

# Spring Boot 導入 Native Image 的挑 戰與實踐



**ANDERSEN**  
思想科技



# Agenda

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● 背景與動機

● Native Image

● 挑戰與成果



# 思想科技

# One Google 解決方案



Google Workspace

Google 辦公協作系統



Google Cloud

Google 雲端運算平台



Google Maps Platform

Google 地圖平台

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跨區域技術支援

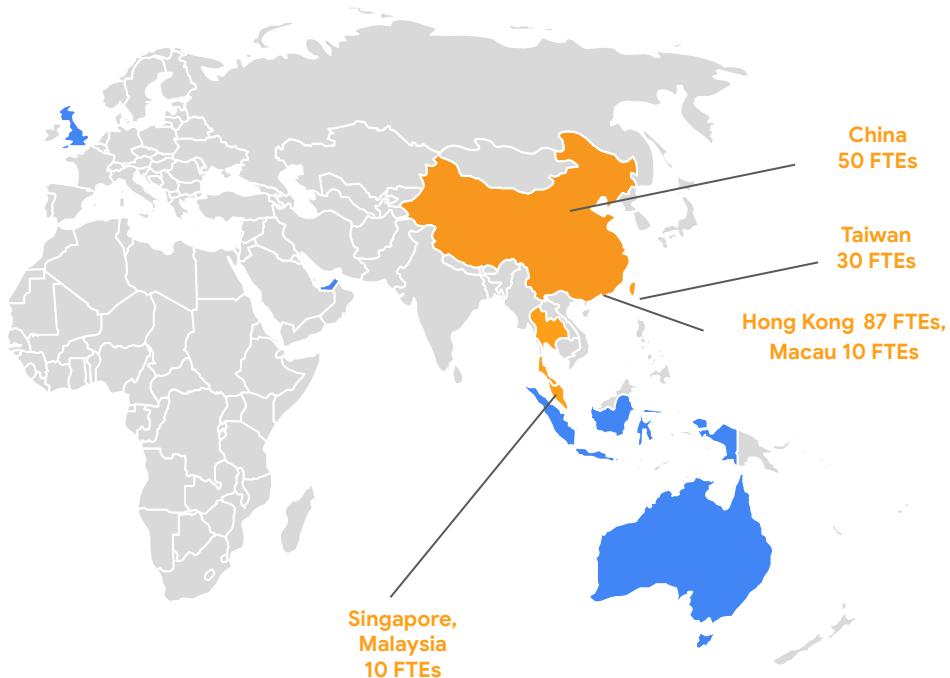
多產業客戶合作

One Google



# 營業據點分佈

Master Concept 的銷售和服務團隊遍佈亞洲 8 個國家和地區，為本地和國際客 戶提供服務，並準備擴大在英國和澳洲的業務



200+ staffs across  
12 locations

1. Hong Kong\*
2. Taiwan
3. Macau
4. Singapore\*
5. Malaysia
6. Beijing
7. Shenzhen
8. Hangzhou
9. Nanjing
10. Xian

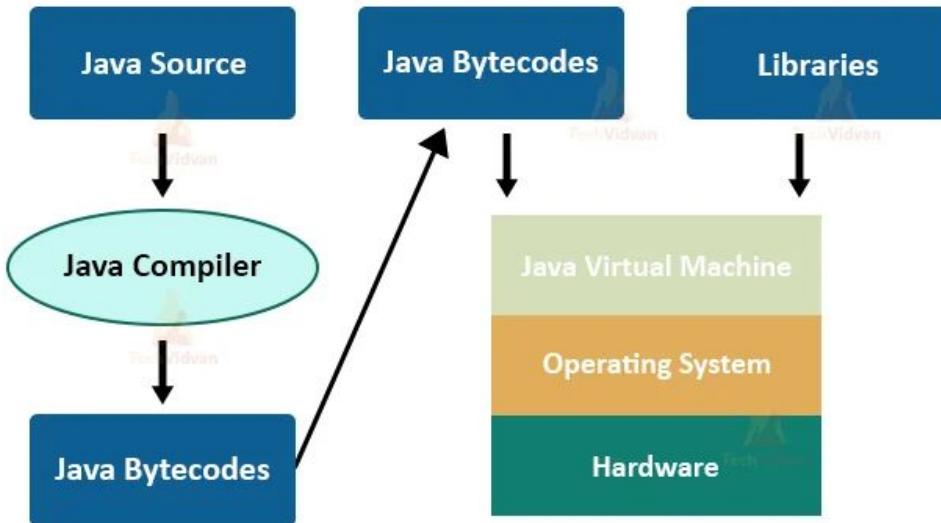
New and Upcoming  
offices

1. Ireland
2. Sydney
3. London (soon)
4. Dubai (soon)
5. Delaware (U.S.)
6. India

\*Dual-HQ

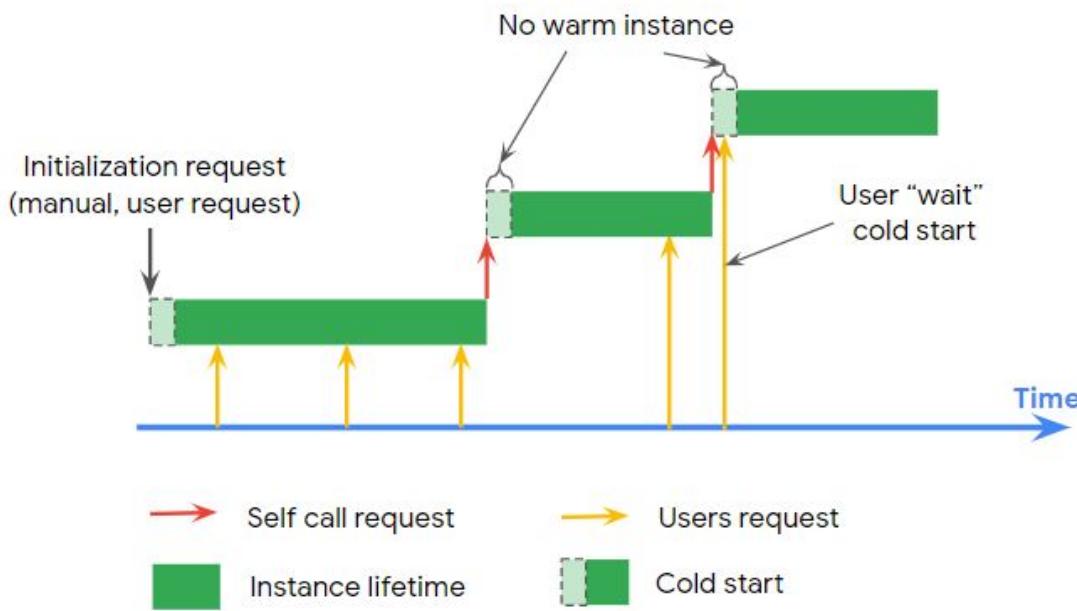
# 基於 VM 的語言

## Working of JVM



基於此類型語言編寫的程式，啟動(startup)速度顯著慢於Native 語言，若在應用層使用了較為大型的框架則啟動速度會更慢。

# 冷啟動問題

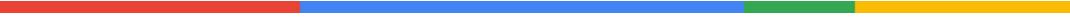


我們使用 **Cloud Run** 作為 Serverless 平台，但其他平台運作原理也類似的。

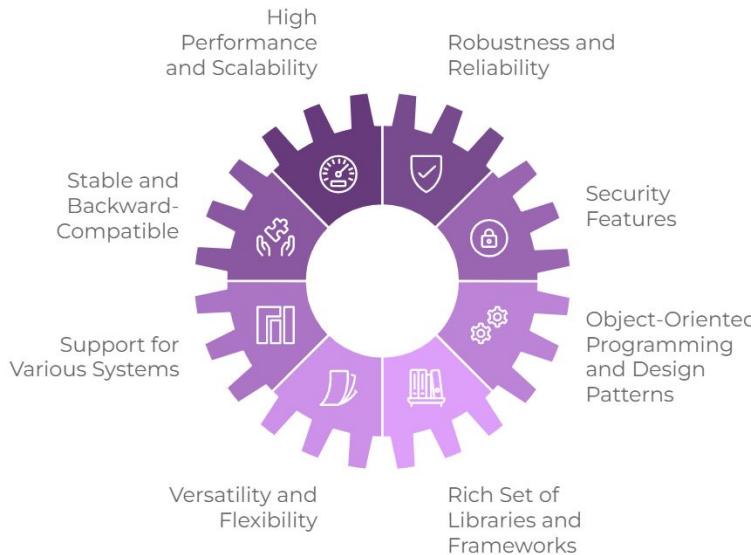
當執行實例長時間沒有處理流量後，基礎架構會將執行實例數縮減到 0。

當使用者下次造訪時，必須先等待應用程式啟動然後才能收到回應。

# Java 的重要性



Why Choose Java for Enterprise Development?



<https://www.tiobe.com/tiobe-index/>

Oct 2025	Oct 2024	Change	Programming Language	Ratings
1	1		Python	24.45%
2	4	▲	C	9.29%
3	2	▼	C++	8.84%
4	3	▼	Java	8.35%
5	5		C#	6.94%
6	6		JavaScript	3.41%
7	7		Visual Basic	3.22%
8	8		Go	1.92%
9	10	▲	Delphi/Object Pascal	1.86%
10	11	▲	SQL	1.77%

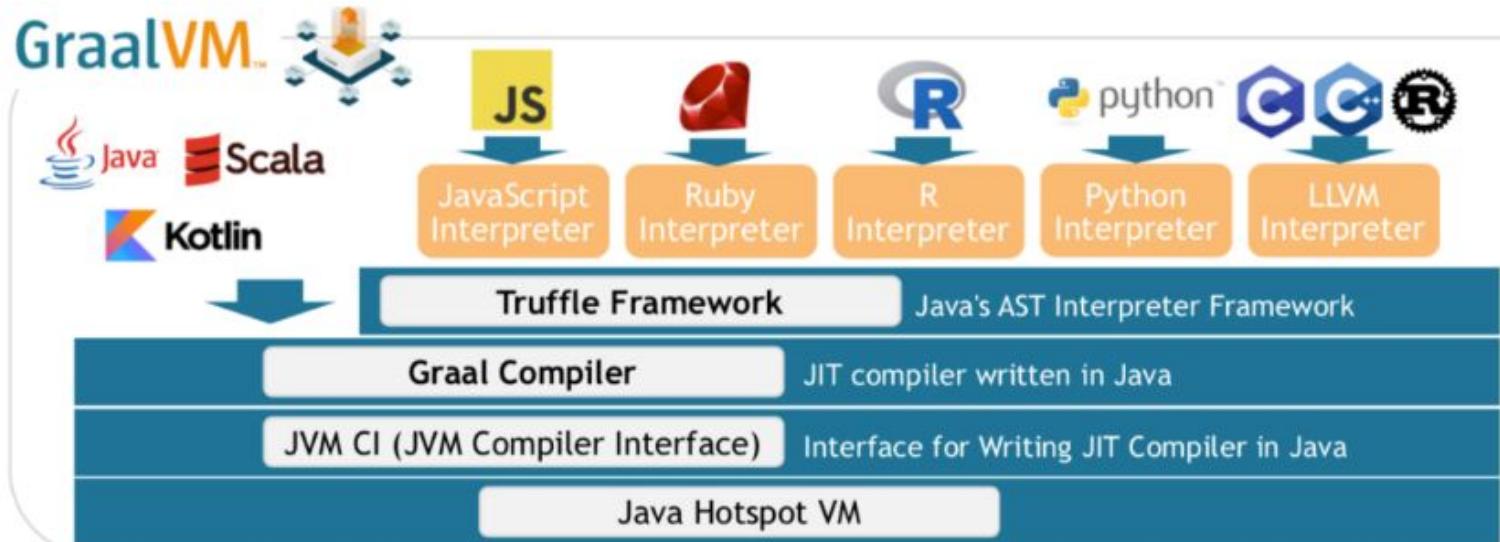
<https://broscorp.net/java-for-enterprise-development/>

Google Cloud



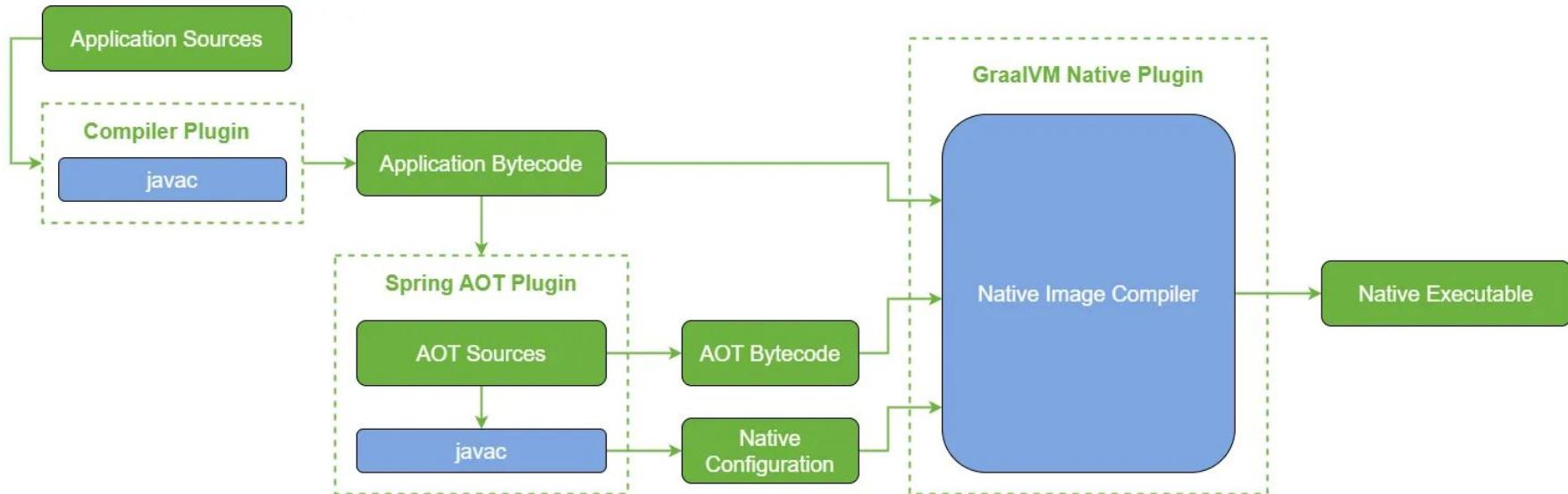
Google Cloud

# GraalVM Project



<https://www.graalvm.org/>

# Spring Native 編譯過程



<https://medium.com/mastering-spring-native-and-graalvm-with-kubernetes/spring-native-and-graalvm-guide-1-spring-native-overview-f4db935840fd>

# 效能統計分析



Metric	Quarkus	SpringBoot	Quarkus-Native	SpringBoot-Native	Rust
<b>Size of Deployable</b>	36M	45M	77M	129M	6M
<b>Build time</b>	13s	19s	6m18s	9min	3m12s
<b>Start time</b>	2.5s	6s	0.1s	0.2s	0.1s
<b>CPU max usage under load (max value observed)</b>	155%	189%	113%	102% <b>46%</b>	33%
<b>CPU average usage under load</b>	120%	130%	92%	85% <b>35%</b>	27%
<b>RAM usage idle</b>	207M	378M	67M	143M	12M
<b>RAM max usage under load (max value observed)</b>	325M	501M	434M	402M	21M



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## 資安新聞-【iThome新聞】Rust編譯效能調查出爐，近半數停用 ...

... 編譯效能調查出爐，近半數停用者點名編譯時間過久。Rust官方首次進行編譯器效能調查，整體滿意度平均為6分，最常見評分為7分，但開發者體驗差異明顯，在已不再使用Rust的受訪者 ...

Facebook · 台灣雲端計算學會

1 month ago

⋮

## Rust編譯效能調查出爐，近半數停用者點名

# \*\*Rust編譯效能調查出爐，近半數停用者點名編譯時間過久\*\* Rust官方首次公布編譯器效能調查，顯示開發者最常抱怨增量重建延遲，部分人因此放棄Rust ...

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## Rust官方公布編譯器效能調查，顯示開發者最常抱怨增量重建 ...

Rust官方公布編譯器效能調查，顯示開發者最常抱怨增量重建延遲，部分人因此放棄Rust，官方提出短中期改進計畫，包括預設改用LLD連結器、強化快取與IDE整合 ...

iThome

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⋮

## LLD連結器

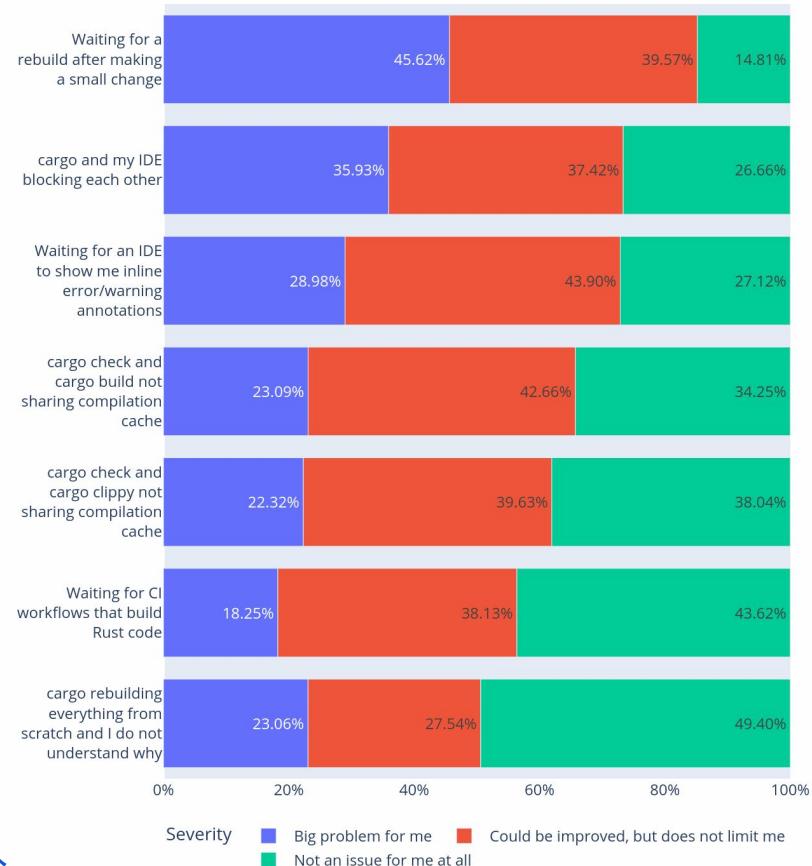
Rust官方首次公布編譯器效能調查，顯示開發者最常抱怨增量重建延遲，部分人因此放棄Rust，官方提出短中期改進計畫，包括預設改用LLD連結器、強化快取與IDE整合。

Google Cloud

[Rust編譯效能調查出爐，近半數停用者點名編譯時間過久](#)

## Which of the following problems do you most struggle with?

(total responses = 2463)



# 使用方式



The screenshot shows a code editor interface with a dark theme. At the top, there are two tabs: "Groovy" (highlighted in white) and "Kotlin". On the right side of the editor, the word "GROOVY" is displayed. The main code area contains the following Groovy script:

```
plugins {
    id 'org.springframework.boot' version '3.5.0'
    id 'org.graalvm.buildtools.native' version '0.10.6'
    id 'java'
}
```

\_> gradle bootBuildImage

<https://docs.spring.io/spring-boot/gradle-plugin/aot.html>

迄今各大框架都有對 native image 的支持，得益於 buildpack 的普及，使用 native 不需另外安裝工具鏈，只需要有 docker daemon，代碼/業務邏輯/構建命令均不變

# 項目成果

啟動時間降低到了2秒平均，這其中也包括了網路時間，包括從 secret manager 取得金鑰以及連接資料庫等



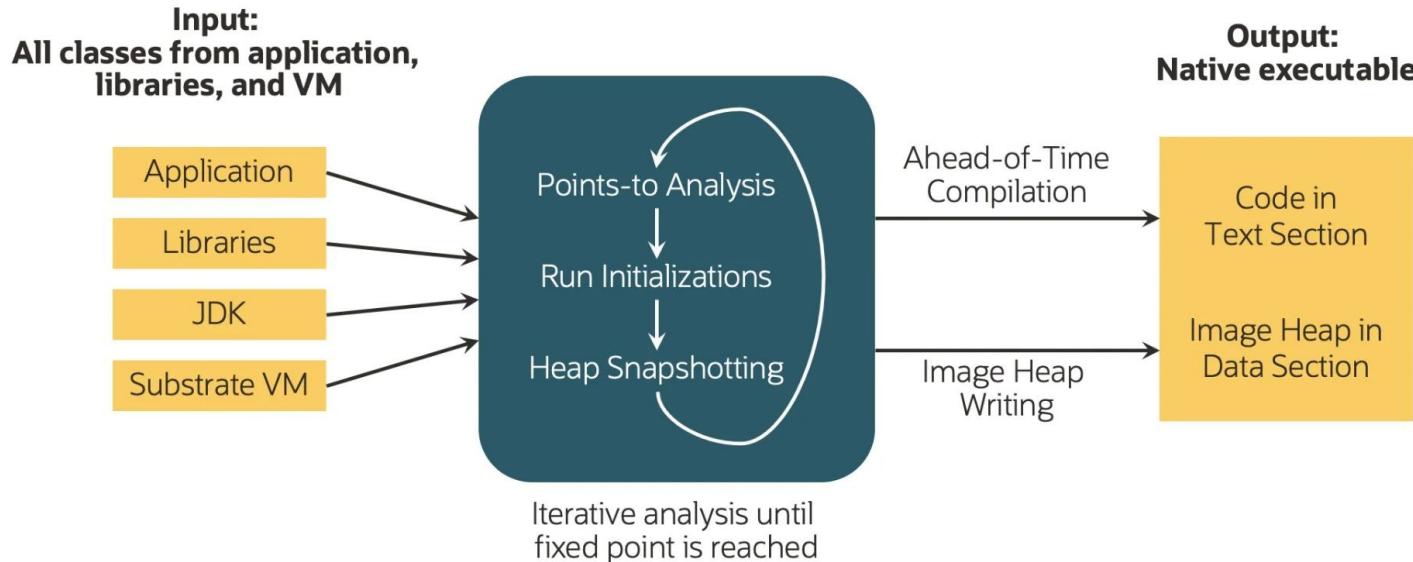
# 相容性限制

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- 不支援運行時產生/載入新程式碼
- 可能需要額外的元資訊才能使用反射/動態代理
- 預設不會打包全部編碼集
- 不支援早已過時的內容, 例如 SecurityManager, Thread.stop(), Object.finalize()
- 不支援 musl

<https://www.graalvm.org/latest/reference-manual/native-image/metadata/Compatibility/>

# Native Image Compiler



在編譯時將 Java bytecode 全部轉換為機器碼並打包為對應平台的可執行文件，打包產物中不包含 JVM。

# 反射問題

---

```
Class.forName("Foo")
```

```
Class.forName(readFile("class.txt"))
```

可偵測的反射會被 Graalvm 自動處理, 但有例外

# 反射處理

**Folder:**

META-INF/native-image/<group.Id>\<artifactId>\

**reflection.json**

```
{  
  "reflection": [  
    {  
      "type": "Foo"  
    }  
  ]  
}
```

# 反射處理

```
class RuntimeReflectionRegistrationFeature implements Feature {  
    public void beforeAnalysis(BeforeAnalysisAccess access) {  
        RuntimeReflection.register(Foo.class);  
    }  
}
```

# 社區支持



Spring

<https://docs.spring.io> › packaging › native-image



## GraalVM Native Images

GraalVM Native Images are standalone executables that can be generated by processing compiled Java applications ahead-of-time. Native Images generally have ...



Quarkus

<https://quarkus.io> › guides › building-native-image



## Building a Native Executable

The Quarkus Micro Image is a small container image providing the right set of dependencies to run your native application. It is based on UBI Micro. This base ...



Akka Documentation

<https://doc.akka.io> › current › additional › native-image



## Building Native Images

Building native images with Akka is supported, both for local and cluster actor system applications. Most built-in features in Akka can be used as is.

Google Cloud



Google Cloud

<https://cloud.google.com> › Java › Documentation



## Compile native images | Java

Apr 17, 2025 — Using the Cloud Client Libraries for Java, you can compile applications as native images. This approach provides performance benefits to ...



Amazon AWS Documentation

<https://docs.aws.amazon.com> › latest › developer-guide



## Set up a GraalVM Native Image project that uses the ...

Set up a GraalVM Native Image project for the AWS SDK for Java 2.x using Maven archetype. Create, configure, and build a native image application with Amazon S3



Google Cloud

# Build Time 很重要



```
[INFO] Successfully built image 'docker.io/library/image-analysis-maven-native:latest'  
[INFO]  
[INFO] -----  
[INFO] BUILD SUCCESS  
[INFO] -----  
[INFO] Total time: 10:54 min  
[INFO] Finished at: 2025-10-20T04:28:50Z  
[INFO] -----
```

```
[INFO] Successfully built image 'docker.io/library/image-analysis-maven-jit:latest'  
[INFO]  
[INFO] -----  
[INFO] BUILD SUCCESS  
[INFO] -----  
[INFO] Total time: 01:18 min  
[INFO] Finished at: 2025-10-20T05:37:56Z  
[INFO] -----
```

# CI/CD

---

- 各大框架都支援 Buildpack, 產物也都是 Docker image, CI 並不會因為使用了 Native Image 而改變
- 變更在於編譯時記憶體佔用和時間

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Recommendations:

HEAP: Set max heap for improved and more predictable memory usage.

CPU: Enable more CPU features with '-march=native' for improved performance.

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31.8s (10.1% of total time) in 123 GCs | Peak RSS: 15.63GB | CPU load: 12.50

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Produced artifacts:

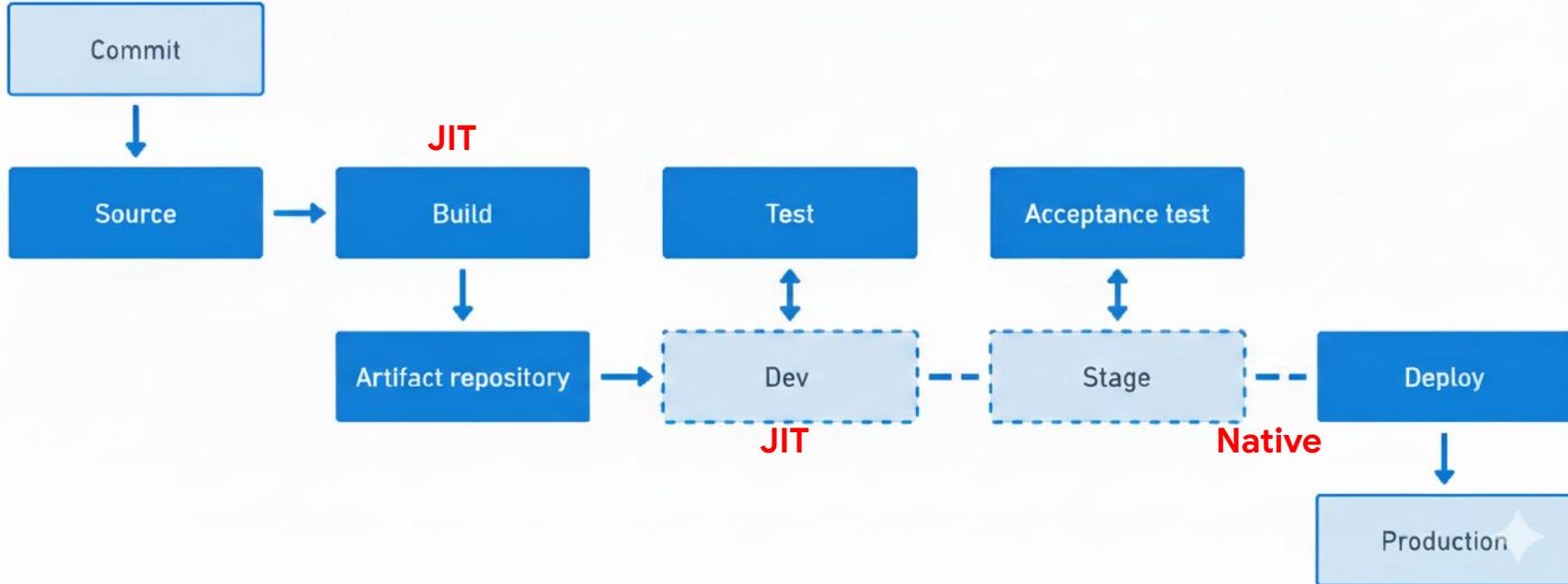
/layers/paketo-buildpacks\_native-image/native-image/com.hkmci.web.bms2.microservice.mc

---

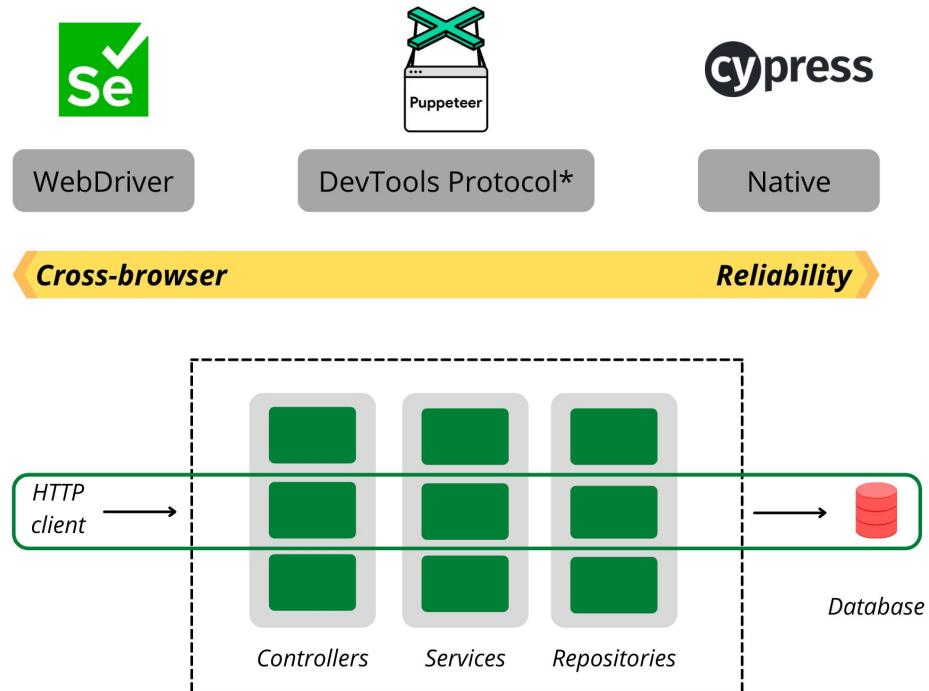
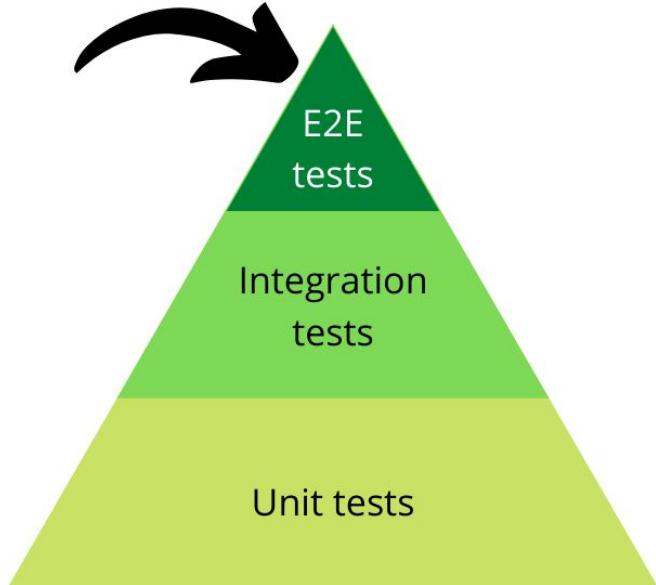
=====

Finished generating 'com.hkmci.web.bms2.microservice.monolith.ApplicationKt' in 5m 15s.

---



# Test your App end-to-end





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# 參考資料

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<https://www.graalvm.org/latest/reference-manual/native-image/>

<https://www.graalvm.org/native-image/libraries-and-frameworks/>

<https://docs.spring.io/spring-boot/reference/packaging/native-image/introducing-graalvm-native-images.html>

<https://quarkus.io/guides/building-native-image>

<https://cloud.google.com/java/docs/compile-native-images>

<https://docs.oracle.com/en/graalvm/enterprise/20/docs/reference-manual/native-image/#install-native-image>

<https://github.com/oracle/graalvm-reachability-metadata>