

KARSTEN SILZ

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**WHY IS JAVA SO
EXPENSIVE – AND HOW
CAN I MAKE IT CHEAPER?**



SUMMARY

**JAVA EXPENSIVE:
USES MORE RAM & CPU
THAN JAVASCRIPT OR GO**

YOU CARE:
JAVASCRIPT & PYTHON
COMPETITION

JAVA CHEAPER:
CLASS SHARING,
CRAC¹², GRAALVM³⁴⁵

SLIDES & MORE



[HTTPS://BPFELI/JEX](https://bpfeli/jex)

AGENDA

WHY EXPENSIVE?

COMPETITION

HOW CHEAPER?

WHY EXPENSIVE?

JAVA USES MORE
RAM & CPU THAN
JAVASCRIPT OR GO

WHY?

JAVA UNDER THE HOOD

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

MORE CPU TIME

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

RUNS EACH TIME,
SAME RESULT:
MANY JAVA OBJECTS

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

PROFILING,
FAST COMPILATION (C1),
PROFILING,
OPTIMIZED COMPILATION (C2)

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

MORE RAM

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

PROFILER & COMPILER
RUNS IN OUR APP

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

WORKS FOR LONG-
RUNNING APPS NEEDING
A LOT OF MEMORY

= JAVA APP SERVERS

JAVA USES MORE
RAM & CPU THAN
JAVASCRIPT OR GO

WHY EXPENSIVE?

AGENDA

WHY EXPENSIVE?

COMPETITION

HOW CHEAPER?

AGENDA

WHY EXPENSIVE?

COMPETITION

HOW CHEAPER?

COMPETITION

JAVASCRIPT & PYTHON

COMPETITION

WHY?

JAVA APP SERVERS

IN THE PAST

APP SERVER

JAVA
MONOLITH

JAVA
MONOLITH

NOW

CONTAINER MANAGER

JAVA
MIC.-SERV.

JAVA
MIC.-SERV.

C#
MIC.-SERV.

GO
MIC.-SERV.

JS
MIC.-SERV.

PYTHON
MIC.-SERV.

JAVASCRIPT & PYTHON

COMPETITION FOR

ENTERPRISE JAVA

JAVA IS FASTER...

...**BUT** THAT OFTEN
DOES **NOT** MATTER

SLOW JAVASCRIPT APP

BETTER THAN

NO JAVA APP

OFTEN NOT ENOUGH
JAVA DEVELOPERS

IF APP SPENDS
90% OF TIME **WAITING**
FOR DB & APIS...

...THEN **JAVA** CAN BE
ONLY **10%** FASTER

JAVASCRIPT & PYTHON

COMPETITION

COMPETITION

AGENDA

WHY EXPENSIVE?

COMPETITION

HOW CHEAPER?

AGENDA

WHY EXPENSIVE?

COMPETITION

HOW CHEAPER?

HOW CHEAPER?

**CLASS SHARING,
CRAC, GRAALVM**

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

RUNS EACH TIME,
SAME RESULT:
MANY JAVA OBJECTS

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

CACHE JAVA OBJECTS

STORE
JAVA OBJECTS
ON **FIRST** RUN...

...AND **LOAD** THEM
ON **NEXT** RUNS

#1

CLASS DATA SHARING

SAVES CPU TIME

CACHE CLASS LIST

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

SAVES [~]10% OF
STARTUP TIME

ENABLED WITH JAVA 17

JRE PARAMETERS

#2

CRAC SAVES CPU TIME

COORDINATED RESTORE AT CHECKPOINT

CACHE
FULL APPLICATION
SNAPSHOT

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

CRAC SAVES STARTUP TIME:

QUARKUS: 1 S \Rightarrow 46 MS

SPRING BOOT: 3.9 S \Rightarrow 38 MS

JAVA CHEAPER:
CLASS SHARING,
CRAC¹², GRAALVM³⁴⁵

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CLASS SHARING,
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1 AZUL JDK

2 SPRING BOOT 3.1 /

QUARKUS / MICRONAUT

#3

GRAALVM NATIVE IMAGE
SAVES CPU **TIME & RAM**

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

**MOVE WORK
TO BUILD TIME**

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

BUILD TIME

JVM

JIT COMPILER

BYTE-
CODE

CLASS
LIST

INIT JDK &
FRAMEWORK

INIT
APP

...

MACHINE
CODE

RUNTIME

JAVA COMPILER

**SOURCE
CODE**

**BYTE-
CODE**

JIT COMPILER

**MACHINE
CODE**

BUILD TIME

JVM

**BYTE-
CODE**

**CLASS
LIST**

**INIT JDK &
FRAMEWORK**

**INIT
APP**

...

RUNTIME

JAVA COMPILER

**SOURCE
CODE**

**BYTE-
CODE**

BUILD TIME

**AOT: AHEAD-OF-TIME
(LIKE C++-COMPILER)**

AOT COMPILER

**MACHINE
CODE**

JVM

**BYTE-
CODE**

**CLASS
LIST**

**INIT JDK &
FRAMEWORK**

**INIT
APP**

...

RUNTIME

JAVA COMPILER

**SOURCE
CODE**

**BYTE-
CODE**

AOT COMPILER

**MACHINE
CODE**

BUILD TIME

JVM

**MACHINE
CODE**

**CLASS
LIST**

**INIT JDK &
FRAMEWORK**

**INIT
APP**

...

RUNTIME

JAVA COMPILER

**SOURCE
CODE**

**BYTE-
CODE**

AOT COMPILER

**MACHINE
CODE**

BUILD TIME

JVM

**MACHINE
CODE**

**CLASS
LIST**

**INIT JDK &
FRAMEWORK**

**INIT
APP**

RUNTIME

JAVA COMPILER

AOT COMPILER

**SOURCE
CODE**

**BYTE-
CODE**

**CLASS
LIST**

**MACHINE
CODE**

BUILD TIME

JVM

**MACHINE
CODE**

**INIT JDK &
FRAMEWORK**

**INIT
APP**

RUNTIME

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

CLASS
LIST

AOT COMPILER

INIT JDK &
FRAMEWORK

INIT
APP

MACHINE
CODE

BUILD TIME

JVM

MACHINE
CODE

INIT JDK &
FRAMEWORK

INIT
APP

RUNTIME

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

CLASS
LIST

AOT COMPILER

MUCH INIT JDK &
FRAMEWORK

MUCH INIT
APP

MACHINE
CODE

BUILD TIME

JVM

MACHINE
CODE

INIT JDK &
FRAMEWORK

INIT
APP

RUNTIME

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

CLASS
LIST

AOT COMPILER

MUCH INIT JDK &
FRAMEWORK

MUCH INIT
APP

MACHINE
CODE

BUILD TIME

JVM

MACHINE
CODE

LITTLE INIT JDK &
FRAMEWORK

LITTLE INIT
APP

RUNTIME

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

CLASS
LIST

GRAALVM NATIVE IMAGE

MUCH INIT JDK &
FRAMEWORK

MUCH INIT
APP

MACHINE
CODE

BUILD TIME

JVM

MACHINE
CODE

LITTLE INIT JDK &
FRAMEWORK

LITTLE INIT
APP

RUNTIME

JAVA COMPILER

SOURCE
CODE

BYTE-
CODE

CLASS
LIST

GRAALVM NATIVE IMAGE

MUCH INIT JDK &
FRAMEWORK

MUCH INIT
APP

MACHINE
CODE

BUILD TIME

SUBSTRATE VM

MACHINE
CODE

LITTLE INIT JDK &
FRAMEWORK

LITTLE INIT
APP

RUNTIME

**GRAALVM NATIVE IMAGE =
NATIVE EXECUTABLES**

INSTEAD OF 1X **BYTECODE**...

```
java -jar my-app-1.2.jar
```

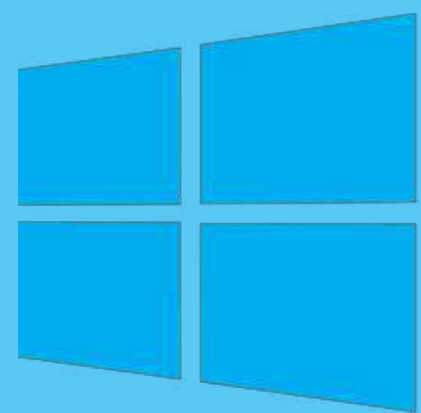
...3 EXECUTABLE PROGRAMS



`./my-app-1.2-runner`



`./my-app-1.2-runner`



`my-app-1.2-runner.exe`

SAVINGS WITH
GRAALVM NATIVE IMAGE

SB 2 \Rightarrow **QUARKUS:**

STARTUP

MS: 640 \Rightarrow **10.4**

MB: 98 \Rightarrow **7.3**

SB 2 \Rightarrow **QUARKUS** \Rightarrow **GO:**

STARTUP

MS: 640 \Rightarrow **10.4** \Rightarrow **2.6**

MB: 98 \Rightarrow **7.3** \Rightarrow **2.8**

JAVA CHEAPER:
CLASS SHARING,
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3 NOT ALL JAVA WORKS

4 SPRING BOOT 3.0 /

QUARKUS / MICRONAUT

**5 BUILD &
TROUBLESHOOTING
MORE EXPENSIVE**

**CLASS SHARING,
CRAC, GRAALVM**

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