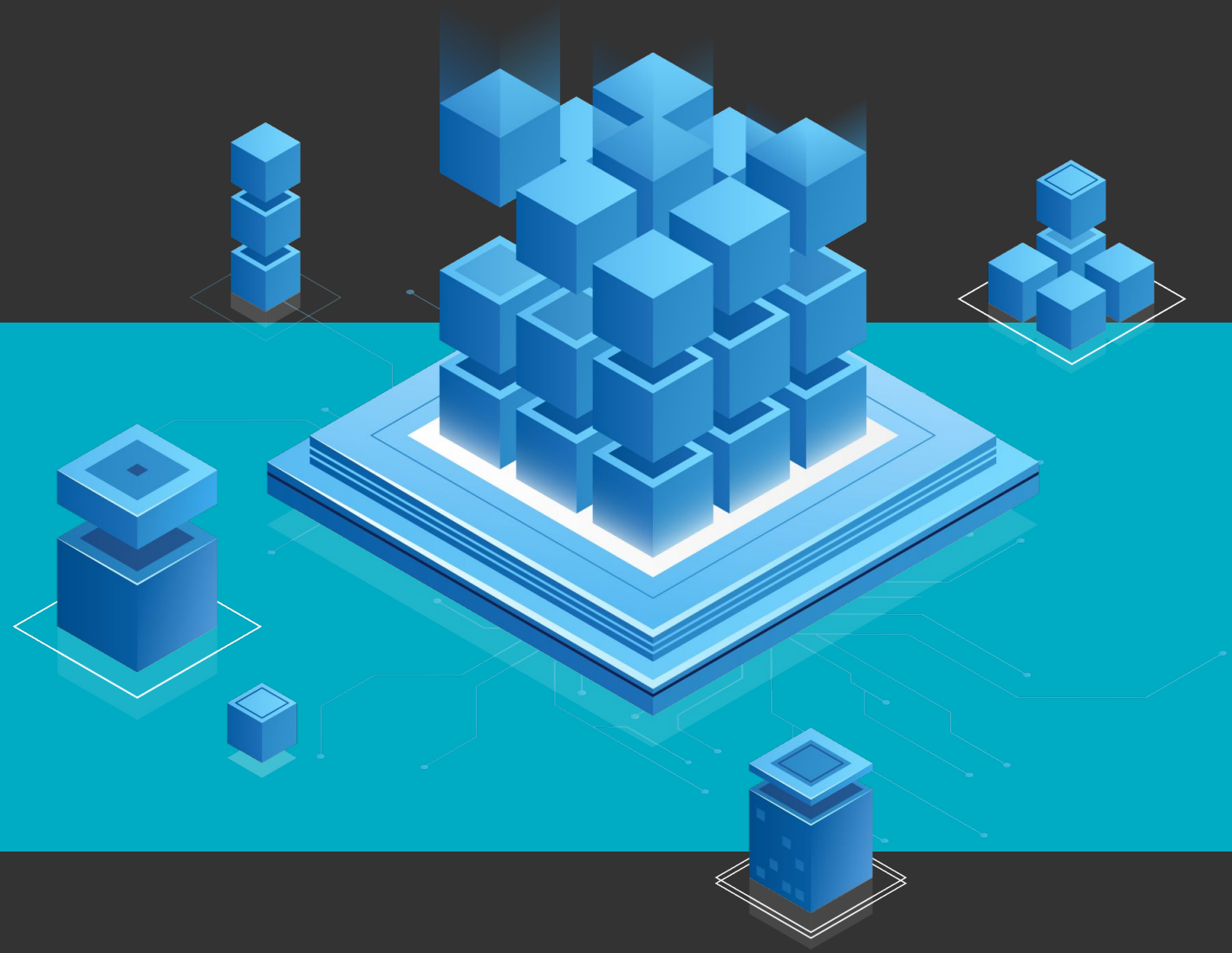
BELLSOFT

Going beyond the container



Dmitry Chuyko

2021

Who we are

Dmitry Chuyko

BELLSOFT

Liberica www.bell-sw.com
supported OpenJDK binaries

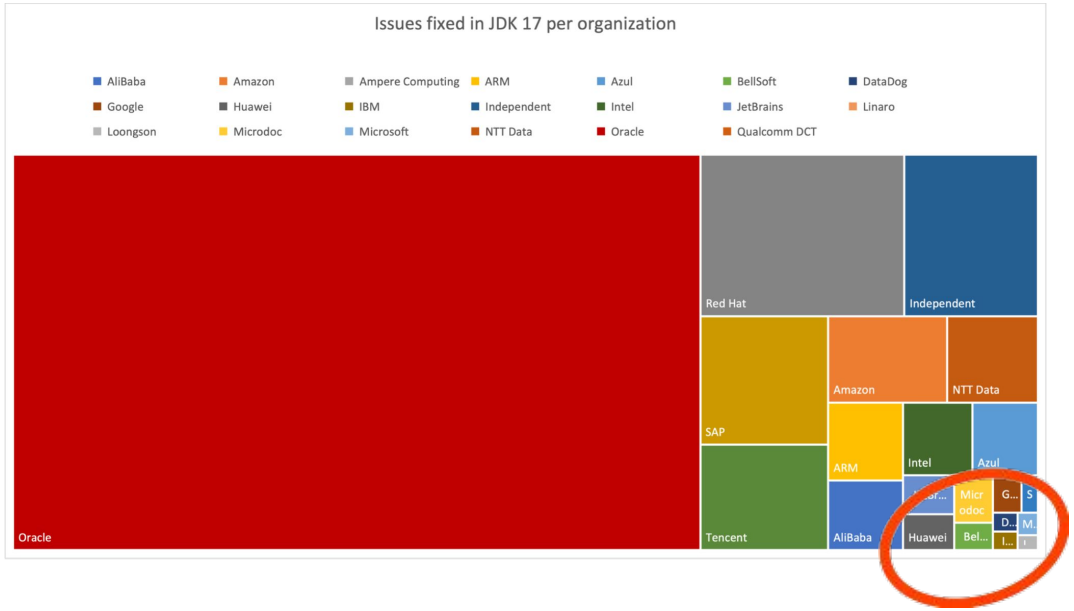
ex-employers:

ORACLE

@dchuyko

OpenJDK Contributions

LTS



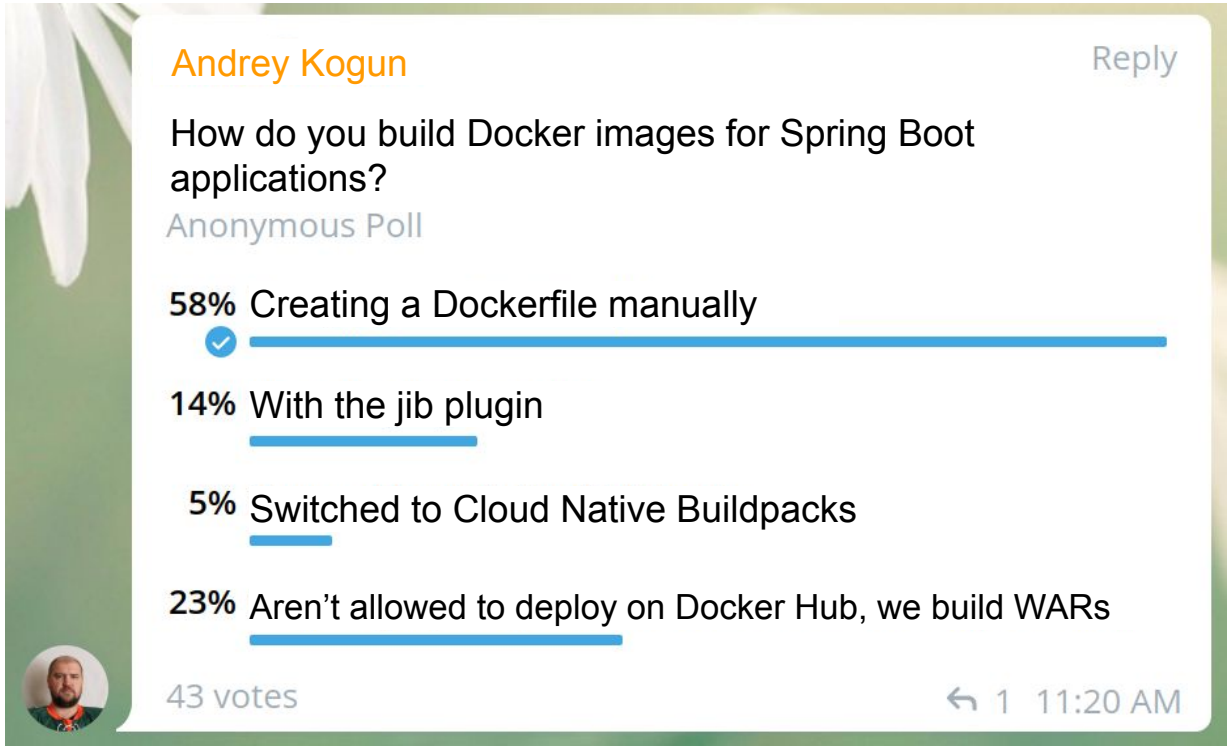
BELLSOFT

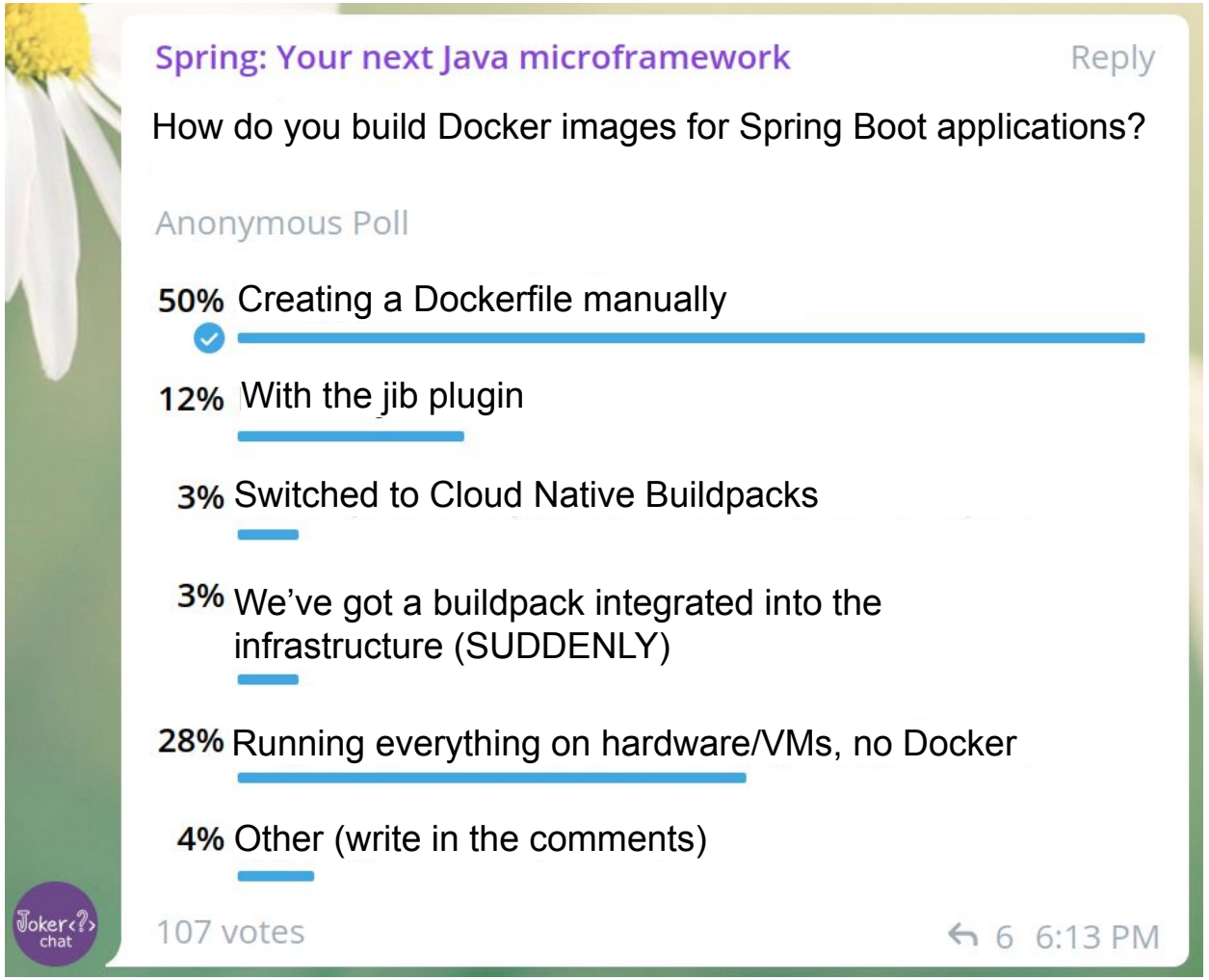
Deployment

> *...package an application with all of its dependencies into a standardized unit for software development.*
>
> — Docker

Developer Voice

- Aleksey Nesterov. Spring: Your next Java microframework
- Vladimir Plizga. Spring Boot "fat" JAR: Thin parts of a thick artifact





Sample Microservice

- Spring Initializr
- Spring Boot 2.5.6 (release)
- Spring Data JPA
- Lombok
- Spring Web
- H2
- Java 11
- Spring Native 0.10.4 (*experimental*)

- Thin jar 50 kB
- Fat jar **38 MB**

Pull Time (100 Mbps)

```
$ time docker pull openjdk
...
real    0m27.990s
user    0m0.095s
sys 0m0.096s
```

28 s

Uncompressed Size (disk)

```
$ docker history openjdk
IMAGE          CREATED       CREATED BY                                      SIZE
ff693b5bd1bb   5 weeks ago   /bin/sh -c #(nop)  CMD ["jshell"]               0B
<missing>      5 weeks ago   /bin/sh -c set -eux;   arch="$(objdump="$(co…   321MB
<missing>      5 weeks ago   /bin/sh -c #(nop)  ENV JAVA_VERSION=17          0B
<missing>      5 weeks ago   /bin/sh -c #(nop)  ENV LANG=C.UTF-8             0B
<missing>      5 weeks ago   /bin/sh -c #(nop)  ENV PATH=/usr/java/openjd…   0B
<missing>      5 weeks ago   /bin/sh -c #(nop)  ENV JAVA_HOME=/usr/java/o…   0B
<missing>      5 weeks ago   /bin/sh -c set -eux;  microdnf install   gzi…   39.3MB
<missing>      5 weeks ago   /bin/sh -c #(nop)  CMD ["/bin/bash"]            0B
<missing>      5 weeks ago   /bin/sh -c #(nop) ADD file:ab982d6f37710c434…   111MB
```

```
$ docker images | head -n 1; docker images | grep openjdk
REPOSITORY          TAG                 IMAGE ID            CREATED             SIZE
openjdk             latest              ff693b5bd1bb        5 weeks ago         471MB
```

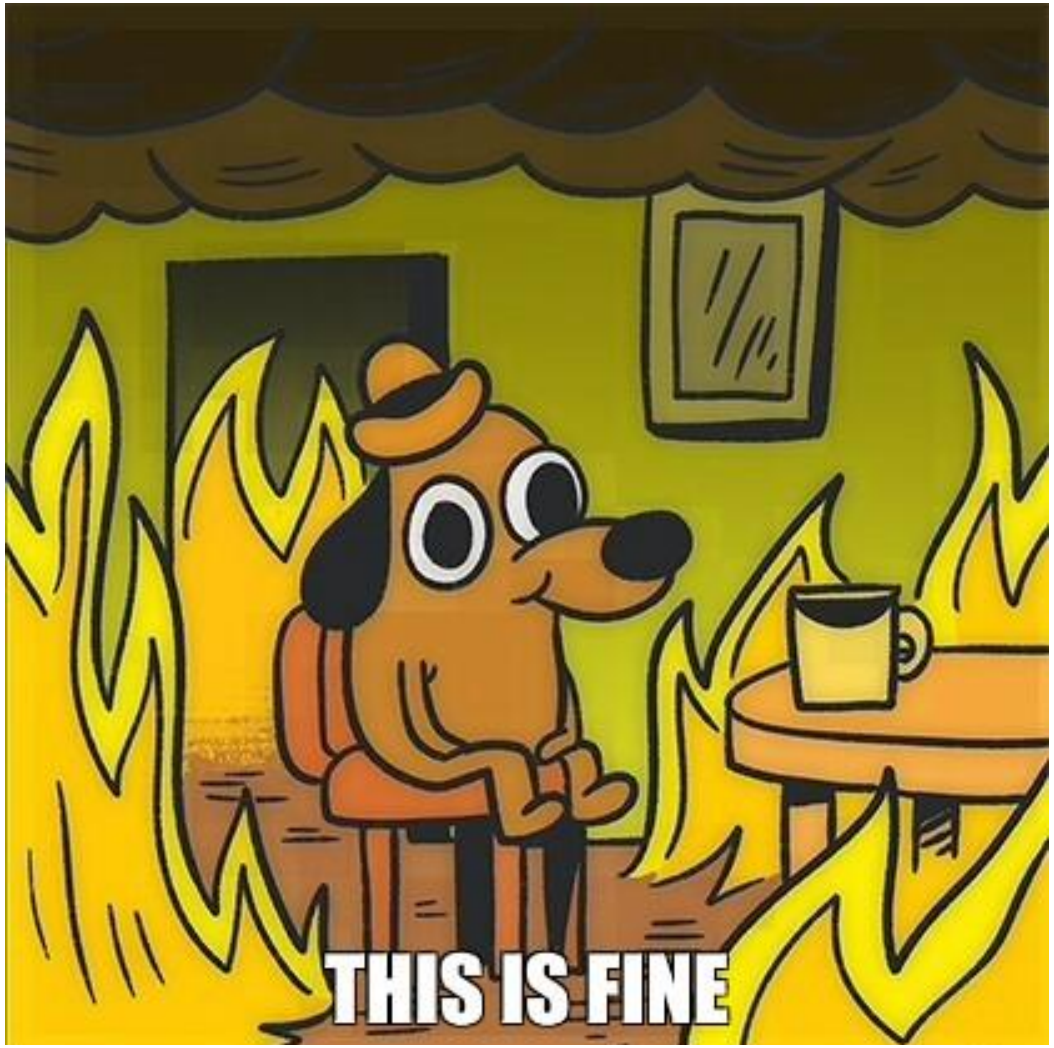
471 MB

Deployment Costs. Cloud

x 0.251 GB
x 1k deploys

= 0.25 TB

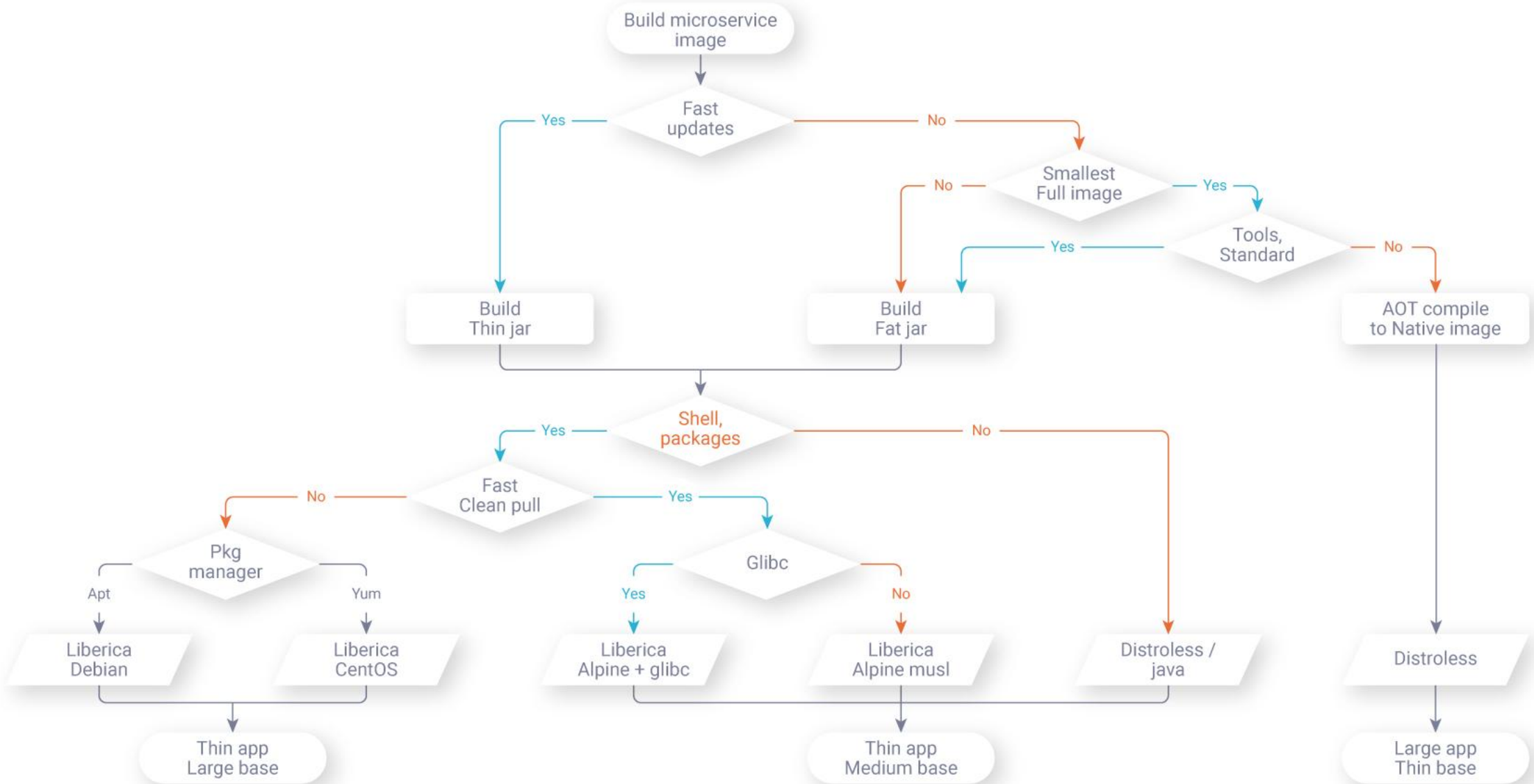
- Tens of seconds for a single pull
- Shared HW
- Shared I/O limits
- Keep old versions
- On-premise / private cloud?
- Elastic fleet
- 10 Mbps
- JDK update



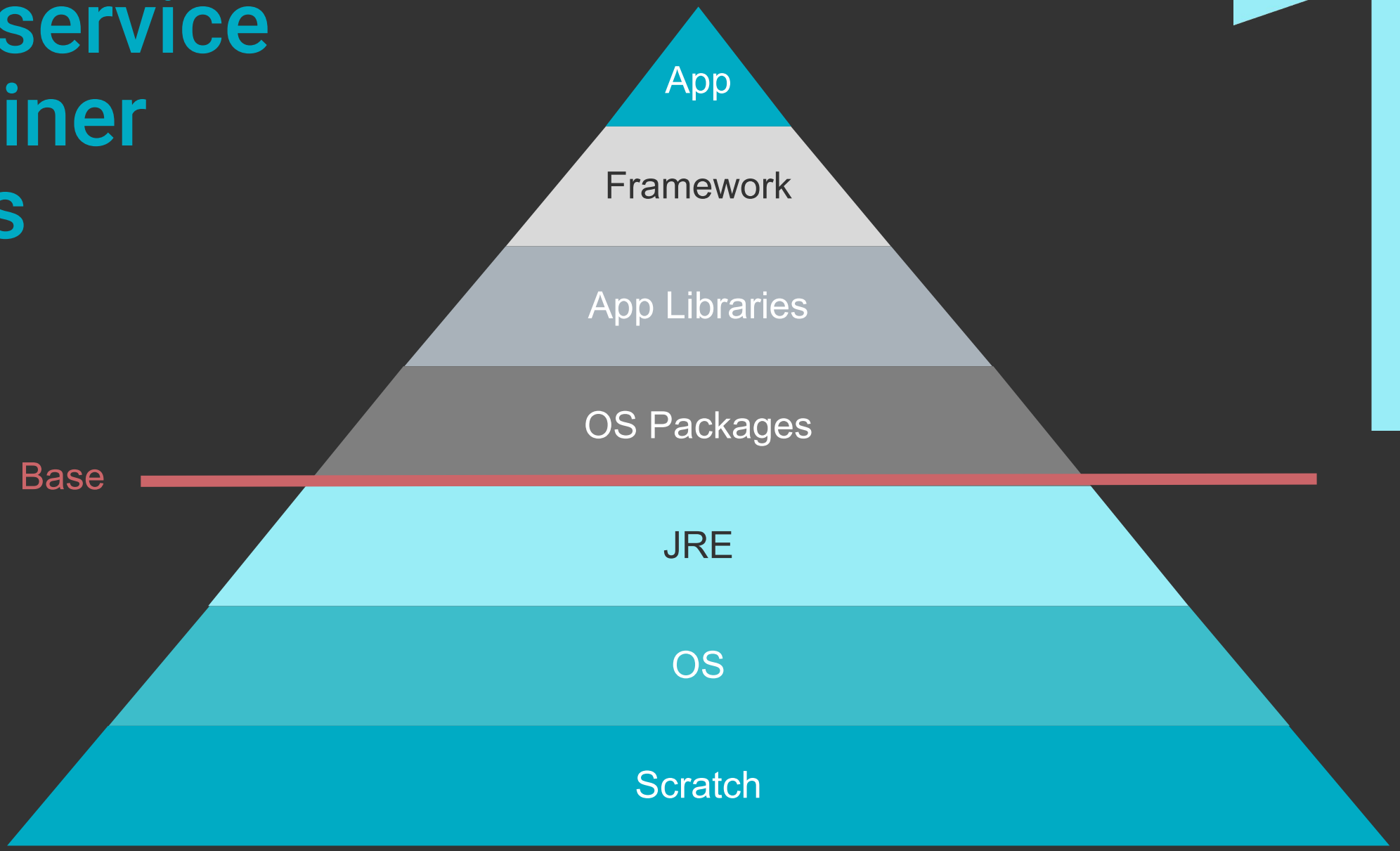
Smaller Containers Can Help

Images are transferred over the network across domains, so less traffic is cheaper. At the same time, every deployment will go faster.

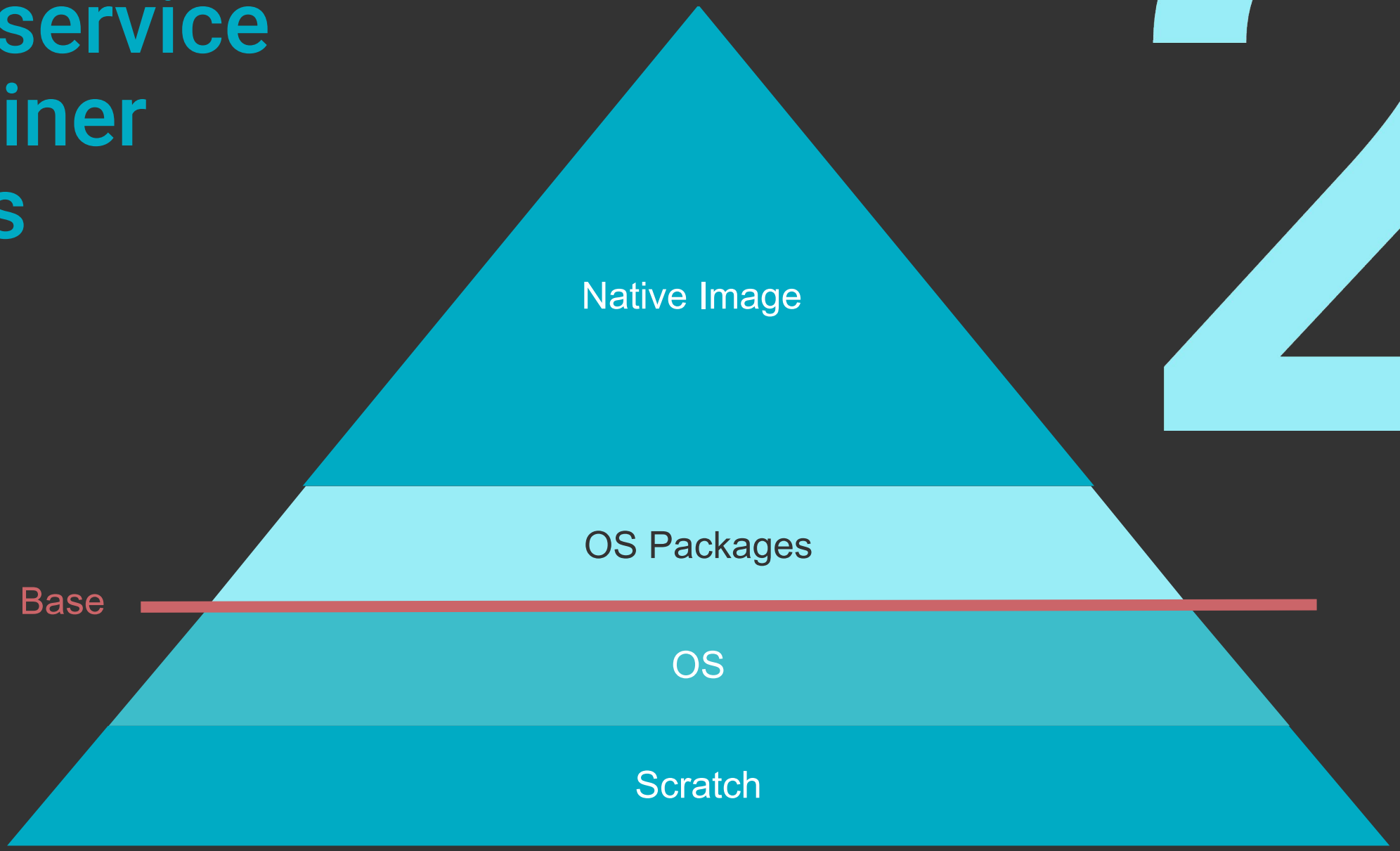
The paid registry needs to contain less volume of data, and less data is transferred out.


Build microservice image
Fast updates
Yes
No
Smallest Full image
No
Yes
Tools, Standard
Yes
No
Build Thin jar
Build Fat jar
AOT compile to Native image
Shell, packages
Yes
No
Fast Clean pull
No
Yes
Pkg manager
Apt
Yum
Glibc
Yes
No
Liberica Debian
Liberica CentOS
Liberica Alpine + glibc
Liberica Alpine musl
Distroless / java
Distroless
Thin app Large base
Thin app Medium base
Large app Thin base

Microservice Container Layers



Microservice Container Layers



Base/Parent Images

A **base image** has **FROM scratch** in its Dockerfile.

A **parent image** is the one that your image is based on. It refers to the contents of the FROM directive in the Dockerfile. Each subsequent declaration in the Dockerfile modifies this parent image. Most Dockerfiles start from a parent image rather than a base image. **However, the terms are sometimes used interchangeably**.

OS + JDK images

- **Based on OS images**
- **JDK package installation**
  - Package manager
  - Package
  - Same vendor
- **JDK binary installation**
  - Requirements
  - Compatibility
- **Ask your provider about testing**

Everyone wants out of the box service

“...out of the box services that assist you when building Microservices, monoliths or any application in a linux container (Docker/Rocket) environment and are built on top of Kubernetes.”

— *Fabric8*

Everyone wants out of the box service

“transform your application source code into images that can run on any cloud.”

— *Cloud Native Buildpacks*

Fabric8? Centos?

```
$ docker run -it fabric8/java-centos-openjdk8-jre java -version

openjdk version "1.8.0_262"
OpenJDK Runtime Environment (build 1.8.0_262-b10)
OpenJDK 64-Bit Server VM (build 25.262-b10, mixed mode)

$ docker run -it bellsoft/liberica-openjre-centos:8-x86_64 java -version
openjdk version "1.8.0_302"
OpenJDK Runtime Environment (build 1.8.0_302-b08)
OpenJDK 64-Bit Server VM (build 25.302-b08, mixed mode)

REPOSITORY                          TAG          SIZE
bellsoft/liberica-openjre-centos    8-x86_64     329MB
fabric8/java-centos-openjdk8-jre    latest       424MB
```

```
$ docker run -it fabric8/java-alpine-openjdk8-jre java -XX:StartFlightRecording -version

Unrecognized VM option 'StartFlightRecording'
Error: Could not create the Java Virtual Machine.
Error: A fatal exception has occurred. Program will exit.
```

- JDK-8223147: JFR Backport
  - Fix Version/s: openjdk8u262

Cloud Native Buildpacks

```
<image>
    <builder>paketobuildpacks/builder:base</builder>
        <env>
            <BP_NATIVE_IMAGE>false</BP_NATIVE_IMAGE>
        </env>
</image>
...
```

Cloud Native Buildpacks

```
...

$ mvn spring-boot:build-image
...
[INFO]     [creator]     ===> EXPORTING
[INFO]     [creator]     Adding layer 'paketo-buildpacks/ca-certificates:helper
[INFO]     [creator]     Adding layer 'paketo-buildpacks/bellsoft-liberica:help
[INFO]     [creator]     Adding layer
'paketo-buildpacks/bellsoft-liberica:java-security-properties'
[INFO]     [creator]     Adding layer 'paketo-buildpacks/bellsoft-liberica:jre'
[INFO]     [creator]     Adding layer 'paketo-buildpacks/bellsoft-liberica:jvmkill'
[INFO]     [creator]     Adding layer 'paketo-buildpacks/executable-jar:classpath'
[INFO]     [creator]     Adding layer 'paketo-buildpacks/spring-boot:helper'
[INFO]     [creator]     Adding layer 'paketo-buildpacks/spring-boot:spring-cloud-bindings'
[INFO]     [creator]     Adding layer 'paketo-buildpacks/spring-boot:web-application-type'
[INFO]     [creator]     Adding 5/5 app layer(s)
[INFO]     [creator]     Adding layer 'launcher'
[INFO]     [creator]     Adding layer 'config'
[INFO]     [creator]     Adding layer 'process-types'
...
```

Uncompressed Size (disk)

```
...
[INFO] Successfully built image 'docker.io/library/demo:0.0.1-SNAPSHOT'

$ docker images --format "table {{.Tag}}\t{{.Size}}" demo

TAG                 SIZE
0.0.1-SNAPSHOT      282MB
```

282 MB

OS Layer	Wire	Disk	libc	pkg man	shell
Ubuntu	27 MB	73 MB	glibc	apt	bash
Debian	48 MB	114 MB	glibc	apt	bash
Debian Slim	26 MB	69 MB	glibc	apt	bash
CenOS	71 MB	215 MB	glibc	yum	bash
RHEL Atomic Base	31 MB	78 MB	glibc	microdnf	bash
GCR Distroless base	7.6 MB	17 MB	glibc	—	—
Alpine	**2.7 MB**	**5.6 MB**	musl	apk	ash
GCR Distroless static	0.6 MB	1.8 MB	—	—	—

Alpine Linux Port

... is a security-oriented, lightweight Linux distribution based on musl libc and busybox.

— Alpine

JDK 16

- JEP 386: Alpine Linux Port
- openjdk.java.net/jeps/386
- openjdk.java.net/projects/portola
  - Port of the JDK to the Alpine Linux distribution, and in particular the musl C library

Owner	Boris Ulasevich
Type	Feature
Scope	Implementation
Status	Integrated
Release	16
Component	hotspot / runtime
Discussion	portola dash dev at openjdk dot java dot net
Effort	M
Duration	M
Reviewed by	Alan Bateman, Vladimir Kozlov
Endorsed by	Mikael Vidstedt
Created	2019/08/13 10:33
Updated	2020/10/14 07:48
Issue	8229469

Summary

Port the JDK to Alpine Linux, and to other Linux distributions that use musl as their primary C library, on both the x64 and AArch64 architectures,

Motivation

Musl is an implementation, for Linux-based systems, of the standard library functionality described in the ISO C and POSIX standards. Several Linux distributions including Alpine Linux and OpenWrt are based on musl, while some others provide an optional musl package (e.g., Arch Linux).

The Alpine Linux distribution is widely adopted in cloud deployments, microservices, and container environments due to its small image size. A Docker base image for Alpine Linux, for example, is less than 6 MB. Enabling Java to run out-of-the-box in such settings will allow Tomcat, Jetty, Spring, and other popular frameworks to work in such environments natively.

By using `jlink` (JEP 282) to reduce the size of the Java runtime, a user will be able to create an even smaller image targeted to run a specific application. The set of modules required by an application can be determined via the `jdeps` command.

Portola Expansion

- **JDK 11 LTS**
  - Not in mainline (yet)
  - Historical downports in Liberica 9+
- **JDK 8 LTS**
  - Liberica 8u on Dockerhub
- **AArch64**

Pull Time

```
$ time docker pull bellsoft/liberica-openjdk-alpine-musl:latest
...
real    0m3.957s
user    0m0.026s
sys 0m0.061s
```

4 s

Alfa Bank

> ***Microcontainers are an obvious benefit of Liberica JDK! As time has shown, it is really important.***
>
> **— Pavel Derendyaev**

JDK 8. Fabric8? Alpine?

```
REPOSITORY                                TAG   SIZE
bellsoft/liberica-openjdk-alpine-musl     8     152MB
fabric8/java-alpine-openjdk8-jdk          8     108MB
```

```
# zipinfo /usr/lib/jvm/jdk-8u282-bellsoft-x86_64/jre/lib/rt.jar

19839 files, 61949762 bytes uncompressed, 61949762 bytes compressed:  0.0%

# zipinfo /usr/lib/jvm/java-1.8-openjdk/jre/lib/rt.jar

19783 files, 70086222 bytes uncompressed, 31066529 bytes compressed:  55.7%
```

```
$ run -it -v $(pwd)/demo:/demo bellsoft/liberica-openjdk-alpine-musl:8 \
  java -jar /demo/spring-petclinic-2.4.2.jar
```

Avg. startup
6.03 s

```
$ run -it -v $(pwd)/demo:/demo fabric8/java-alpine-openjdk8-jdk \
  java -jar /demo/spring-petclinic-2.4.2.jar
```

Avg. startup
6.81 s

Difference is 12.6%

Profiling. Fabric8?

```
Download async-profiler, setup host

$ docker run --cap-add SYS_ADMIN -it -v $(pwd)/demo:/demo <...> ash

# apk add libstdc++

# java -jar ...

# ./profiler.sh -d 4 $(pidof java)
```

Profiling. Fabric8?

```
fabric8/java-alpine-openjdk8-jdk

          ns  percent  samples  top
  ----------  -------  -------  ---
 12291873038   85.40%     1229  /usr/lib/jvm/java-1.8-openjdk/jre/lib/amd64/serve      jvm.so
   150020578    1.04%       15  /lib/libz.so.1.2.11
    90100718    0.63%        9  /lib/ld-musl-x86_64.so.1
    90021783    0.63%        9  sun.net.www.ParseUtil.encodePath
    80099952    0.56%        8  tss_get

bellsoft/liberica-openjdk-alpine-musl:8

          ns  percent  samples  top
  ----------  -------  -------  ---
   979986354    6.03%       98  PhaseIdealLoop::is_dominator(Node*, Node*) [clone .part.0]
   740006769    4.55%       74  IndexSetIterator::advance_and_next()
   430016656    2.65%       43  PhaseChaitin::Split(unsigned int, ResourceArea*)
   360010587    2.22%       36  PhaseChaitin::build_ifg_physical(ResourceArea*)
   339999295    2.09%       34  SpinPause
```

Profiling. Fabric8?

```
fabric8/java-alpine-openjdk8-jdk

# objdump --syms /usr/lib/jvm/java-1.8-openjdk/jre/lib/amd64/server/libjvm.so

SYMBOL TABLE:
no symbols


bellsoft/liberica-openjdk-alpine-musl:8

# objdump --syms /usr/lib/jvm/jdk-8u282-bellsoft-x86_64/jre/lib/amd64/server/libjvm.so \
  | wc -l

41695
```

Alpine?

```
$ docker run -it -v $(pwd)/lists:/lists alpine ash

# apk add openjdk8

# java -jar ....

# jcmd $(pidof java)

ash: jcmd: not found

# /usr/lib/jvm/java-1.8-openjdk/bin/jcmd $(pidof java) VM.uptime
```

Alpine?

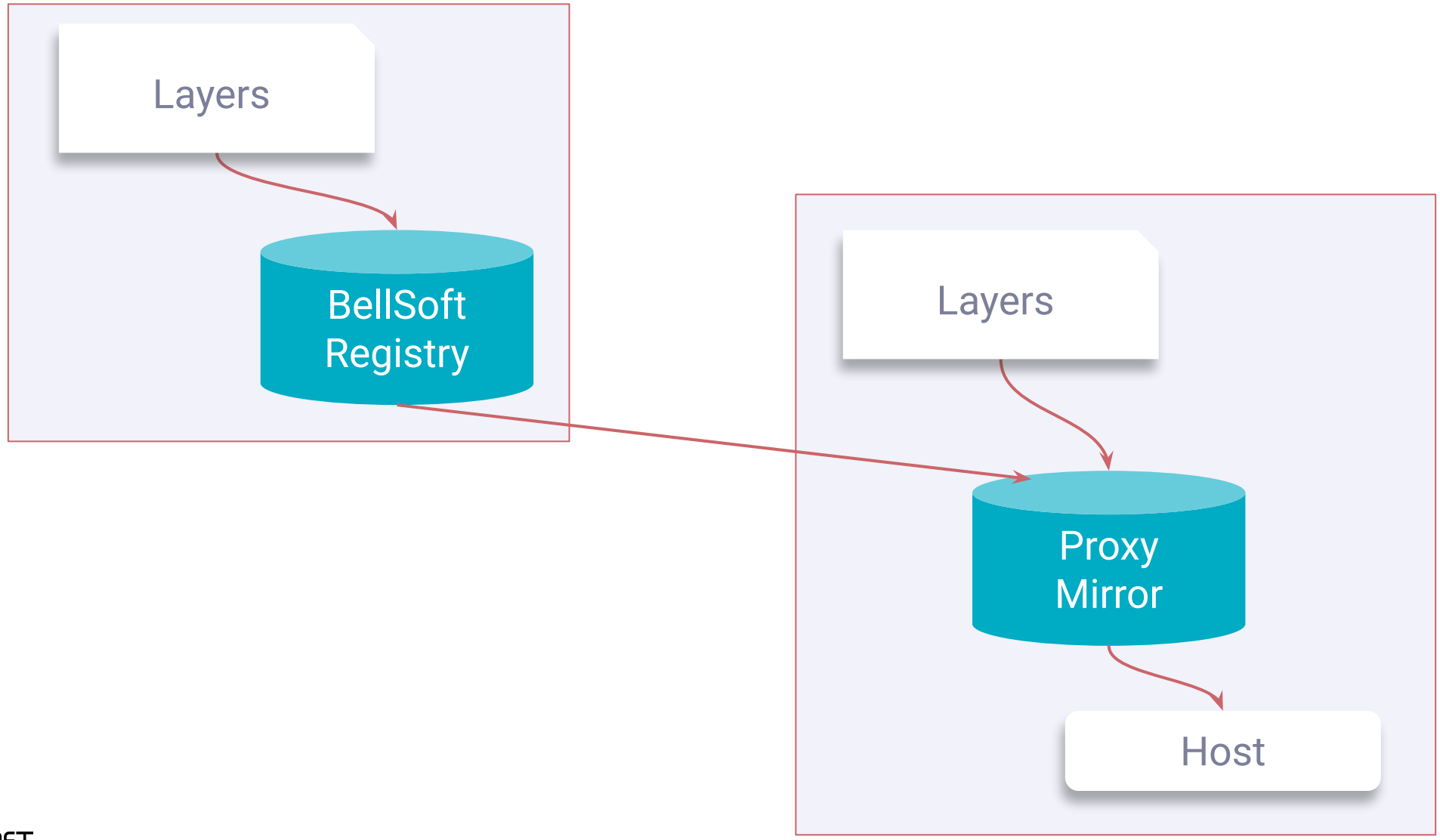
```
48:
2021-04-20 20:20:06
Full thread dump OpenJDK 64-Bit Server VM (25.275-b01 mixed mode):

"Service Thread" #9 daemon prio=9 os_prio=0 tid=0x00007fcb4675c800 nid=0x105 runn
[0x0000000000000000]
   java.lang.Thread.State: RUNNABLE
.......

$ docker run -it -v $(pwd)/lists:/lists bellsoft/liberica-openjdk-alpine-musl:8 ash

# java -jar ...

# jcmd $(pidof java) VM.uptime

6:
26.695 s
```

Trusted Registry

On November 20, 2020, rate limits anonymous and free authenticated use of Docker Hub went into effect.

— Dockerhub

Deploy an Image. Networks



Connect to Trusted Registry

Don't forget to configure credential helper

https://docs.docker.com/engine/reference/commandline/login/#credentials-store

```
$ docker login registry.bell-sw.com

Username: demo-user
Password:

Login Succeeded
```

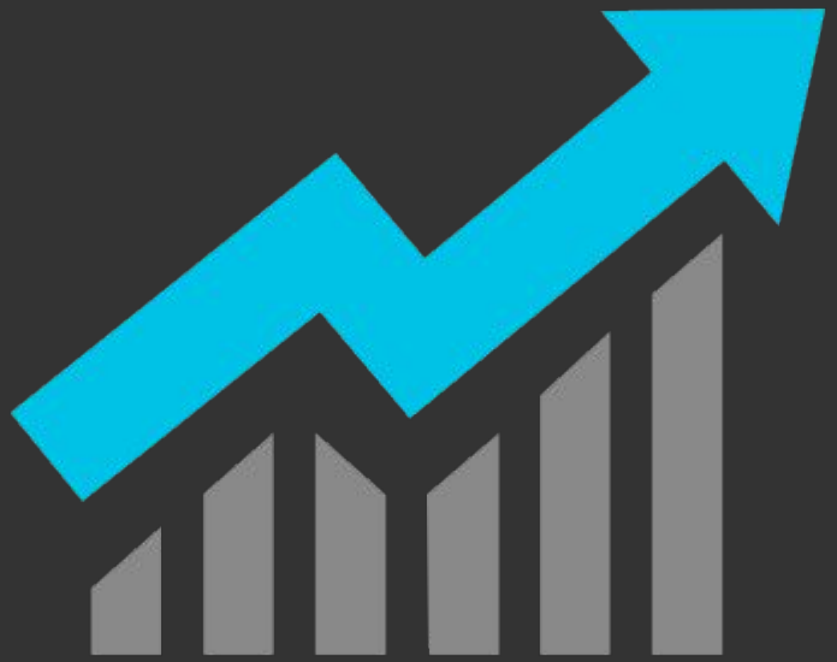
Download and Run a Container

```
$ docker pull registry.bell-sw.com/demo/liberica-openjdk-alpine-musl:11.0.10-9
...

$ docker pull registry.bell-sw.com/demo/liberica-openjdk-alpine-musl:11.0.10-10-ea
...

$ docker images --format "table {{.Tag}}\t{{.Size}}" \
> registry.bell-sw.com/demo/liberica-openjdk-alpine-musl

TAG                 SIZE
11.0.10-10-ea       99.8MB
11.0.10-9           106MB

$ docker run --rm -it registry.bell-sw.com/demo/liberica-openjdk-alpine-musl:11.0.10-10-ea

openjdk version "11.0.10" 2021-01-19
OpenJDK Runtime Environment (build 11.0.10+10-ea)
OpenJDK 64-Bit Server VM (build 11.0.10+10-ea, mixed mode)
```

Experimental optimizations

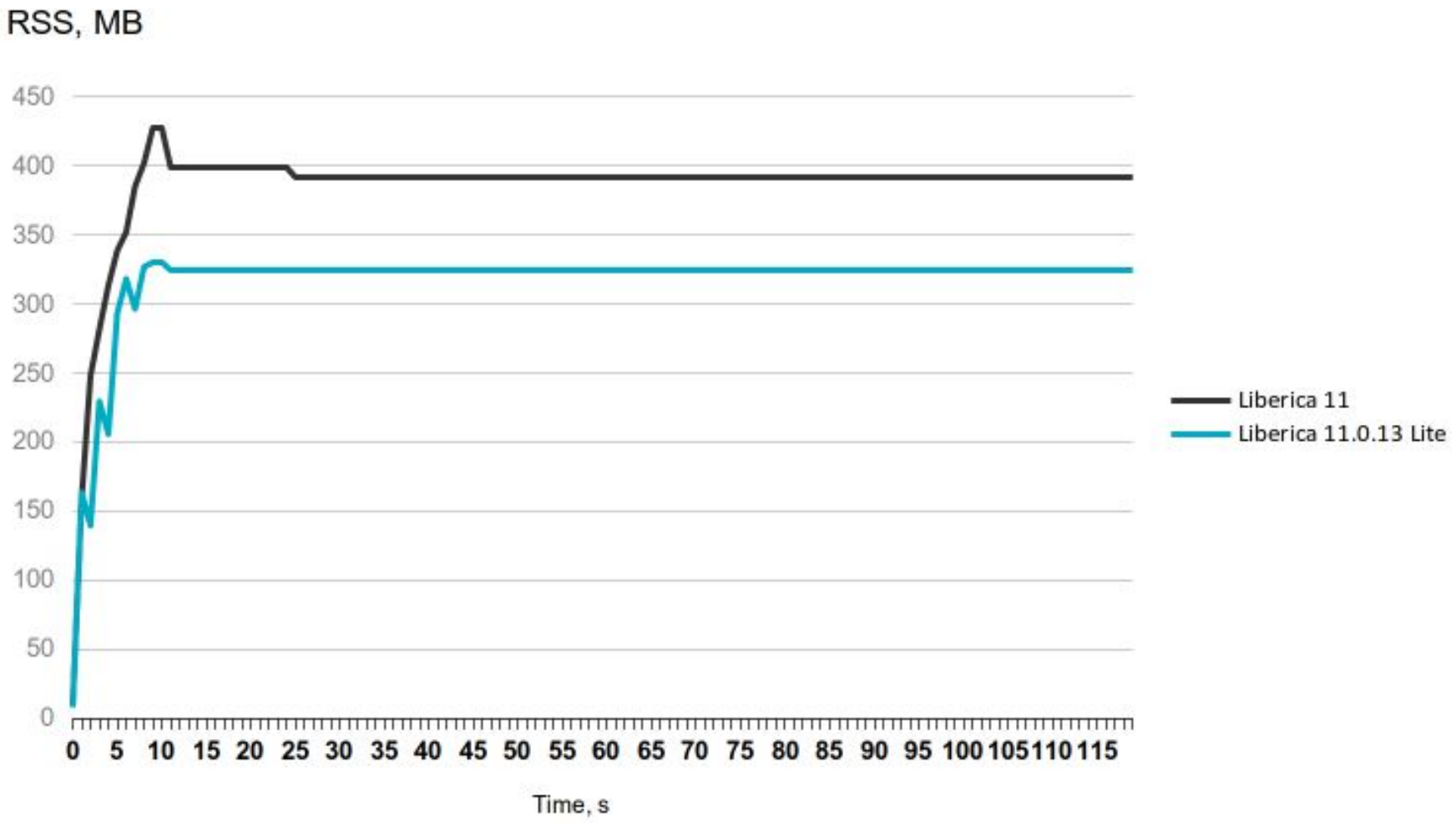
Experimental Optimizations

- Smaller size: by 6% slimmer
- Faster GC (G1, safepoints,...) - Up to 11% better latency
- Decreased memory footprint



Footprint

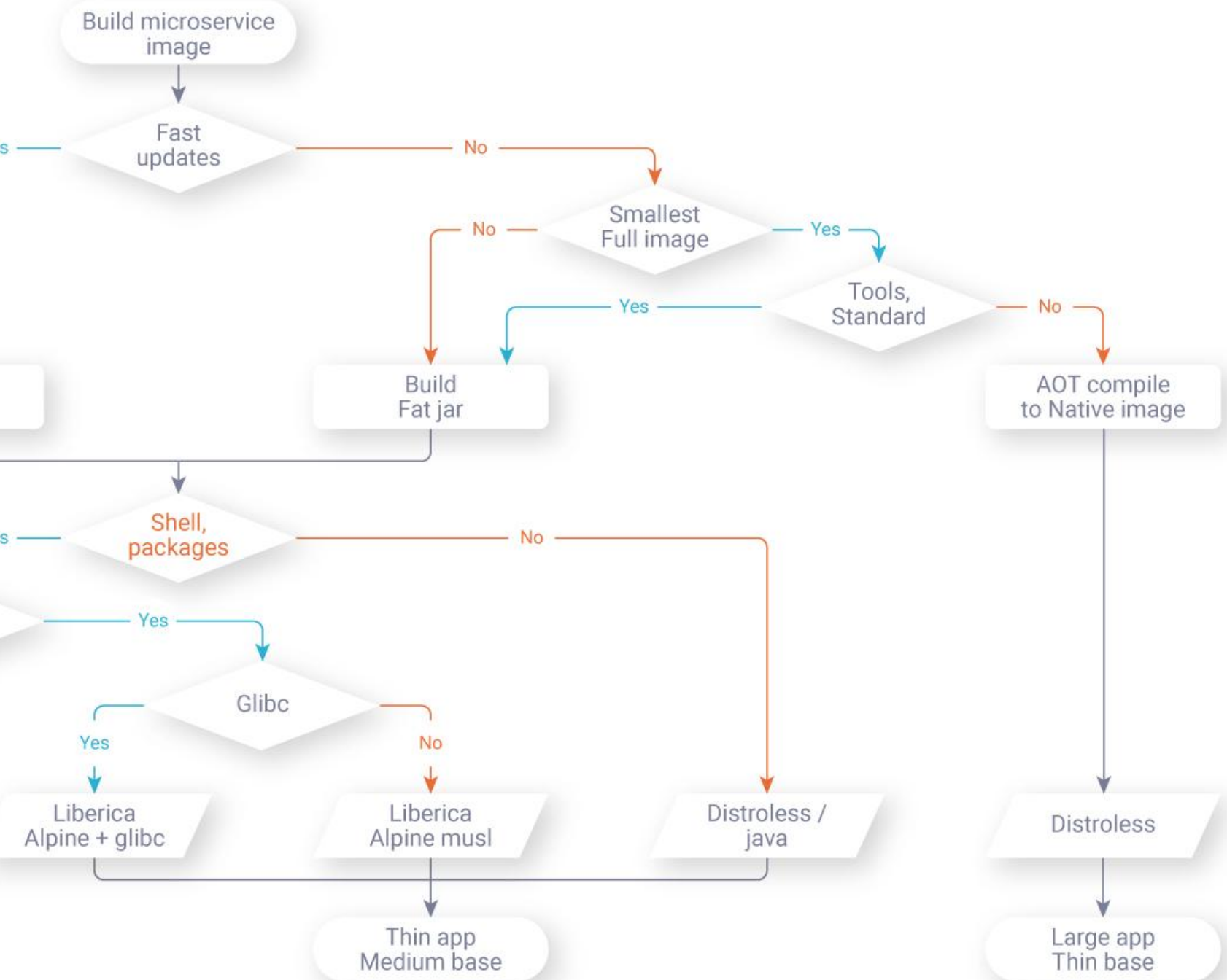
Petclinic. No load



Liberica JDK Images

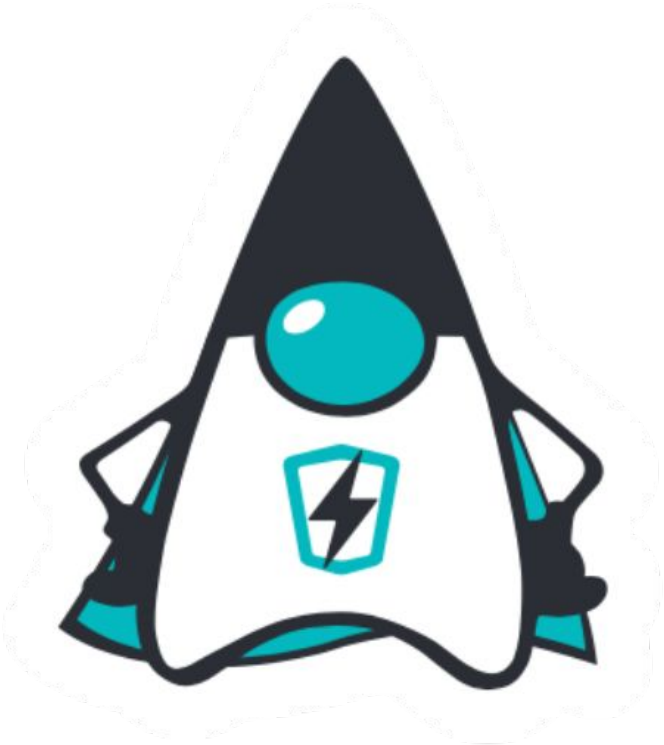
- hub.docker.com/r/bellsoft

OS + JDK 17 Image	Wire	Disk
bellsoft/liberica-openjdk-debian	131 MB	238 MB
bellsoft/liberica-openjdk-centos	147 MB	314 MB
bellsoft/liberica-openjdk-alpine	79 MB	124 MB
bellsoft/liberica-openjdk-alpine-musl	**71 MB**	**100 MB**


Build microservice image
Fast updates
No
Smallest Full image
No
Yes
Tools, Standard
Yes
No
Build Fat jar
AOT compile to Native image
Shell, packages
No
Yes
Glibc
Yes
No
Liberica Alpine + glibc
Liberica Alpine musl
Distroless / java
Distroless
Thin app Medium base
Large app Thin base

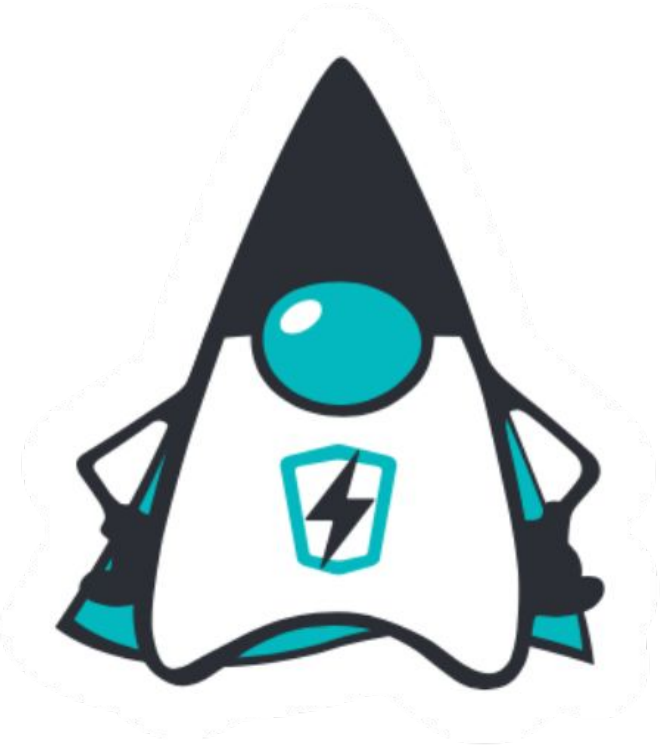
JDK 17

- JEP 410: Remove the Experimental AOT and JIT Compiler
- JVMCI is built and shipped, still experimental



GraalVM Licensing & Support

- Oracle GraalVM Enterprise Edition
  - For Non-production.
    Oracle Technology Network License Agreement
    for GraalVM Enterprise Edition.
  - For Production.
    Oracle Java SE Subscription
- GraalVM Community
  - GPLv2 + ”Classpath” Exception



Liberica NIK

A utility that converts your JVM-based application into a fully AOT compiled native executable [...] based on the open source GraalVM Community Edition.

Liberica Native Image Kit

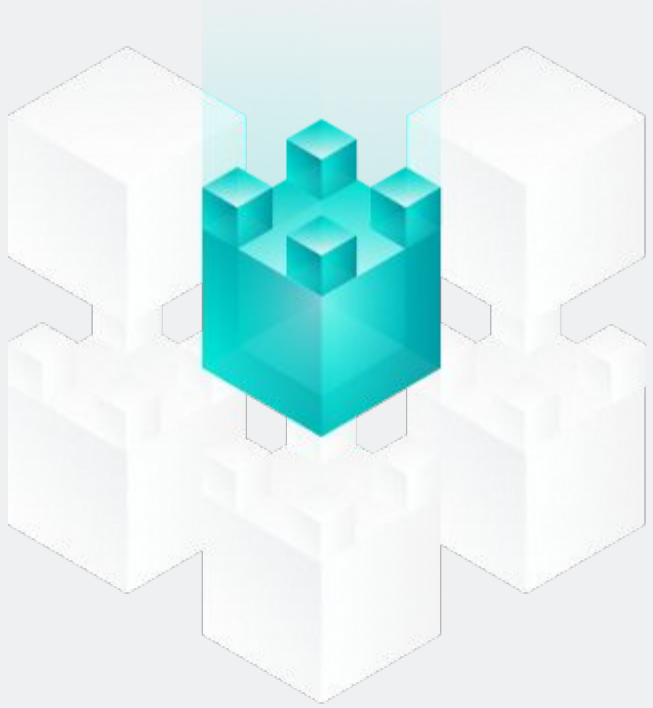
Multiple languages interaction

Most binaries already work with Java, JavaScript, LLVM, Python, Ruby, R, and WebAssembly, as do GraalVM Native Image™ binaries

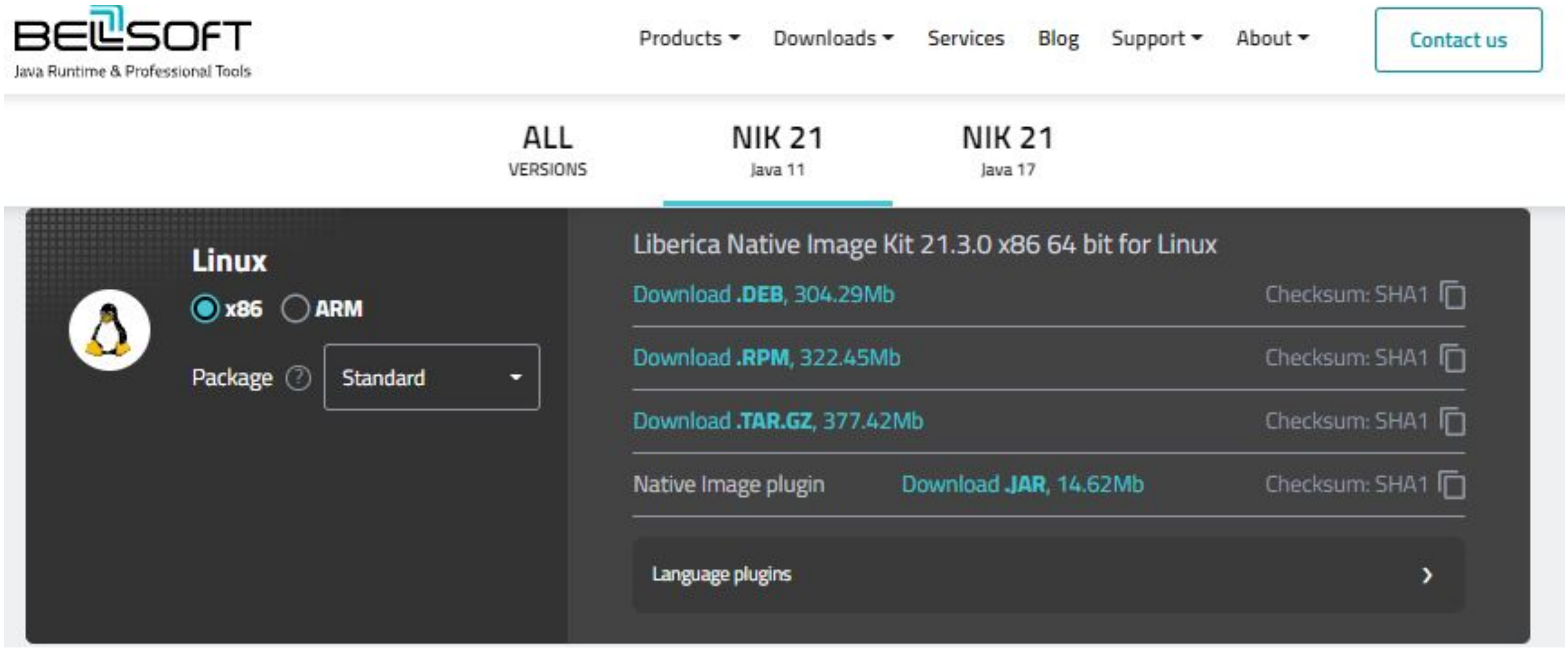
Liberica Native Image Kit

A wide and unique variety of supported platforms

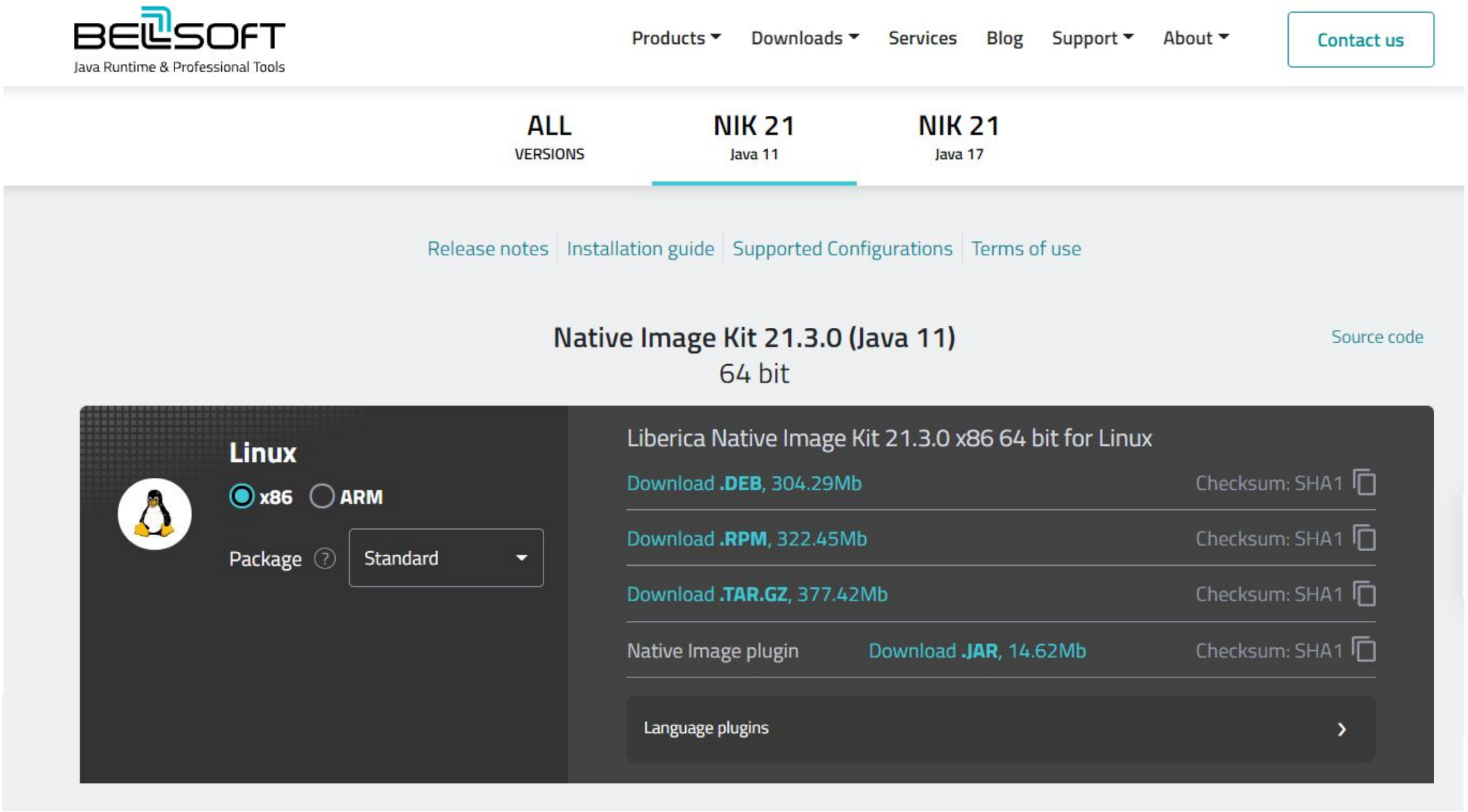
Linux x86_64 (glibc), Linux Alpine x86_64 (musl), Linux AArch64 (glibc), Linux Alpine AArch64 (musl), Mac OS x86_64 are supported



https://bell-sw.com/pages/downloads/native-image-kit/



https://bell-sw.com/pages/downloads/native-image-kit/



Graal Support for Alpine and musl

- Runnable tools
- Static musl linking
- Dynamic linking
  - graal/pull/3141: linux-musl-amd64 support
  - mx/pull/230: Linux-musl support
  - fastr/pull/175: Added linux-musl support
  - truffleruby/pull/2223: Added linux-musl support

Sample Microservice

- spring-guides/gs-rest-service
- gs-rest-service/complete

- Thin jar 32 kB
- Fat jar **17** MB

Enable Native Image Support

pom.xml

```
...
  <pluginRepository>
     <id>spring-release</id>
     <name>Spring release</name>
     <url>https://repo.spring.io/release</url>
  </pluginRepository>
...
     <plugin>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-maven-plugin</artifactId>
        <configuration>
           <classifier>exec</classifier>
        </configuration>
     </plugin>
...
```

Enable Native Image Support

```
<plugin>
   <groupId>org.springframework.experimental</groupId>
   <artifactId>spring-aot-maven-plugin</artifactId>
   <version>0.10.4</version>
   <executions>
      <execution>
         <id>test-generate</id>
         <goals>
            <goal>test-generate</goal>
         </goals>
      </execution>
      <execution>
         <id>generate</id>
         <goals>
            <goal>generate</goal>
         </goals>
      </execution>
   </executions>
</plugin>
```

Enable Native Image Support

```
...
  <repository>
     <id>spring-release</id>
     <name>Spring release</name>
     <url>https://repo.spring.io/release</url>
  </repository>
...
  <dependency>
    <groupId>org.springframework.experimental</groupId>
    <artifactId>spring-native</artifactId>
    <version>0.10.4</version>
  </dependency>
...
```

Enable Native Image Support

```
 <profile>
    <id>native-image</id>
    <build>
       <plugins>
          <plugin>
             <groupId>org.graalvm.nativeimage</groupId>
             <artifactId>native-image-maven-plugin</artifactId>
             <version>21.2.0</version>
             <configuration>
                <!-- The native image build needs to know the entry point to your
application -->
                <mainClass>com.example.restservice.RestServiceApplication</mainClass>
                <buildArgs>
                   -Dspring.native.remove-yaml-support=true
                   -Dspring.spel.ignore=true
                </buildArgs>
             </configuration>
...
```

Enable Native Image Support

```
...
            <executions>
               <execution>
                  <goals>
                     <goal>native-image</goal>
                  </goals>
                  <phase>package</phase>
               </execution>
            </executions>
         </plugin>
      </plugins>
   </build>
</profile>
```

Flexible build

```
$ BP_NATIVE_IMAGE_BUILD_ARGUMENTS=... mvn spring-boot:build-image

BP_BINARY_COMPRESSION_METHOD= none | upx | gzexe
```

Flexible build

```
$ JAVA_HOME=$(pwd)/bellsoft-liberica-vm-core-openjdk11-21.3.0 mvn -Pnative-image install
```

2

Cloud Native Buildpacks

```
BP_NATIVE_IMAGE=true

$ mvn spring-boot:build-image

pom.xml:

<plugin>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-maven-plugin</artifactId>
    <configuration>
        <image>
            <builder>paketobuildpacks/builder:tiny</builder>
            <env>
                <BP_NATIVE_IMAGE>true</BP_NATIVE_IMAGE>
            </env>
            <pullPolicy>IF_NOT_PRESENT</pullPolicy>
        </image>
    </configuration>
</plugin>
```

Use Alpine for the Build

```
$ docker run -it -v $(pwd):/demo alpine

# apk add libstdc++ build-base zlib-dev
# export JAVA_HOME=/demo/bellsoft-liberica-vm-core-openjdk11-21.3.0

/demo/gs-rest-service/complete# /demo/apache-maven-3.6.8/bin/mvn -Pnative-image clean package

...

-rwxr-xr-x 1 root root  65.6M Oct 22 16:30 com.example.restservice.restserviceapplication
```

66 MB

Run the Image in Alpine

```
$ docker run -it -v $(pwd):/demo alpine

# apk add libstdc++

fetch https://dl-cdn.alpinelinux.org/alpine/v3.13/main/x86_64/APKINDEX.tar.gz
fetch https://dl-cdn.alpinelinux.org/alpine/v3.13/community/x86_64/APKINDEX.tar.gz
(1/2) Installing libgcc (10.2.1_pre1-r3)
(2/2) Installing libstdc++ (10.2.1_pre1-r3)
OK: 7 MiB in 16 packages
```

7+5.6 MB

```
# /demo/gs-rest-service/complete/target/com.example.restservice.restserviceapplication

...
INFO 7 --- [           main] c.e.restservice.RestServiceApplication   : Started
RestServiceApplication in 0.055 seconds (JVM running for 0.057)
```

1/20th s

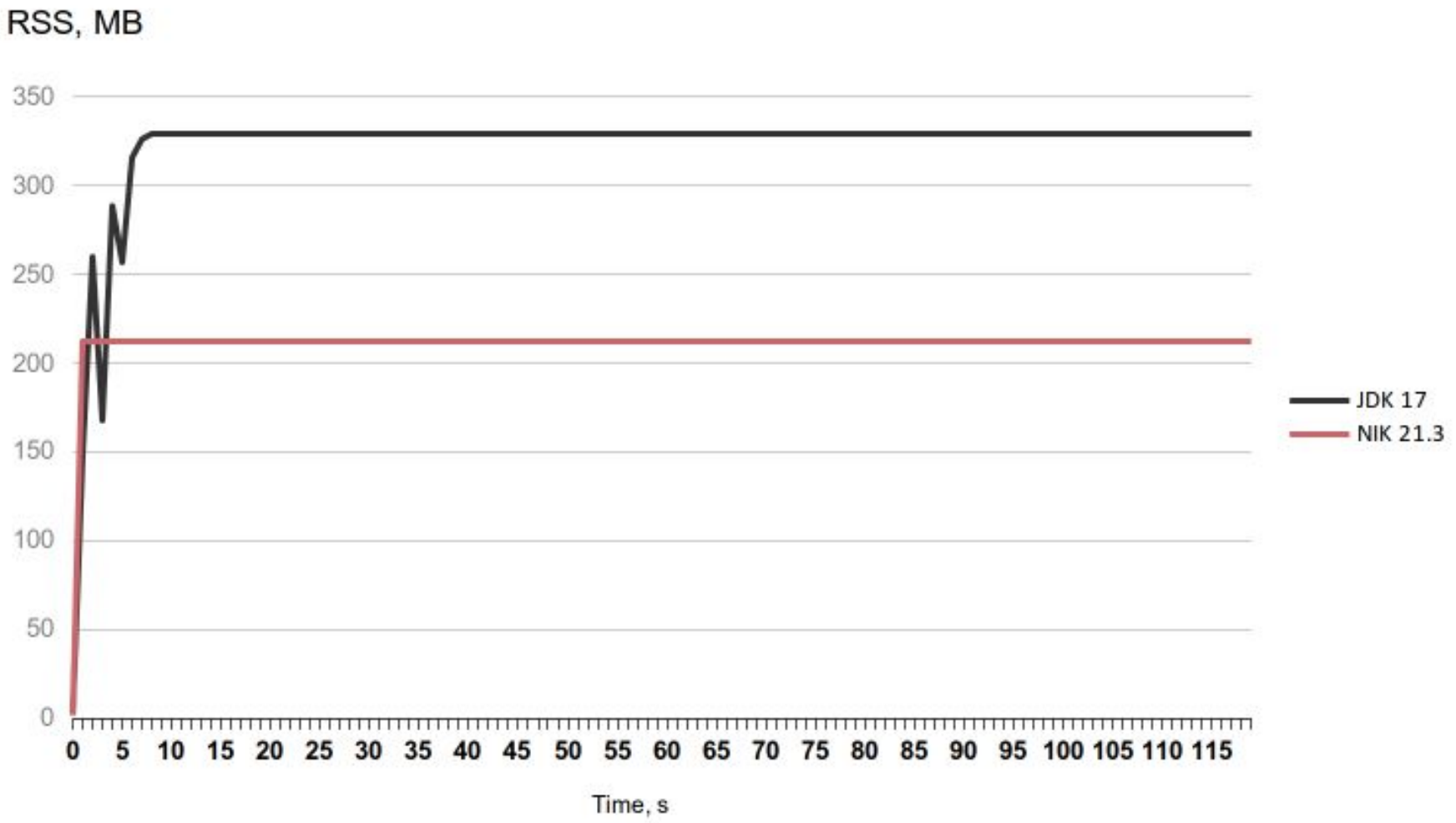
Spring Boot Petclinic JPA

- spring-native/tree/main/samples/petclinic-jpa
- HSQLDB
- Spring Native 0.11.0-**SNAPSHOT**

- Thin jar 535 kB
- Fat jar **44 MB**
  - Startup 4 s
- CE Native image **159 MB**
  - Startup 0.14 s
- gzexe **46 MB**
  - Extra 1.7 s to startup time

Footprint

Petclinic. No load



Petclinic Load

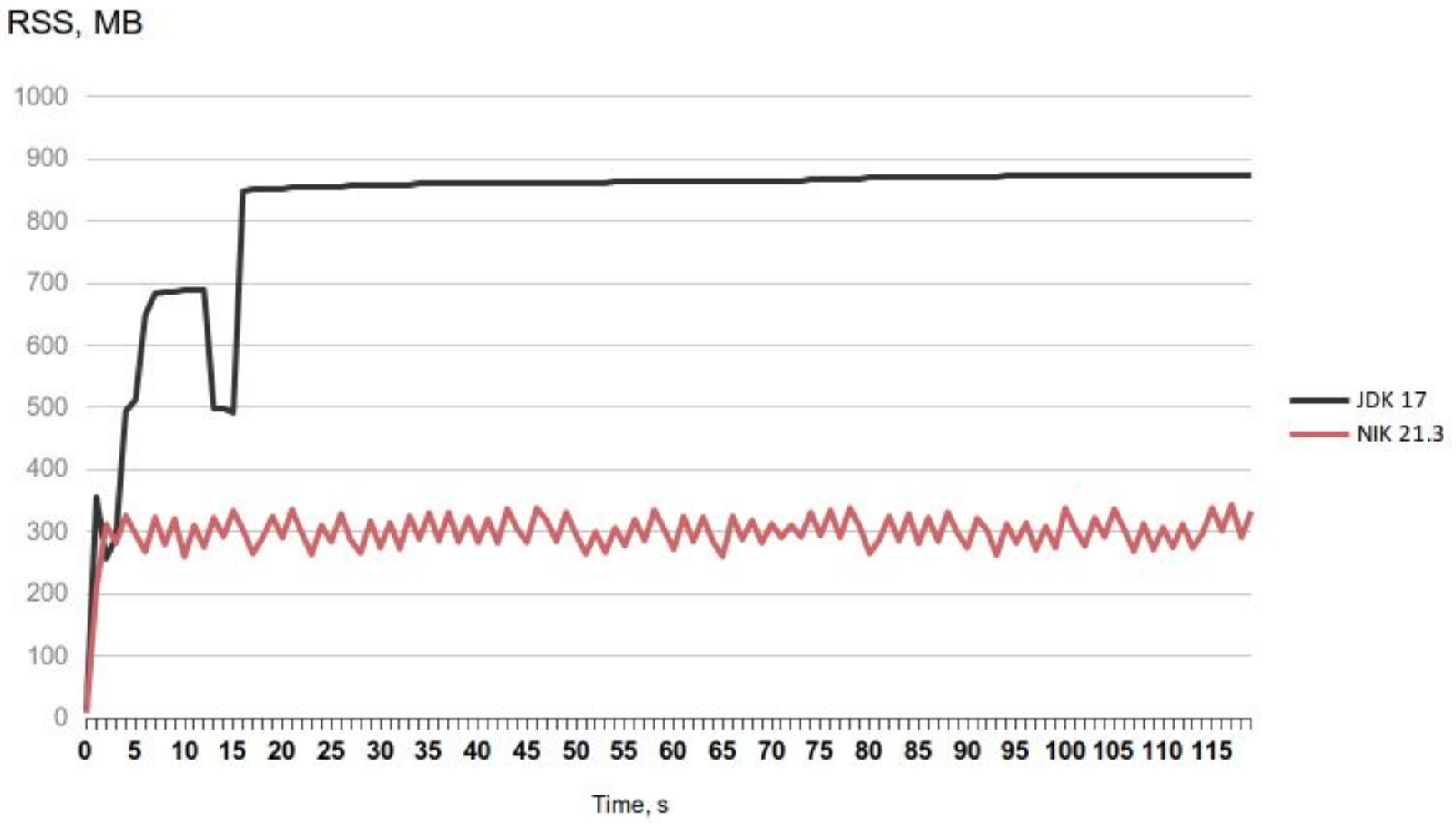
- WRK2 + HdrHistogram
- Fixed rate
- Query all default pet owners
  - Low GC pressure
- Max Rate detection
- Warmup study
- Latency measurement

- Intel(R) Xeon(R) Platinum 8268
- 1x24x2
- 4 cores for the service
- 1 GB service heap
- 10 cores for `wrk`
- 100 connections

```
$ SPRING_PROFILES_ACTIVE=hsqldb taskset -c 0-3 <petclinic> -Xmx1g

$ taskset -c 4-13 ./wrk -t10 -c100 -d30s -R1200 --latency \
http://localhost:8080/owners?lastName=
```

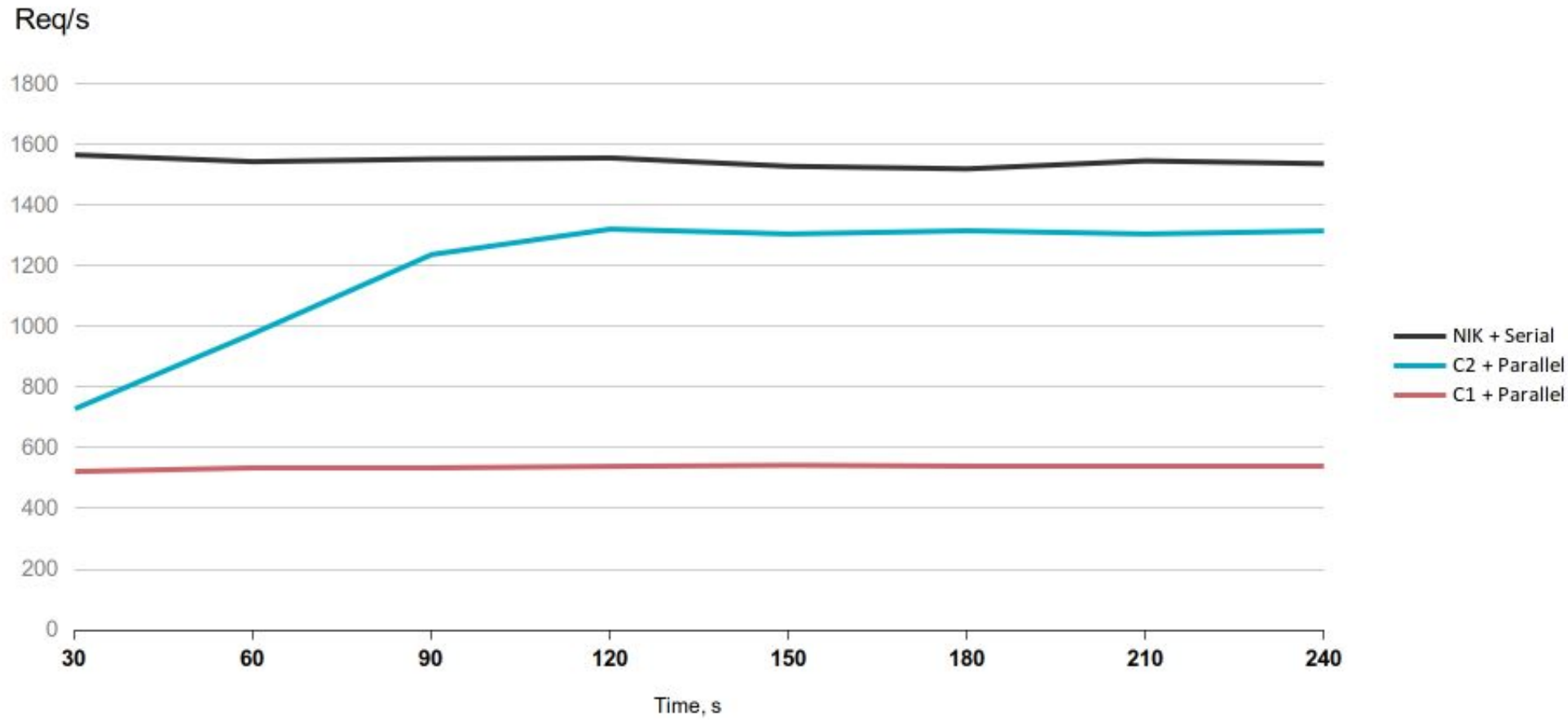
Footprint

Petclinic. 2000 rps



Warmup

Petclinic. 2000 rps

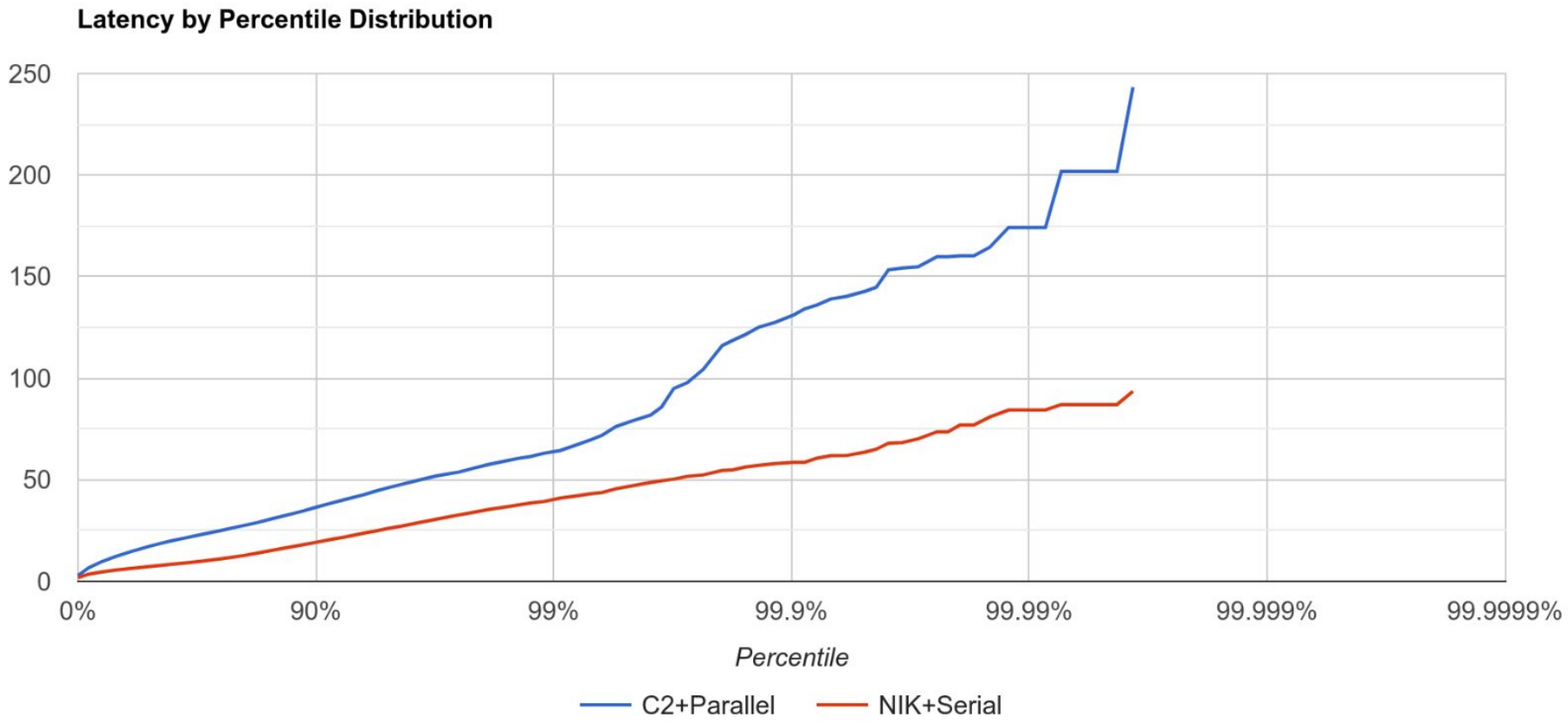


Latency

Petclinic

1200 rps

After 210 s

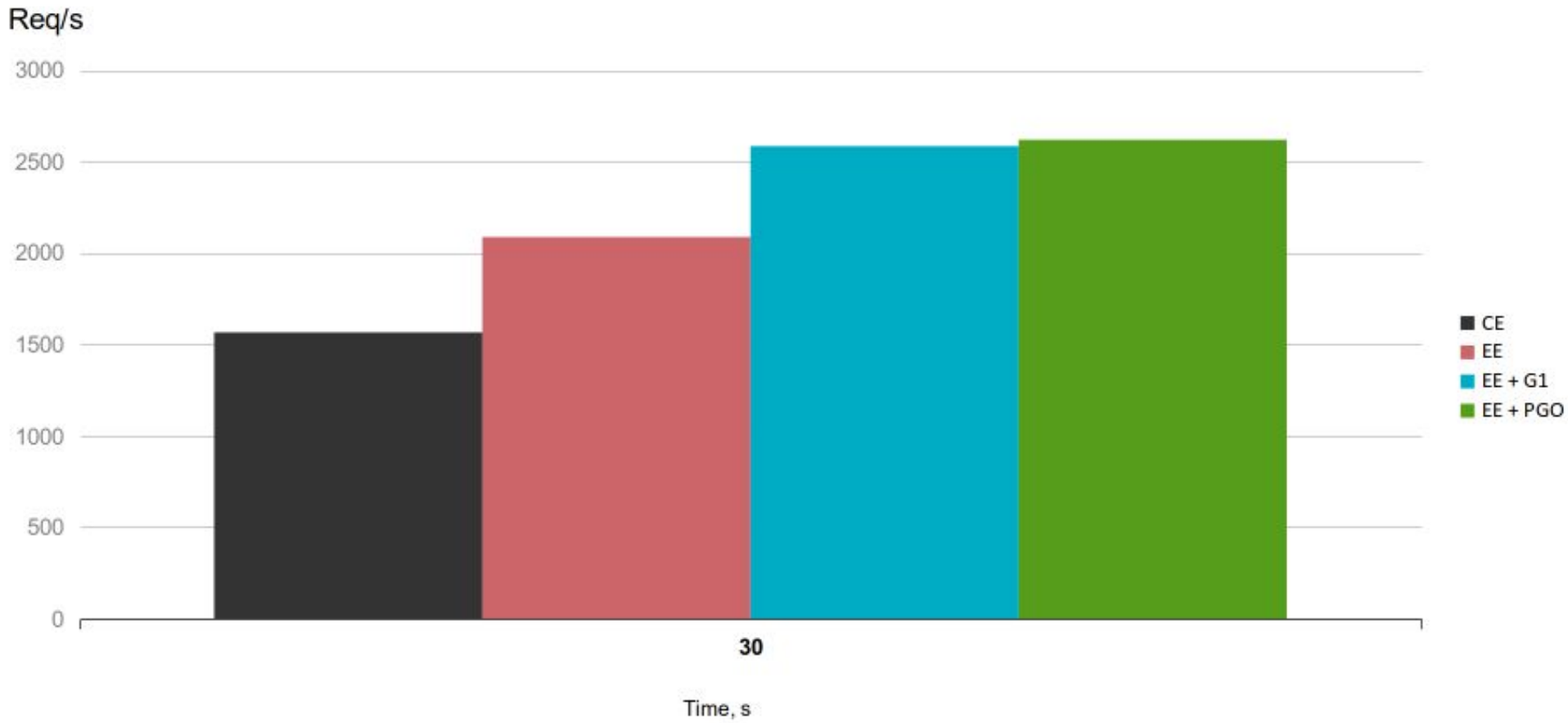


GraalVM EE vs CE

- CE + Serial
- EE + Serial
  - Image size with default parameters is 5-10% larger than CE
- EE + G1
  - Build with ‘--gc=G1’
  - Image size is ~1.5x larger than EE + Serial
- EE + PGO
  - Build with ‘--pgo-instrument’
  - Run with ‘-XX:ProfilesDumpFile=*profile.iprof*’ and get *profile.iprof* (Nx10 MB)
  - Build with ‘--pgo=*profile.iprof*’

Max Rate

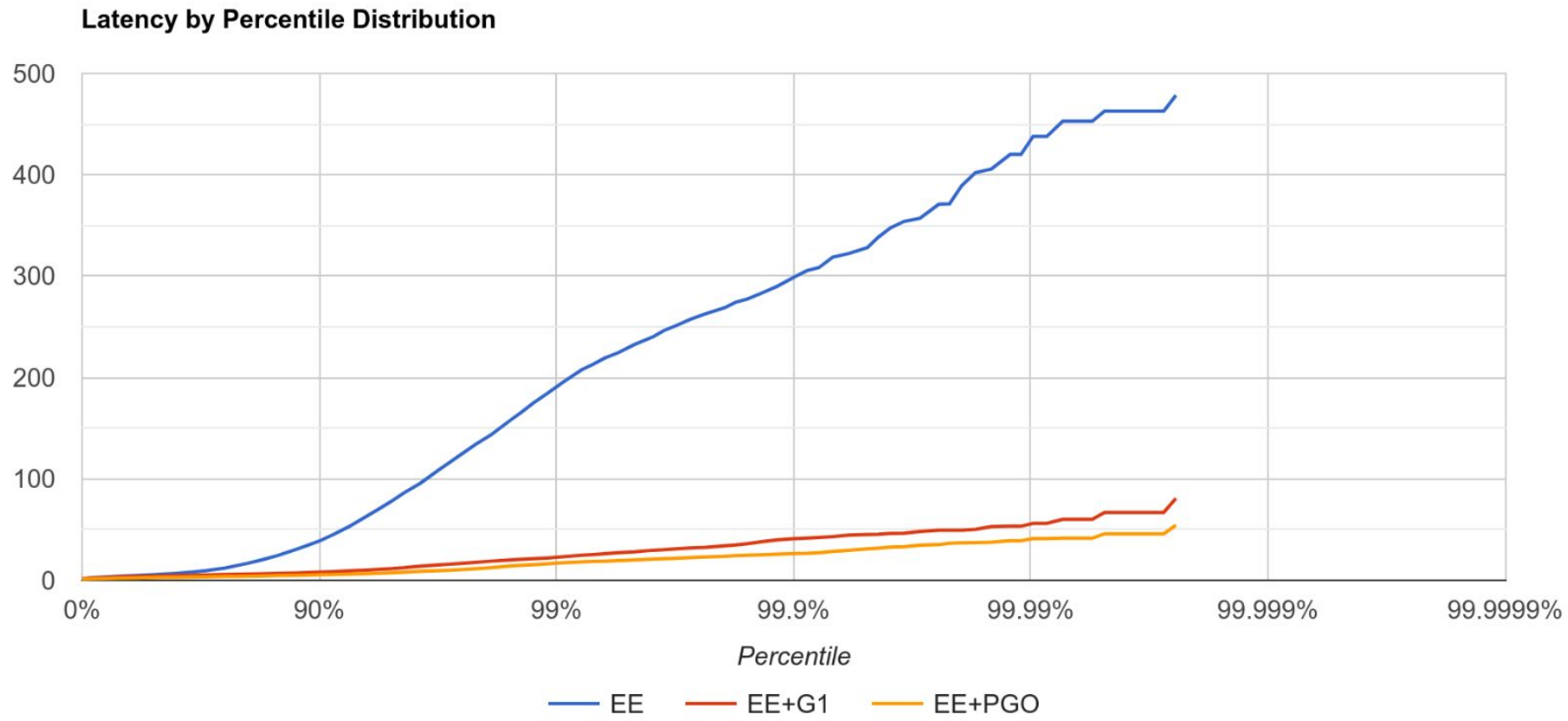
Petclinic. 3000 rps



Latency

Petclinic

2000 rps



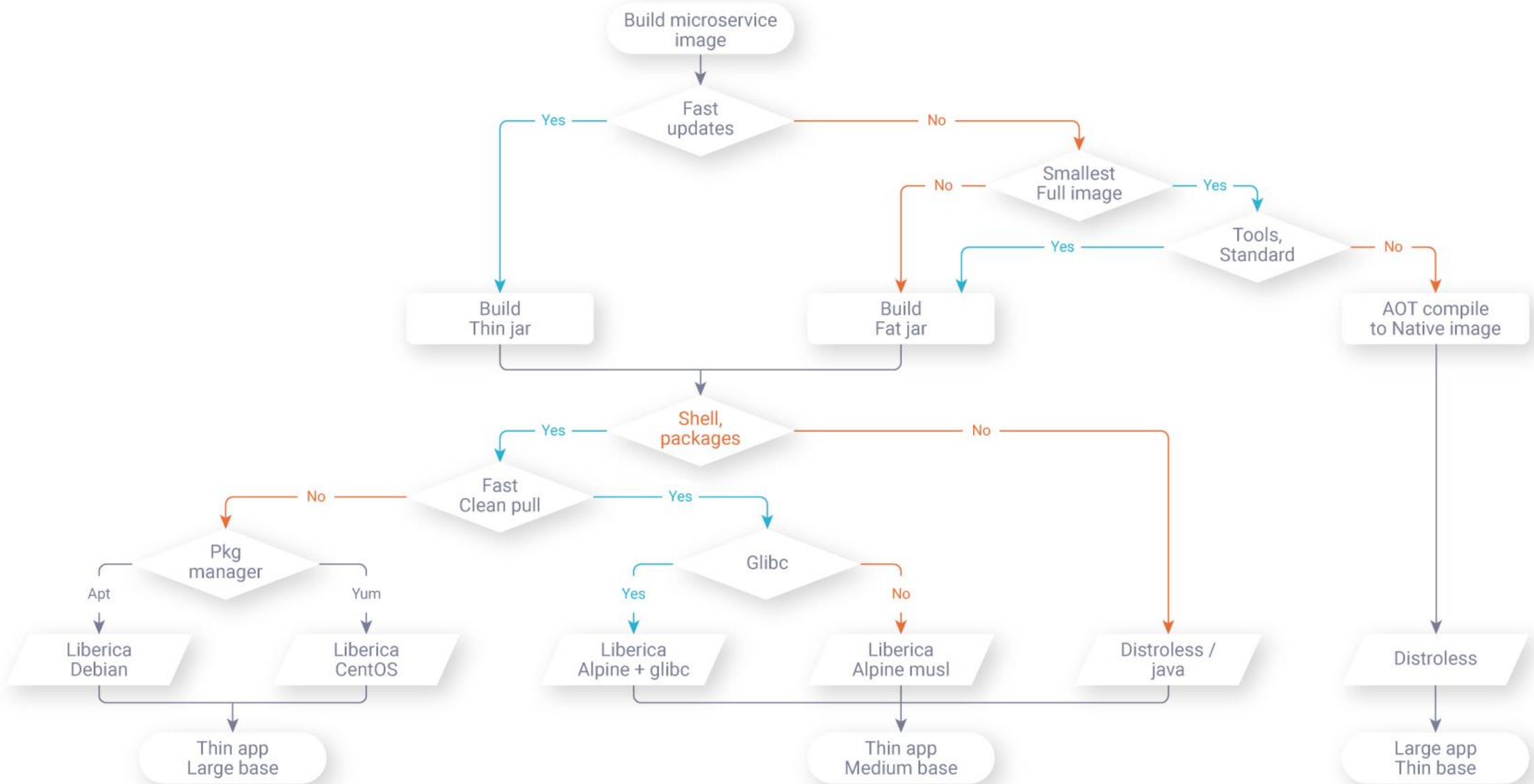
Liberica Native Image Kit

Running with most JDK versions

Update levels:

- JDK 11.0.10 and newer
- GraalVM CE 21.0 and newer

- JDK 17 and newer
- GraalVM CE 21.3 and newer


Build microservice image
Fast updates
Yes
No
Smallest Full image
No
Yes
Tools, Standard
Yes
No
Build Thin jar
Build Fat jar
AOT compile to Native image
Shell, packages
Yes
No
Fast Clean pull
No
Yes
Pkg manager
Apt
Yum
Glibc
Yes
No
Liberica Debian
Liberica CentOS
Liberica Alpine + glibc
Liberica Alpine musl
Distroless / java
Distroless
Thin app Large base
Thin app Medium base
Large app Thin base

Thank you for your attention!

Web: www.bell-sw.com
Email: dmitry.chuyko@bell-sw.com
Twitter: @dchuyko