



Effortless Containerization with Cloud Native Buildpacks

Photo by [nikko osaka](#) on [Unsplash](#)



Daniel Mikusa

- Staff Software Engineer @ 7SIGNAL, Inc
- Paketo Steering Committee Member
- Cloud-Native Buildpacks Maintainer

Contact Me

- dan@mikusa.com
- <https://github.com/dmikusa>
- <https://www.mikusa.com>



Slides



<https://github.com/dmikusa/effortless-containerization-with-cnbs>

Why are we here today?

1. A Quick primer
2. Getting Started
3. How to build containers
4. Adoption Plan



What are Cloud Native Buildpacks?

What they are?

- Source Code => OCI
- Standard & specification
- Support Multiple Languages
- Integrated into Platforms

What they're not?

- Total replacement for Dockerfiles
- An implementation
- Replacement for CI/CD
- Dev-only Tool

What are Cloud Native Buildpacks?

Technically:

- A build + detect executable
- A metadata config file called
buildpack.toml
- Bundled as an OCI image

Current Layer Contents			
Permission	UID:GID	Size	Filetree
-----	0:0	12 MB	cnb
-----	0:0	12 MB	└── buildpacks
drwxr-xr-x	0:0	12 MB	└── paketo-buildpacks_bellsoft-liberica
drwxr-xr-x	0:0	12 MB	└── 11.5.4
-rw-r--r--	0:0	11 kB	├── LICENSE
-rw-r--r--	0:0	493 B	├── NOTICE
-rw-r--r--	0:0	29 kB	├── README.md
drwxr-xr-x	0:0	12 MB	└── bin
-rwxr-xr-x	0:0	0 B	└── build → main
-rwxr-xr-x	0:0	0 B	└── detect → main
-rwxr-xr-x	0:0	5.0 MB	└── helper
-rwxr-xr-x	0:0	7.4 MB	└── main
-rw-r--r--	0:0	28 kB	└── buildpack.toml

What are Paketo Buildpacks?



- Cloud Native Buildpacks Implementation
- Written in Go
- Open Source Apache v2
- Part of Cloud Foundry Foundation

Paketo Provides

- Base images: Ubuntu Jammy, Ubuntu Noble, or UBI 8-10
- Four run image sizes: static, tiny, base & full
- Languages: Java, GraalVM, Scala, Kotlin, Clojure, Go, .NET, Node.js, Python, Ruby, Rust, PHP & web servers
- Builders with and without buildpacks





Paketo is Enterprise Ready

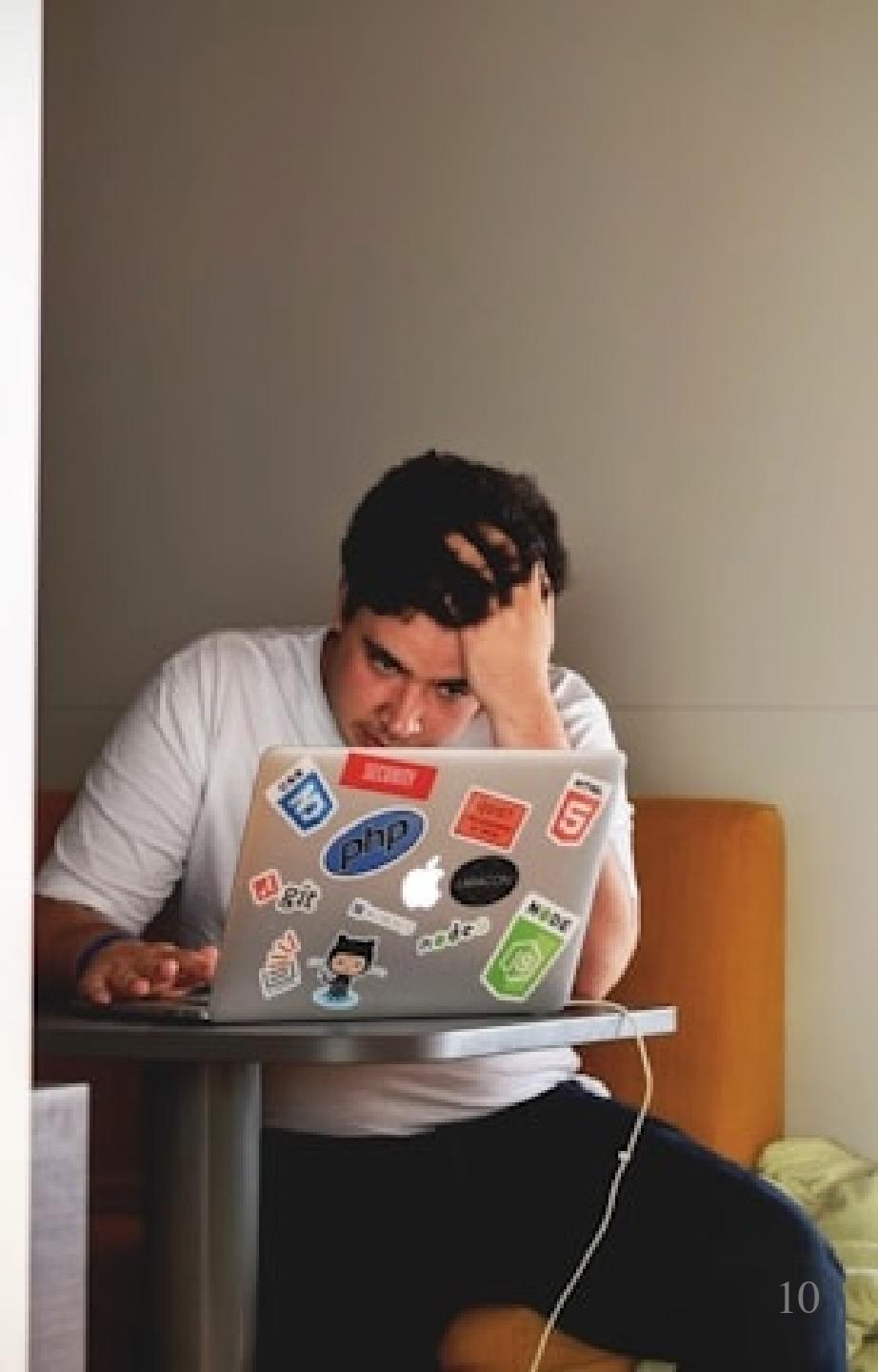
- Custom CA certificates
- Proxies for Internet access
- Local mirrors
- Air Gapped Environments
- SBOM Support

Photo by [Sean Pollock](#) on [Unsplash](#)

What about Dockerfiles?

Common Problems

- Dockerfile copy & paste
- Dockerfile sprawl



Dockerfiles: More problems...

- Base image too big
- Base image too small
- Base image not maintained
- Not your golden base image
- Forgets to use multi-stage builds
- Implements multi-stage incorrectly
- Bad layer ordering (cache invalidation)
- Bad layer breakdown (decreases sharing)
- Runs the app as root
- No PID1 handler
- Forget company CA certs
- exec vs shell to start process



Getting Started!

Photo by [Braden Collum](#) on [Unsplash](#)

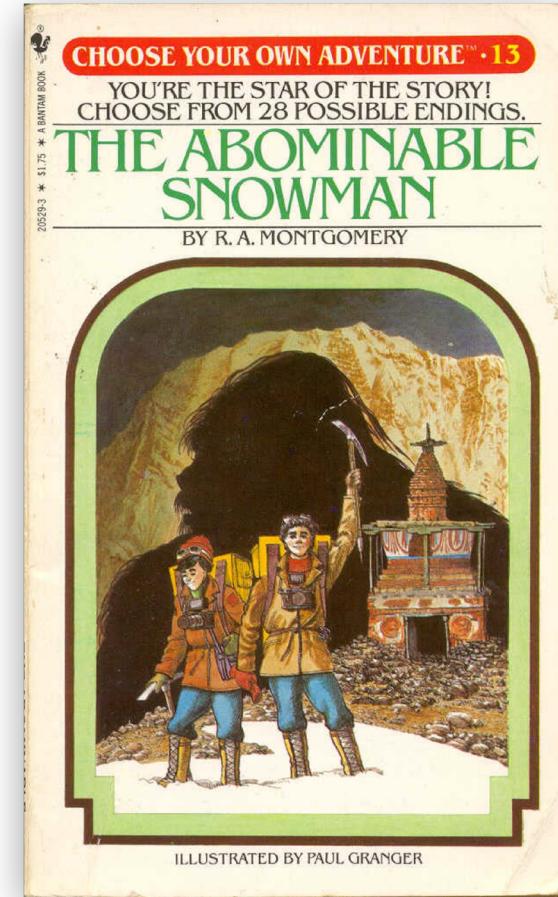
Getting Started

Most Users

- Install pack
- Run `pack build`

Spring Boot

- <https://start.spring.io/>
- `./mvnw spring-boot:build-image`
or `./gradlew bootBuildImage`



Let's Build!

Maven starts a normal build

```
dmikusa@oddjob ~|C/O/p/s/j/maven (main)|> ./mvnw spring-boot:build-image
[INFO] Scanning for projects ...
[INFO]
[INFO] -----< io.paketo:demo >-----
[INFO] Building demo 0.0.1-SNAPSHOT
[INFO] -----[ jar ]-----
[INFO]
[INFO] >>> spring-boot-maven-plugin:4.0.2:build-image (default-cli) > pac
[INFO]
[INFO] --- maven-resources-plugin:3.3.1:resources (default-resources) @ demo
[INFO] Copying 1 resource from src/main/resources to target/classes
[INFO] Copying 0 resource from src/main/resources to target/classes
[INFO]
[INFO] --- maven-compiler-plugin:3.14.1:compile (default-compile) @ demo
[INFO] Nothing to compile - all classes are up to date.
[INFO]
[INFO] --- maven-resources-plugin:3.3.1:testResources (default-testResourc
[INFO] skip non existing resourceDirectory /Users/dmikusa/Code/OSS/paketo
[INFO]
[INFO] --- maven-compiler-plugin:3.14.1:testCompile (default-testCompile)
[INFO] Nothing to compile - all classes are up to date.
[INFO]
[INFO] --- maven-surefire-plugin:3.5.4:test (default-test) @ demo ---
[INFO] Using auto detected provider org.apache.maven.surefire.junitplatfo
[INFO]
[INFO] -----
[INFO] T E S T S
[INFO] -----
[INFO] Running io.paketo.demo.DemoApplicationTests
17:11:30.419 [main] INFO org.springframework.test.context.support.Annotat
ot declare any static, non-private, non-final, nested classes annotated w
17:11:30.477 [main] INFO org.springframework.boot.test.context.SpringBootTest
```

Let's Build!

Maven builds a JAR &
starts buildpacks

```
[INFO] --- maven-jar-plugin:3.4.2:jar (default-jar) @ demo --- ←
[INFO]
[INFO] --- spring-boot-maven-plugin:4.0.2:repackage (repackage) @ demo ---
[INFO] Replacing main artifact /Users/dmikusa/Code/OSS/paketo-buildpacks/samples-pristine
[INFO] The original artifact has been renamed to /Users/dmikusa/Code/OSS/paketo-buildpack
[INFO]
[INFO] <<< spring-boot-maven-plugin:4.0.2:build-image (default-cli) < package @ demo <<<
[INFO]
[INFO]
[INFO] --- spring-boot-maven-plugin:4.0.2:build-image (default-cli) @ demo --- ←
[INFO] Building image 'docker.io/library/demo:0.0.1-SNAPSHOT' ←
[INFO]
[INFO] > Pulling builder image 'docker.io/paketobuildpacks/builder-noble-java-tiny:lates
[INFO] > Pulled builder image 'docker.io/paketobuildpacks/builder-noble-java-tiny@sha256
[INFO] > Pulling run image 'docker.io/paketobuildpacks/ubuntu-noble-run-tiny:0.0.53' for
[INFO] > Pulled run image 'docker.io/paketobuildpacks/ubuntu-noble-run-tiny@sha256:33b7b
[INFO] > Executing lifecycle version v0.21.1
[INFO] > Using build cache volume 'pack-cache-5cbe5692dbc4.build'
[INFO]
```

Let's Build!

Next creator starts.

It analyzes &
runs detect.

```
[INFO] > Running creator ←  
[INFO] [creator] ===> ANALYZING  
[INFO] [creator] Image with name "docker.io/library/demo:0.0.1-SNAPSHOT" not found  
[INFO] [creator] ===> DETECTING ←  
[INFO] [creator] target distro name/version labels not found, reading /etc/os-release file  
[INFO] [creator] 6 of 26 buildpacks participating  
[INFO] [creator] paketo-buildpacks/ca-certificates 3.11.1  
[INFO] [creator] paketo-buildpacks/bellsoft-liberica 11.5.4  
[INFO] [creator] paketo-buildpacks/syft 2.29.1  
[INFO] [creator] paketo-buildpacks/executable-jar 6.14.1  
[INFO] [creator] paketo-buildpacks/dist-zip 5.11.1  
[INFO] [creator] paketo-buildpacks/spring-boot 5.35.2  
[INFO] [creator] ===> RESTORING ←
```

Let's Build!

Then buildpacks run!

```
[INFO] [creator] Paketo Buildpack for CA Certificates 3.11.1
[INFO] [creator] https://github.com/paketo-buildpacks/ca-certifi
[INFO] [creator] Build Configuration:
[INFO] [creator]   $BP_EMBED_CERTS           false
[INFO] [creator]   $BP_ENABLE_RUNTIME_CERT_BINDING true
[INFO] [creator]   $BP_RUNTIME_CERT_BINDING_DISABLED false
[INFO] [creator] Launch Helper: Contributing to layer
[INFO] [creator]   Creating /layers/paketo-buildpacks_ca-certifi
[INFO] [creator]
[INFO] [creator] Paketo Buildpack for BellSoft Liberica 11.5.4
[INFO] [creator] https://github.com/paketo-buildpacks/bellsoft
[INFO] [creator] Build Configuration:
[INFO] [creator]   $BP_JVM_JLINK_ARGS          --no-man-pages
[INFO] [creator]   $BP_JVM_JLINK_ENABLED       false
[INFO] [creator]   $BP_JVM_TYPE             JRE
[INFO] [creator]   $BP_JVM_VERSION          21
[INFO] [creator] Launch Configuration:
[INFO] [creator]   $BPL_DEBUG_ENABLED        false
[INFO] [creator]   $BPL_DEBUG_PORT          8000
[INFO] [creator]   $BPL_DEBUG_SUSPEND       false
[INFO] [creator]   $BPL_HEAP_DUMP_PATH
[INFO] [creator]   $BPL_JAVA_NMT_ENABLED      true
[INFO] [creator]   $BPL_JAVA_NMT_LEVEL        summary
[INFO] [creator]   $BPL_JFR_ARGS
[INFO] [creator]   $BPL_JFR_ENABLED         false
[INFO] [creator]   $BPL_JMX_ENABLED         false
[INFO] [creator]   $BPL_JMX_PORT           5000
[INFO] [creator]   $BPL_JVM_HEAD_ROOM        0
[INFO] [creator]   $BPL_JVM_LOADED_CLASS_COUNT 35% of classes
[INFO] [creator]   $BPL_JVM_THREAD_COUNT     250
[INFO] [creator]   $JAVA_TOOL_OPTIONS
[INFO] [creator] Using Java version 21 extracted from MANIFEST.MF
[INFO] [creator] BellSoft Liberica JRE 21.0.10: Contributing to layer
```

Let's Build!

Lastly, an image is exported.

```
[INFO] [creator] ==> EXPORTING
[INFO] [creator] Adding layer 'paketo-buildpacks/ca-certificates:helper'
[INFO] [creator] Adding layer 'paketo-buildpacks/bellsoft-liberica:helper'
[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/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 layer 'buildpacksio/lifecycle:launch.sbom'
[INFO] [creator] Added 5/5 app layer(s)
[INFO] [creator] Adding layer 'buildpacksio/lifecycle:launcher'
[INFO] [creator] Adding layer 'buildpacksio/lifecycle:config'
[INFO] [creator] Adding layer 'buildpacksio/lifecycle:process-types'
[INFO] [creator] Adding label 'io.buildpacks.lifecycle.metadata'
[INFO] [creator] Adding label 'io.buildpacks.build.metadata'
[INFO] [creator] Adding label 'io.buildpacks.project.metadata'
[INFO] [creator] Adding label 'org.opencontainers.image.title'
[INFO] [creator] Adding label 'org.opencontainers.image.version'
[INFO] [creator] Adding label 'org.springframework.boot.version'
[INFO] [creator] Setting default process type 'web'
[INFO] [creator] Saving docker.io/library/demo:0.0.1-SNAPSHOT...
[INFO] [creator] ** Images (f62f5515f82b):
[INFO] [creator]   docker.io/library/demo:0.0.1-SNAPSHOT
[INFO] [creator] Adding cache layer 'paketo-buildpacks/syft:syft'
[INFO] [creator] Adding cache layer 'paketo-buildpacks/spring-boot:spring-cloud-bindings'
[INFO] [creator] Adding cache layer 'buildpacksio/lifecycle:cache.sbom'
[INFO]
[INFO] Successfully built image 'docker.io/library/demo:0.0.1-SNAPSHOT'
```

Configuration

Pack

- CLI arguments
- `project.toml` file

Spring Boot

- `build.gradle`
- `pom.xml`

Configuration: pack CLI arguments

Ex:

```
pack build company/app-name \  
  --builder paketobuildpacks/builder-jammy-base:latest \  
  --buildpack paketo-buildpacks/nginx \  
  --pull-policy=always \  
  --creation-time=now \  
  --trust-builder \  
  --publish
```

Configuration: pack project.toml

```
[__]
schema-version = "0.2"
id = "com.example.my-app"

[io.buildpacks]
builder = "paketobuildpacks/builder-jammy-base"
exclude = [
    ".pytest_cache/",
    ".vscode/"
]

[[io.buildpacks.build.env]]
name = "BP_CPYTHON_VERSION"
value = "3.13.*"

[[io.buildpacks.group]]
id = "paketo-buildpacks/python"
```

Configuration: Spring

Gradle

```
tasks.named<BootBuildImage>("bootBuildImage") {  
    builder.set("paketobuildpacks/builder-jammy-base")  
    runImage.set("paketobuildpacks/ubuntu-noble-run-tiny:latest")  
}
```

Maven

```
<plugin>  
    <groupId>org.springframework.boot</groupId>  
    <artifactId>spring-boot-maven-plugin</artifactId>  
    <configuration>  
        <image>  
            <env>  
                <BP_JVM_VERSION>17</BP_JVM_VERSION>  
            </env>  
        </image>  
    </configuration>  
</plugin>
```



Demos

Adoption Plan



Photo by [Glenn Carstens-Peters](#) on [Unsplash](#)

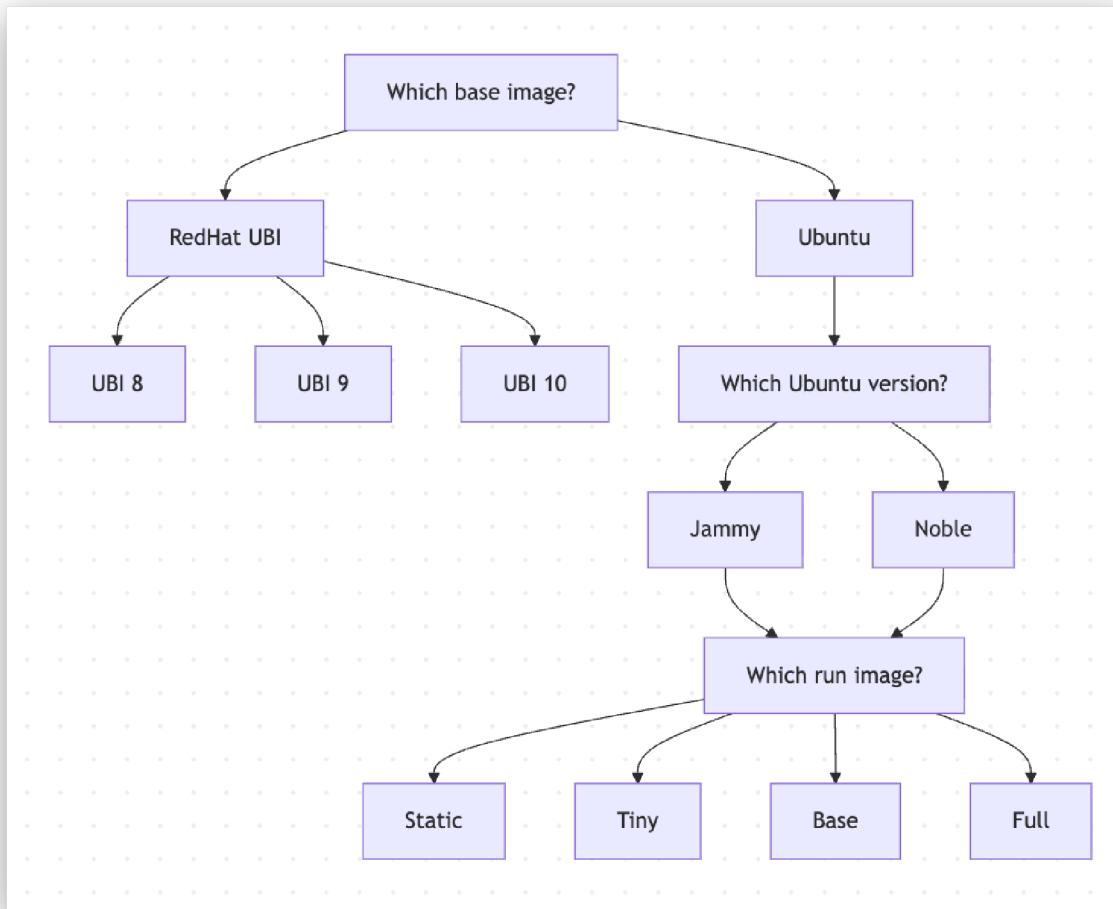
Adoption Plan

1. What languages do you need to support?



ruby javascript
typescript
scala graalvm node
web java clojure
kotlin servers php
python go dotnet
rust

Adoption Plan

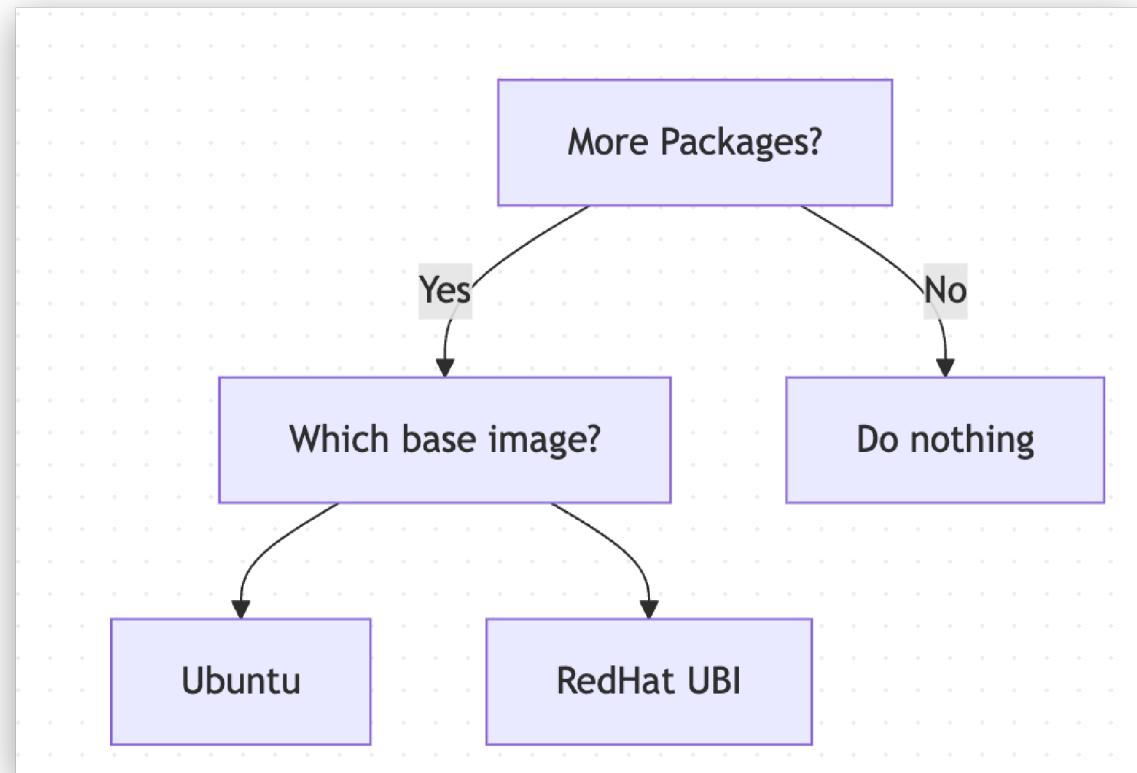


1. What languages do you need to support?

2. What builder should you use?

1. What languages do you need to support?
2. What builder should you use?

3. Do you need to add OS packages?



Adoption Plan



1. What languages do you need to support?
 2. What builder should you use?
 3. Do you need to add OS packages?
- 4. Do you require Corporate CA Certs?**

Automating App Builds

CI/CD Support

- **pack** cli runs in some CI/CD systems like GitHub Actions
- **kpack** can build on top of Kubernetes
- CircleCI, Gitlab, Jenkins and Tekton are also supported
- **lifecycle** direct



Slides



<https://github.com/dmikusa/effortless-containerization-with-cnbs>

Questions?

