **single file** of Java source code
  - Reduce the ‘ceremony’ of running trivial applications
  - Including usage from within a script by means of "shebang" files and related techniques
- Example:

```
java HelloWorld.java
```

- Parameters:
  - **After** the name of the source file are passed as parameters when executing application
  - **Before** the name of the source file are passed as parameters to launcher after code has been compiled
- Example:

```
java -classpath /home/foo/java Hello.java Bonjour
```

- is equivalent to:

```
javac -classpath /home/foo/java Hello.java
java -classpath /home/foo/java Hello Bonjour
```

Launch Single-File Source-Code Programs – Shebang files support

- Usage from within a script by means of "shebang" files and related techniques
- "Shebang" file – small utility single-file program starting with **#!**

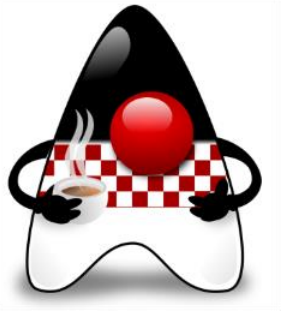
  `#!interpreter [optional-arg]`
  - On Unix-derived systems (Linux, macOS)
  - Allows a script or source code to be placed in any executable file (whose first line begins with #!), specifying name of a program to "execute" the contents of the file
- Reducing the need to even mention the Java launcher on the command line
- Simply included on the first line of the source file
- Example:

```
#!/usr/bin/java --source 11
    public class HelloWorld {
    ...
```

- However, necessary to specify the **`–source`** flag with the version of Java

HTTP Client (Standard)

- **JEP 321** http://openjdk.java.net/jeps/321
- New API in JDK 9 to provide support for the HTTP Client protocol (JEP 110) with **HTTP/2 support**
  - Since JDK 9 introduced the Java Platform Module System (JPMS), it was included as an incubator module
  - Later updated in JDK 10
- **HTTP Client API** is now part of the Java SE 11 standard
- New module and package **java.net.http**
- Main types:
  - **HttpClient, HttpRequest, HttpResponse, WebSocket**
- API can be used **synchronously** or **asynchronously**
  - Asynchronous mode makes use of **CompletableFutures** and **CompletionStages**



HTTP Client (Standard) – Some details

- While incubating in JDK 9 and JDK 10, implementation was almost completely rewritten
- The implementation is now completely **asynchronous**
  - Previous HTTP/1.1 implementation was blocking
- Provides **non-blocking request and response** semantics through CompletableFutures
  - Which can be chained to trigger dependent actions
- Back-pressure and flow-control of request and response bodies is provided for via the Platform's **reactive-streams** support in the **java.util.concurrent.Flow** API
- Use of the **RX Flow** concept has been pushed down into the implementation
  - Eliminated many of the original custom concepts needed to support HTTP/2
- The flow of data can now be more easily **traced**
  - From user-level request publishers and response subscribers down to the underlying socket
  - Significantly reduces the number of concepts and complexity in the code
  - Maximizes the possibility of **reuse** between HTTP/1.1 and HTTP/2

Remove Java EE and CORBA Modules

- **JEP 320** http://openjdk.java.net/jeps/320
- Remove **Java EE and CORBA** modules from Java SE Platform and JDK
  - Modules **deprecated** in Java SE 9 with intent to remove them in a future
- Java SE 6 included a full Web Services stack (originally developed for the Java EE Platform):
  - JAX-WS (Java API for XML-Based Web Services)
  - JAXB (Java Architecture for XML Binding)
  - JAF (the JavaBeans Activation Framework)
  - Common Annotations

Remove Java EE and CORBA Modules #2

- **JEP 320** http://openjdk.java.net/jeps/320 cont'd
- At the time of inclusion, versions in Java SE and Java EE were identical
  - Except one package in Common Annotations
- Over time, versions in Java EE evolved (difficulties for versions in Java SE):
  - Technologies gained features that were not relevant to Java SE (like Common Annotations package for data sources in a Java EE container)
  - Maintenance problematic due to having to sync the Java SE (in OpenJDK) with the Java EE versions (in upstream repositories)
  - Possible to obtain standalone versions of the technologies from the upstream projects and deploy them – unfortunately, it was not widely used in practice
- With JPMS we can divide the monolithic **rt.jar** file into multiple modules
  - Additionally possible to create a Java runtime only with modules you need – reduces size

Remove Java EE and CORBA Modules

- Java.se.ee meta-module includes **six modules** that are **no longer part** of JDK:
  - **corba**
  - **transaction**
  - **activation**
  - **xml.bind**
  - **xml.ws**
  - **xml.ws.annotation**
- If you still use APIs from these modules in your code, you supply them as a **separate module** or **library**
- It seems that the **java.xml** modules, which are part of the JAX-WS, SOAP-based web services support are the ones that are causing most problems

Flight Recorder

- **JEP 328** http://openjdk.java.net/jeps/328
- **Low-overhead data collection framework** for **troubleshooting** Java applications on JVM
- Prior to JDK 11 it was a **commercial** feature in Oracle JDK binary
- Oracle eliminated functional differences between Oracle JDK and OpenJDK and it was contributed to the OpenJDK
- Goals:
  - Provides APIs for producing and consuming data as events
  - Provides a buffer mechanism and a binary data format
  - Allows the configuration and filtering of events
  - Provides events for the OS, the HotSpot JVM, and the JDK libraries
- Two new modules : **jdk.jfr** and **jdk.management.jfr**

New API in JDK 11

- A lot of the **new APIs** in JDK 11
  - For a complete list of API changes, comparison by Gunnar Morling
    - https://gunnarmorling.github.io/jdk-api-diff/jdk10-jdk11-api-diff.html
- 6 new classes and 8 methods in **java.security** modules
  - Specific to the changes of JEP 324 and JEP 329
- New methods
  - In 8 slides

New Methods in JDK 11

- **New methods** – java.**io**:
- java.io.**ByteArrayOutputStream**
  - void **writeBytes**(byte[]) – write all the bytes of the parameter to the output stream
- java.io.**FileReader**
  - Two new constructors that allow a Charset to be specified
- java.io.**FileWriter**
  - Four new constructors that allow a Charset to be specified
- java.io.**InputStream**
  - io.InputStream **nullInputStream**() – returns an InputStream that reads no bytes
- java.io.**OutputStream**
  - io.OutputStream **nullOutputStream**() – like dev/null
- java.io.**Reader**
  - io.Reader **nullReader**()
- java.io.**Writer**
  - io.Writer **nullWriter**()

New Methods in JDK 11 #2

- **New methods** – java.**lang**:
- java.lang.**Character**
  - String **toString**(int) – overloaded form takes an int instead of a char as Unicode code point
- java.lang.**CharSequence**
  - int **compare**(CharSequence , CharSequence) – compares two CharSequence instances lexicographically
  - Negative, zero, or positive if 1st CharSequence is lexicographically less than, equal to, or greater than 2nd CharSequence, respectively
- java.lang.ref.**Reference**
  - lang.Object **clone**() – confusing, maybe for the future
- java.lang.**System** and java.lang.**Runtime**
  - No new methods, **runFinalizersOnExit**() method removed
- java.lang.**Thread**
  - No additional methods, **destroy**() and **stop**(Throwable) methods removed

New Methods in JDK 11 #3

- **New methods** – java.**lang**:
- java.lang.**String**
  - boolean **isBlank**() – returns true if string is empty or contains only white space codepoints
  - Stream **lines**() – returns a stream of lines extracted from this string, separated by line terminators
  - String **repeat**(int) – returns a string whose value is the concatenation of this string repeated count times
  - String **strip**() – returns a string whose value is this string, with all leading and trailing whitespace removed (different whitespace treatment than in trim())
  - String **stripLeading**() – returns a string whose value is this string, with all leading whitespace removed
  - String **stripTrainling**() – returns a string whose value is this string, with all trailing whitespace removed
- java.lang.**StringBuffer** and java.lang.**StringBuilder**
  - New **compareTo**() method that takes a StringBuffer/StringBuilder and returns an int (lexographical comparison same as for CharSequence)

New Methods in JDK 11 #4

- **New methods** – java.**nio**:
- java.nio.**ByteBuffer**, **CharBuffer**, **DoubleBuffer**, **FloatBuffer**, **LongBuffer**, **ShortBuffer**
  - **mismatch**() - finds and returns the relative index of the first mismatch between this buffer and a given buffer
- java.nio.channels.**SelectionKey**
  - int **interestOpsAnd**(int) – atomically sets this key's interest set to the bitwise intersection ("and") of the existing interest set and the given value
  - int **interestOpsOr**(int) – atomically sets this key's interest set to the bitwise union ("or") of the existing interest set and the given value
- java.nio.channels.**Selector**
  - int **select**(java.util.function.Consumer, long) – selects and performs an action on the keys whose corresponding channels are ready for I/O operations with timeout
  - int **select**(java.util.function.Consumer) – as above, except without the timeout
  - int **selectNow**(java.util.function.Consumer) – as above, except it is non-blocking

New Methods in JDK 11 #5

- **New methods** – java.**nio** (cont'd):
- java.nio.file.**Files**
  - String **readString**(Path): Reads all content from a file into a string, decoding from bytes to characters using the UTF-8 charset.
  - String **readString**(Path, Charset): As above, except decoding from bytes to characters using the specified Charset.
  - Path **writeString**(Path, CharSequence, java.nio.file. OpenOption[]:Write a CharSequence to a file. Characters are encoded into bytes using the UTF-8 charset.
  - Path **writeString**(Path, CharSequence, java.nio.file. Charset, OpenOption[]: As above, except Characters are encoded into bytes using the specified Charset.
- java.nio.file.**Path**
  - Path **of**(String, String[]): Returns a Path by converting a path string, or a sequence of strings that when joined form a path string.
  - Path **of**(net.URI): Returns a Path by converting a URI

New Methods in JDK 11 #6

- **New methods** – java.**util**:
- java.util.concurrent.**PriorityBlockingQueue** and java.util.**PriorityQueue**
  - void **forEach**(java.util.function.Consumer): Performs the given action for each element of the Iterable until all elements have been processed or the action throws an exception.
  - boolean **removeAll**(java.util.Collection): Removes all of this collection's elements that are also contained in the specified collection (optional operation).
  - boolean **removeIf**(java.util.function.Predicate): Removes all of the elements of this collection that satisfy the given predicate.
  - boolean **retainAll**(java.util.Collection): Retains only the elements in this collection that are contained in the specified collection (optional operation).
- java.util.concurrent.**TimeUnit**
  - long **convert**(java.time.Duration): Converts the given time duration to this unit.
- java.util.function.**Predicate**
  - Predicate **not**(Predicate). Returns a predicate that is the negation of the supplied predicate
  - *Example*: convert `lines.stream().filter(s -> !s.isBlank())` to `lines.stream().filter(Predicate.not(String::isBlank))` with static import `lines.stream().filter(not(String::isBlank))`

New Methods in JDK 11 #7

- **New methods** – java.**util**:
- java.util.**Optional**, **OptionalInt**, **OptionalDouble**, **OptionalLong**
  - boolean **isEmpty**():If a value is not present, it returns true, otherwise it is false.
- java.util.regex.**Pattern**
  - Predicate **asMatchPredicate**(): I think this could be a hidden gem in the new JDK 11 APIs. It creates a predicate that tests if this pattern matches a given input string.
- java.util.zip.**Deflater**
  - int **deflate**(ByteBuffer): Compresses the input data and fills the specified buffer with compressed data.
  - int **deflate**(ByteBuffer, int): Compresses the input data and fills the specified buffer with compressed data. Returns the actual number of bytes of data compressed.
  - void **setDictionary**(ByteBuffer): Sets the preset dictionary for compression to the bytes in the given buffer. This is an overloaded form of an existing method that can now accept a ByteBuffer, rather than a byte array.
  - void **setInput**(ByteBuffer): Sets input data for compression. Also an overloaded form of an existing method.
- java.util.zip.**Inflater**
  - int **inflate**(ByteBuffer): Uncompresses bytes into the specified buffer. Returns the actual number of bytes uncompressed.
  - void **setDictionary**(ByteBuffer): Sets the preset dictionary to the bytes in the given buffer. An overloaded form of an existing method.
  - void **setInput**(ByteBuffer): Sets input data for decompression. An overloaded form of an existing method.

New Methods in JDK 11 #8

- **New methods –** javax.**print**, javax.**swing**, and jdk.**jshell**:
- javax.print.attribute.standard.**DialogOwner**
  - This is a new class in JDK 11 and is an attribute class used to support requesting a print or page setup dialog be kept displayed on top of all windows or some specific window.
- javax.swing.**DefaultComboBoxModel**, **DefaultListModel**
  - void **addAll**(Collection): Adds all of the elements present in the collection.
  - void **addAll**(int, Collection): Adds all of the elements present in the collection, starting from the specified index.
- javax.swing.**ListSelectionModel**
  - int[] **getSelectedIndices**(): Returns an array of all of the selected indices in the selection model in increasing order.
  - int **getSelectedItemsCount**(): Returns the number of selected items.
- jdk.jshell.**EvalException**
  - jshell.JShellException **getCause**(): Returns the wrapped cause of the throwable in the executing client represented by this EvalException or null if the cause is non-existent or unknown.

Nest-Based Access Control

- **JEP 181** http://openjdk.java.net/jeps/181
- Java supports **nesting of classes** through **inner classes**
  - Logically, the inner class is part of the same code entity as the outer class
  - However, it is compiled as a separate class
  - Synthetic bridge method is created by the compiler to provide access to the private field of the outer class
- Introducing the concept of **nests**
  - Two members of the same nest (e.g., outer and inner class) are **nestmates**
  - **NestHost** and **NestMembers** attributes are defined for the class file format
  - Useful also for other languages compiled to bytecodes that support nested classes
- This feature introduces three new methods to **java.lang.Class**:
  - Class **getNestHost**()
  - Class[] **getNestMembers**()
  - boolean **isNestmateOf**(Class)
- Changes to JVMS in Access Control

Dynamic Class-File Constants

- **JEP 309** http://openjdk.java.net/jeps/309
- Extension of the class-file format to support a new constant-pool form **CONSTANT_Dynamic** (or "***condy***")
  - Idea of a dynamic constant seems to be an oxymoron
  - However, similar to a final value in Java
  - Like invokedynamic but for class-file constants
- **Constant-pool value** uses a **bootstrap method** to determine the value at **runtime**, not at compile-time (unlike the other constants)
  - Value is therefore "dynamic", but (since its value is only set once) it is also "constant"
- Simplifications primarily aimed at development of new JVM languages and compilers that generate bytecodes
- Introduces **java.lang.invoke.ConstantBootstraps** class with **9 new bootstrap methods** for dynamically computed constants
- Changes to the JVMS in usage of invokespecial bytecode and Constant Pool

Cryptographic-related changes

- **Key Agreement with Curve25519 and Curve448**
  - **JEP 324** http://openjdk.java.net/jeps/324
  - Replacing existing elliptic curve Diffie-Hellman (ECDH) scheme with **Curve25519** and **Curve448**
  - Key agreement scheme defined by **RFC-7748**
- **ChaCha20 and Poly1305 Cryptographic Algorithms**
  - **JEP 329** http://openjdk.java.net/jeps/329
  - Implementation of **ChaCha20** and **ChaCha20-Poly1305** ciphers as specified in RFC 7539, replacing the older insecure RC4 stream cipher

Garbage Collection

- **ZGC A Scalable, Low Latency Garbage Collector**
  - **JEP 333** http://openjdk.java.net/jeps/333
  - New experimental garbage collector designed for applications that require a **large (multi-gigabyte) heap and low-latency**
  - Uses a **single generation heap** and performs most of GC **concurrently** with the application
  - **Read-barrier** that intercepts each read to an object from the application and ensures that the reference returned is correct
  - Eliminates issue of being able to relocate objects concurrently while application threads are running
  - Region-based (like G1), NUMA aware and compacting
  - Not intended as a general-purpose collector

Garbage Collection #2

- **Epsilon: A No-Op Garbage Collector**
  - **JEP 318** http://openjdk.java.net/jeps/318 (by Red Hat)
  - Epsilon Garbage Collector handles memory allocation but does not implement any actual memory reclamation mechanism of space occupied by unreferenced objects
  - Designed to test and compare GC performance with and without GC
  - For very short-lived tasks (like serverless functions in the cloud) which do not exceed the memory allocated to the heap

Other JEPs in JDK 11

- **Unicode 10**
  - **JEP 327** http://openjdk.java.net/jeps/327
  - Support for Unicode 10.0 standard with 8,518 new symbols
  - Includes more Emojis, Bitcoin symbol, Nüshu character set, as well as Soyombo and Zanabazar Square
- **Improve Aarch64 Intrinsics**
  - **JEP 315** http://openjdk.java.net/jeps/315 (by Red Hat)
  - Take advantage of specialized instructions in **Arm64** instruction set
  - Improves performance of sin(), cos() and log() methods of the java.lang.Math class

Housekeeping continues

- **Removals** in JDK 11
  - **Applets, Browser Plugin, Web Start, Java FX**
- **Deprecate the Nashorn Scripting Engine**
  - **JEP 335** http://openjdk.java.net/jeps/335
  - Deprecates **Nashorn** introduced in JDK 8 as a replacement of Rhino Javascript engine
  - Suggests using **Graal VM** as replacement
    - How that will work has not been evaluated
  - Completely remove Nashorn with associated APIs and ***jjs*** tool in the future
- **Deprecate the Pack200 Tools and APIs**
  - **JEP 336** http://openjdk.java.net/jeps/336
  - With **JPMS** in JDK 9, **Pack200** a compression scheme for JARs is no longer used
  - Deprecates pack200 and unpack200 tools, and Pack200 API in java.util.jar, and may be removed in a future

Others

- **Low-overhead Heap Profiling**
  - **JEP 331** http://openjdk.java.net/jeps/331 (by Google)
  - Provides a way to get information about Java object heap allocations from the JVM that:
    - Is low-overhead enough to be enabled by default continuously
    - Is accessible via a well-defined, programmatic interface
    - Can sample all allocations
    - Can be defined in an implementation-independent way (i.e., not limited to a particular GC algorithm or VM implementation)
    - Can give information about both live and dead Java objects
- **Transport Layer Security (TLS) 1.3**
  - **JEP 332** http://openjdk.java.net/jeps/332
  - Implementation of TLS 1.3 (RFC 8446) which provides significant security and performance improvements over previous versions
  - Does not extend to Datagram Transport Layer Security (DTLS)

JDK 12

- **JDK 12** is currently in Early Draft Review
  - JSR 386 – usual suspects: Oracle, IBM, Red Hat, SAP, Azul…
  - openjdk.java.net/projects/jdk/12/
- Schedule:
  - 2018/05 Expert Group formation
  - 2018/07 Early Draft Review
  - 2018/10 - 2018/11 Public Review
  - 2019/01 - 2019/02 Proposed Final Draft
  - **2019/03** **Final Release**
- JEPs targeted to JDK 12, so far:
  - **Switch Expressions** (JEP 325)
  - **Raw String Literals** (JEP 326)

More Long-term Future

- Project **Amber** – incubator for smaller, productivity-oriented **language features** and **simplifying syntax**
  - Local variable type inference, local variable syntax for lambdas, **lambda leftovers**, **raw string literals**, **pattern matching**, **switch expressions**…
- Project **Valhalla** – incubator project for **advanced JVM and language feature** candidates
  - **Value types** and **specialized generics**
- Project **Panama** – to interconnect JVM and native code
  - **Foreign function interface** (**FFI**) replacement for JNI
- Project **Loom** – to reduce complexity in writing concurrent applications
  - **Fibres** (JVM-level threads) and **continuations**
- Project **Metropolis** – JVM re-written in Java, i.e. "***Java on Java***"
  - Using Graal experience, easier porting, performance to be explored (AOT compiler)

Project Amber

- Project **Amber** includes:
  - **Local variable type inference** (JEP 286) – delivered in JDK 10
  - **Local variable syntax for lambda parameters** (JEP 323) – delivered in JDK 11
  - **Switch Expressions** (JEP 325) – expressions in switch statements (lambdas) – planned for JDK 12
  - **Raw string literals** (JEP 326) – use of single backquote – planned for JDK 12
  - **Lambda leftovers** (JEP 302) – underscore for unused parameters – in progress
  - **Pattern matching** (JEP 305) – switch statement with case for different types of objects – in progress
  - **Enhanced Enums** (JEP 301) – generic enums with type parameters – currently on hold
- More at openjdk.java.net/projects/amber/

Raw string literals (JEP 326) – examples

```
Runtime.getRuntime().exec
("\"C:\\Program Files\\foo\" bar");
```

```
Runtime.getRuntime().exec
(`"C:\Program Files\foo" bar`);
```

```
System.out.println
("this".matches("\\w\\w\\w\\w"));
```

```
System.out.println
("this".matches(`\w\w\w\w`));
```

```
String html =
"<html>\n" +
"    <body>\n" +
"                <p>Hello
World.</p>\n" +
"    </body>\n" +
"</html>\n";
```

```
String html =
`<html>
    <body>
        <p>Hello World.</p>
    </body>
 </html>
`;
```

Pattern matching (JEP 305) – example

```
String formatted;
switch (obj) {
    case Integer i:
         formatted = String.format("int %d", i);
         break;
    case Long l:
         formatted = String.format("long %d", l);
         break;
    case Double d:
         formatted = String.format(“double %f", d);
         break;
    case String s:
         formatted = String.format("String %s", s);
         break
    default:
         formatted = obj.toString();
}
```

Switch Expressions (JEP 325) – example

```
int numLetters;
switch (day) {
    case MONDAY:
    case FRIDAY:
    case SUNDAY:
        numLetters = 6;
        break;
    case TUESDAY:
        numLetters = 7;
        break;
    case THURSDAY:
    case SATURDAY:
        numLetters = 8;
        break;
    case WEDNESDAY:
        numLetters = 9;
        break;
    default:
        throw new IllegalStateException("Hmm: " + day);
};
```

```
int numLetters = switch (day) {
    case MONDAY, FRIDAY, SUNDAY -> 6;
    case TUESDAY -> 7;
    case THURSDAY, SATURDAY -> 8;
    case WEDNESDAY -> 9;
    default -> throw new
       IllegalStateException(
       "Hmm: " + day);
};
```

Project Valhalla

- Incubator project for advanced Java VM and language feature candidates
- Problem:
  - Java uses **primitives** for performance and **objects** for OO, encapsulation, polymorphism, inheritance
  - But no **ArrayList<int>** ☹
  - If we use Integer than (un)boxing, creation of object, heap, indirection reference…
- **Value Objects (JEP 169)** – "codes like a class, works like a primitive"
  - Supports methods, fields, implements interface, encapsulation, generic…
  - Doesn't support mutation or sub-classes
- **Generics over Primitive Types (JEP 218)** – extends generic types to support the specialization of generic classes and interfaces over primitive types
- More at openjdk.java.net/projects/valhalla/

Project Panama and Project Loom

- Project **Panama** – interconnecting JVM and native code
  - Featuring **native function calling** from the JVM and **native data access** from the JVM
  - **Foreign function interface (FFI)** replacement for JNI
  - More at http://openjdk.java.net/projects/panama/
- Project **Loom** – reducing complexity in writing concurrent applications
  - Alternative, **user-mode thread implementations**, **delimited continuations**, and other constructs involving **call-stack manipulation**
  - Proposal for lightweight **fibres** (JVM-level threads) as alternative implementation of threads, managed by schedulers like `ForkJoinPool`, written in Java
  - Java programming model of ordinary Java threads would be preserved while performance is improved and the footprint reduced
  - Less memory and almost zero overhead when task switching
  - More at http://openjdk.java.net/projects/loom/

Backwards Compatibility

- It will be **respected** ☺
- But with **no guarantees** ☹
- New version may include **breaking changes**
- Anything for removal will be **deprecated first**
  - Minimum of **one release warning** (6+ months)

Container Awareness and ~~Java~~ Jakarta EE

- JVM more **Docker container aware**
  - Uses container CPU count and memory size

- **Open sourcing Java EE**
  - **Jakarta EE** as a part of **Eclipse Foundation**
  - jakarta.ee/ – *The New Home of Cloud Native Java*
  - **Jakarta EE Developer Survey 2018**, Eclipse Foundation
    - jakarta.ee/news/2018/04/24/jakarta-ee-community-survey/
  - Current status
    - blogs.eclipse.org/post/mike-milinkovich/jakarta-ee-status-%E2%80%93-september-2018-update

Is Java really "Moving Forward Faster"?

- Well… yeah ☺
- **Much more frequent Java releases**
- **Faster access to new features**
- **Many new improvement ideas**
- **A lot of maintenance and housekeeping**
- **Java remains free**

- BTW, what about JavaOne?

No more "JavaOne"?

- In 2018 JavaOne is **larger than ever**
- However, it goes by a **new name**… ☹
- **Oracle Code One –**
  a conference for all developers
  - October 22-25, San Francisco
  - Usual prices $1400-$2000 ☹
- Keynotes:
  - www.oracle.com/code-one/keynotes.html
- On Demand Streaming:
  - www.oracle.com/code-one/on-demand.html

- **11 tracks**:
  - Core Java Platform
  - Java Server-Side Development and Microservices
  - Java Ecosystem
  - Containers, Serverless, and Cloud
  - Emerging Technologies
  - Modern Web
  - Development Tools
  - DevOps and Pipelines
  - Developer Community
  - Database, Big Data, and Data Science
  - MySQL

Back to Croatian Reality

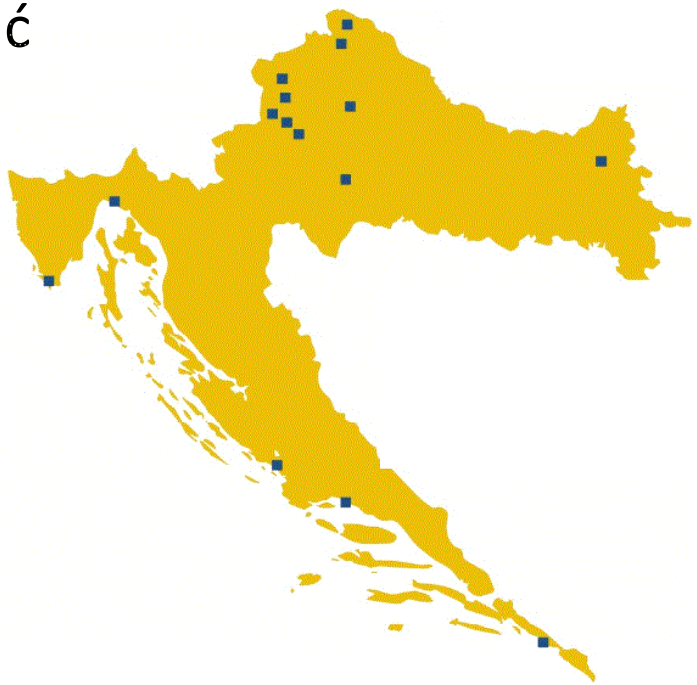
- But before that – one nice link: https://snyk.io/blog/jvm-ecosystem-report-2018

A few nice things in 2017/2018…

- **Java Zagreb meetups** – many great meetups so far
- **Java in high schools initiative**
  - Together with **Oracle Academy**
- **Croatian Makers league** continues
  - Micro:bit, Logo, mBot, Scratch, Arduino, Little Bits…
- Program **Digitalna akademija**
  - ScratchJr, RunMarco, Studio Code, Play Lab, Scratch i App studio, micro:bit, Arduino…
- **Code Club Croatia** and udruga **Programerko**
- Udruga za darovitu djecu "**Dar**"
- Great **Javantura** and **JavaCro** conferences

Where to study IT in Croatia?

- **Java** at **Universities**
  - Java is **#1** for decades!!! ☺
- Where to study **computing / computer science / information technology**?
  - **15+ cities**: Čakovec, Dubrovnik, Krapina, Križevci, Osijek, Pula, Rijeka, Sisak, Split, Šibenik, Varaždin, Velika Gorica, Zabok, Zagreb, Zaprešić
  - **33+ educational organizations**, including:
    - 6 public universities
    - 13 private high schools
  - **80+ educational programs**
    - Undergraduate (3-4 years)
    - Graduate (1-2 years)
    - Professional
    - Postgraduate



Javantura conference

- One **Saturday** in February
- **26 sessions**
- **300 attendees**
- Tickets with **50% discount for students**

Looking forward to
Javantura v6
on **February 23rd, 2019**
in **Zagreb** ☺

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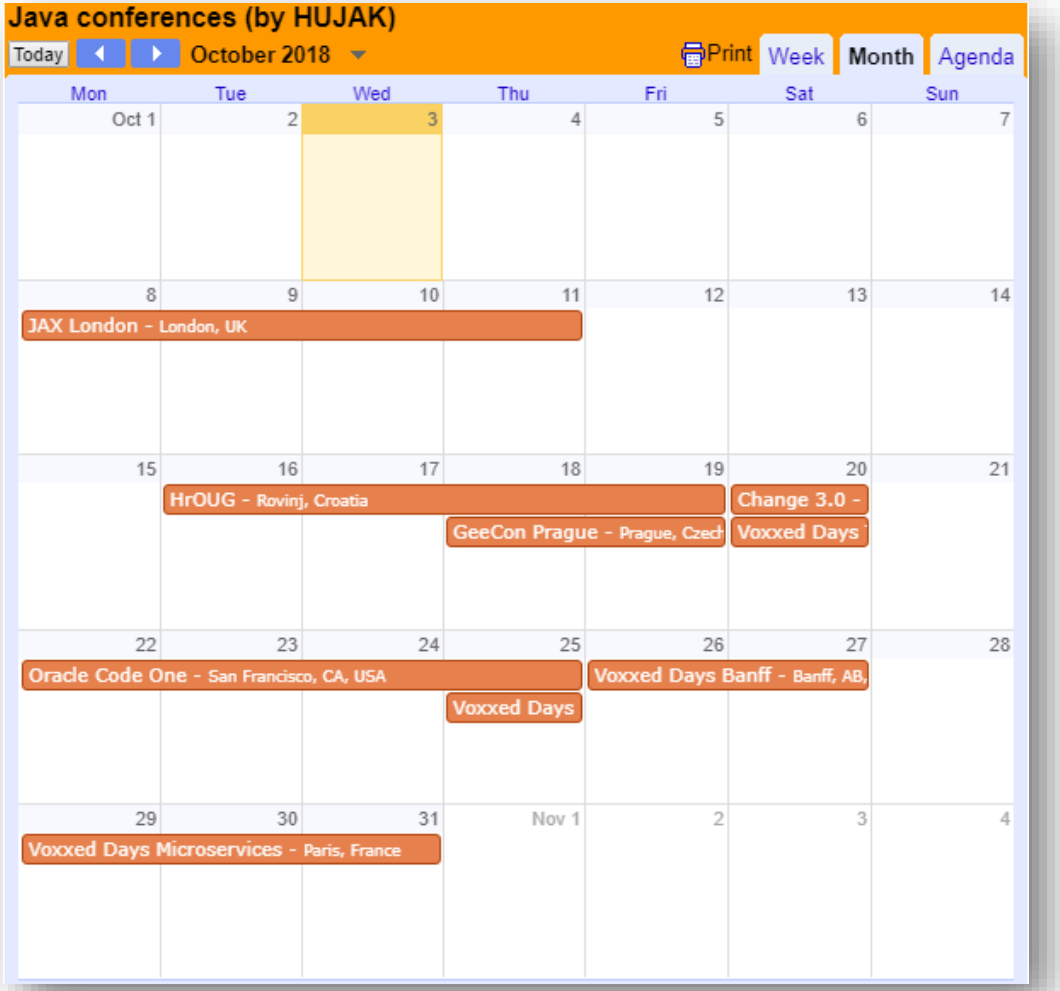
- Available at: hujak.hr/kalendar/
- If we are missing some please send email to info (at) hujak.hr
- Another great conference list at www.baeldung.com/java-conferences-europe



45+ company members

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Agile Croatia

JUG.ba

HULK
hrvatska udruga linux korisnika

javasvet

openBLEND

BULGARIAN Java User Group

NetBeans User Group Serbia

kompetencijski centar za programsko inženjerstvo u otvorenim sustavima
Competence center for software engineering in open systems

SIOUG

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MREŽA

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