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KUBERNETES PATTERNS

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"**m**" for menu, "**?**" for other shortcuts

AGENDA

- Kubernetes
- Patterns
- Categories:
  - Foundational Patterns
  - Structural Patterns
  - Configurational Patterns

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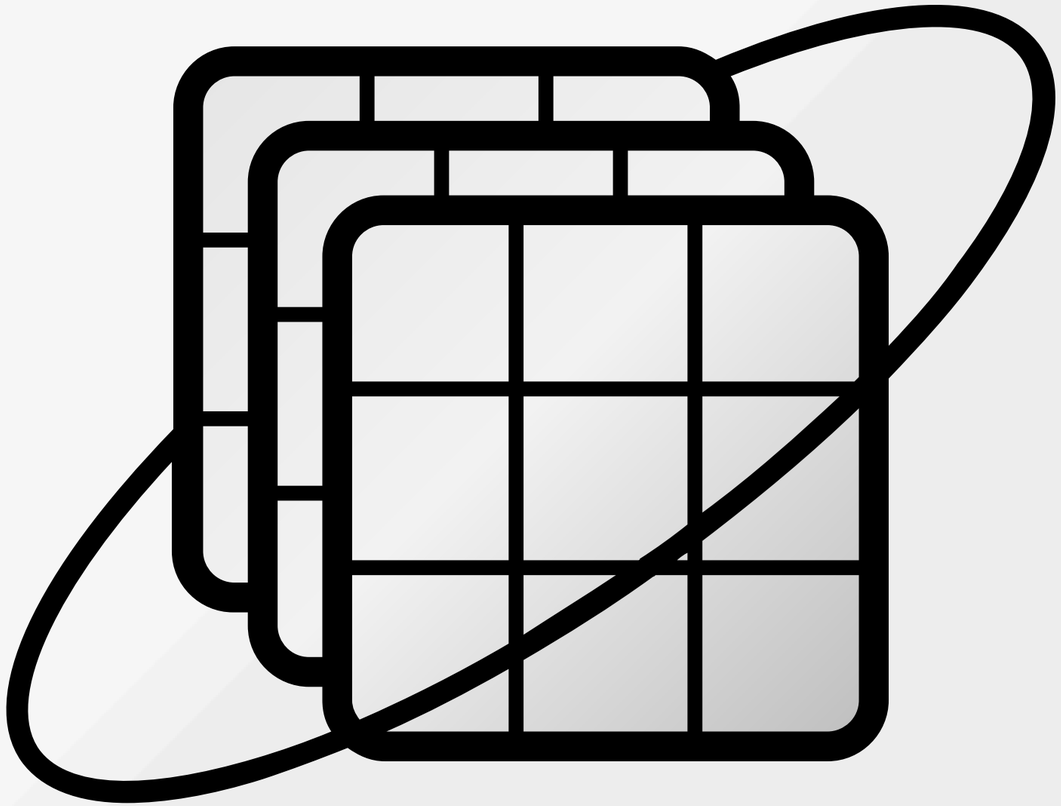

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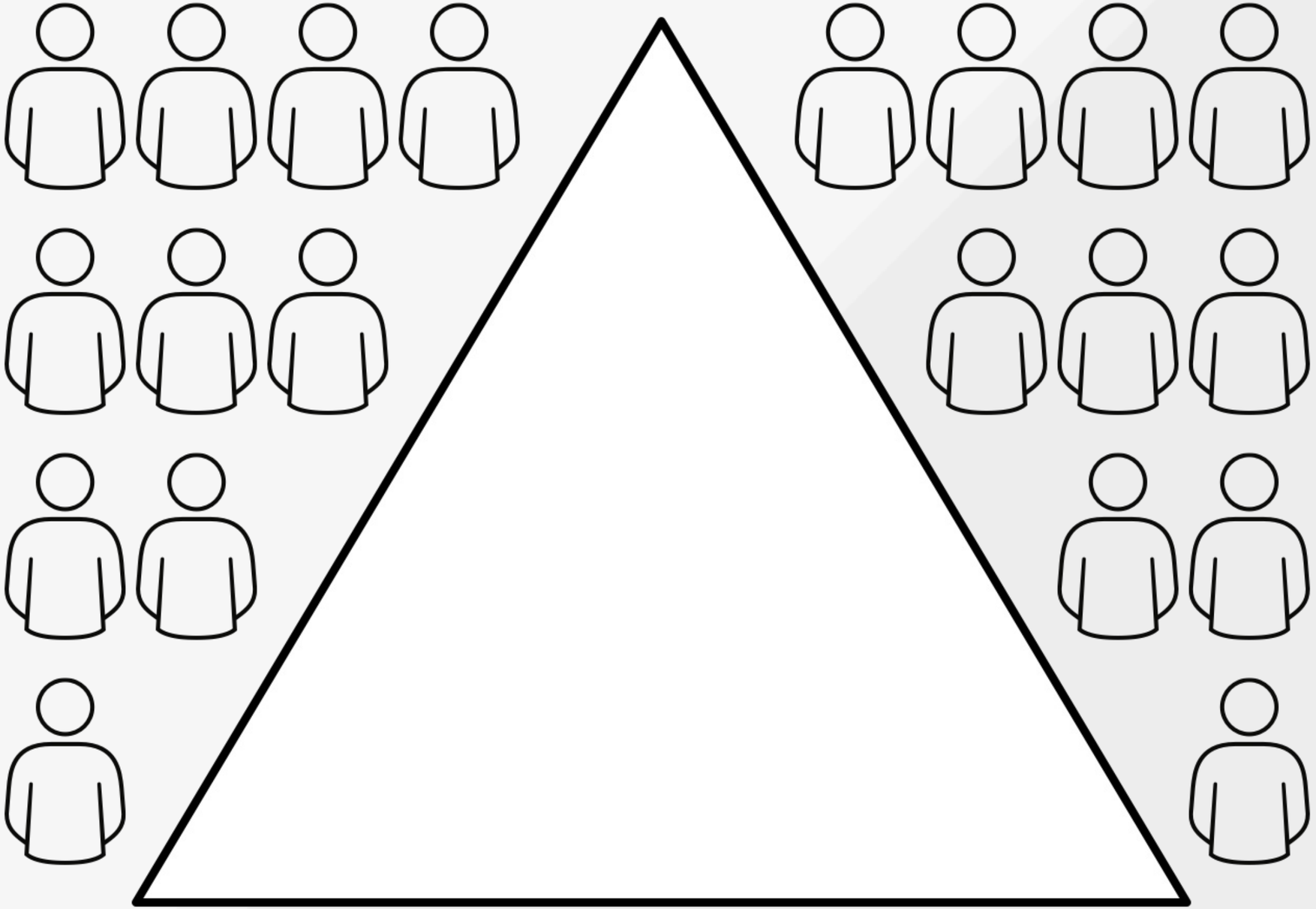

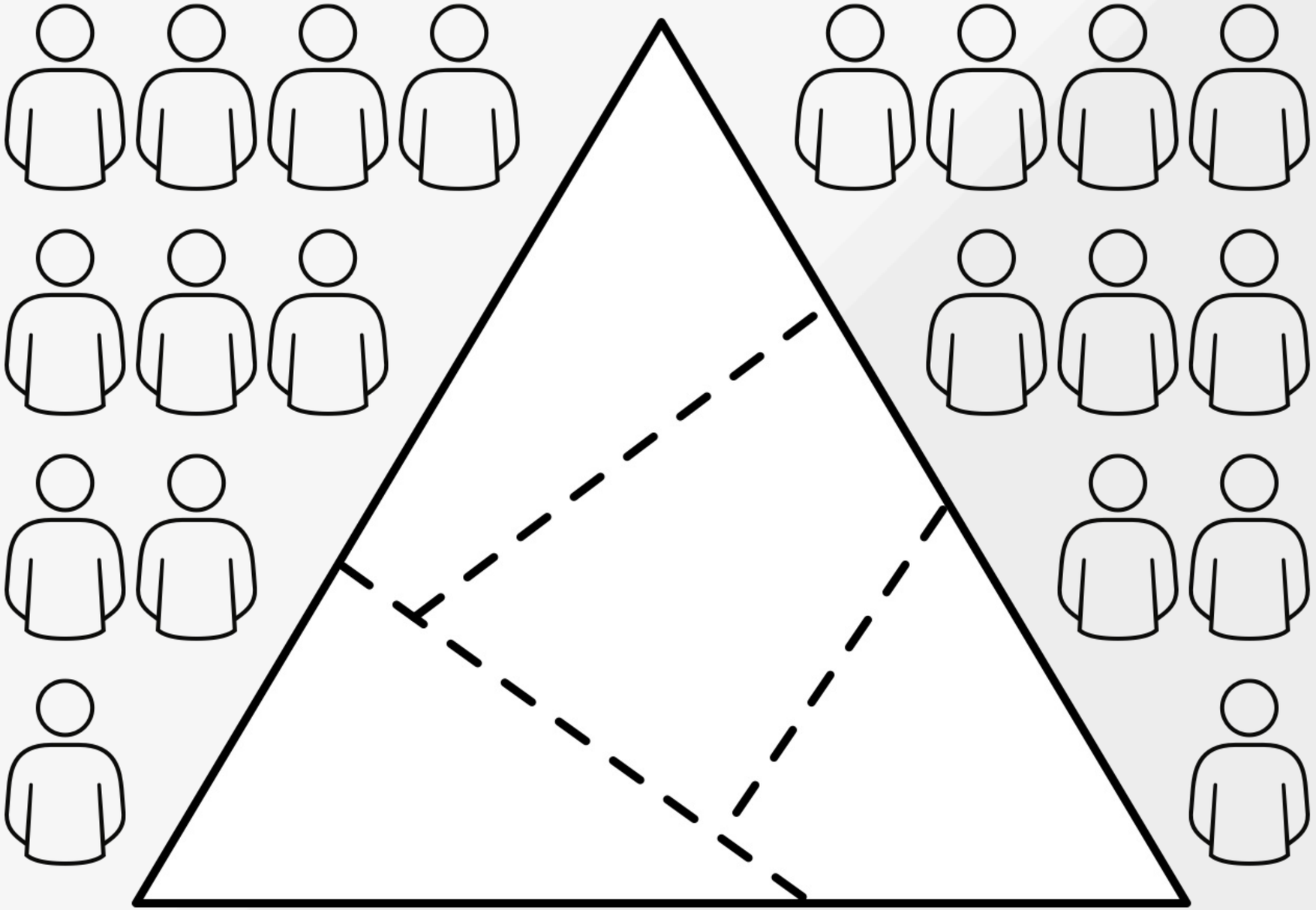

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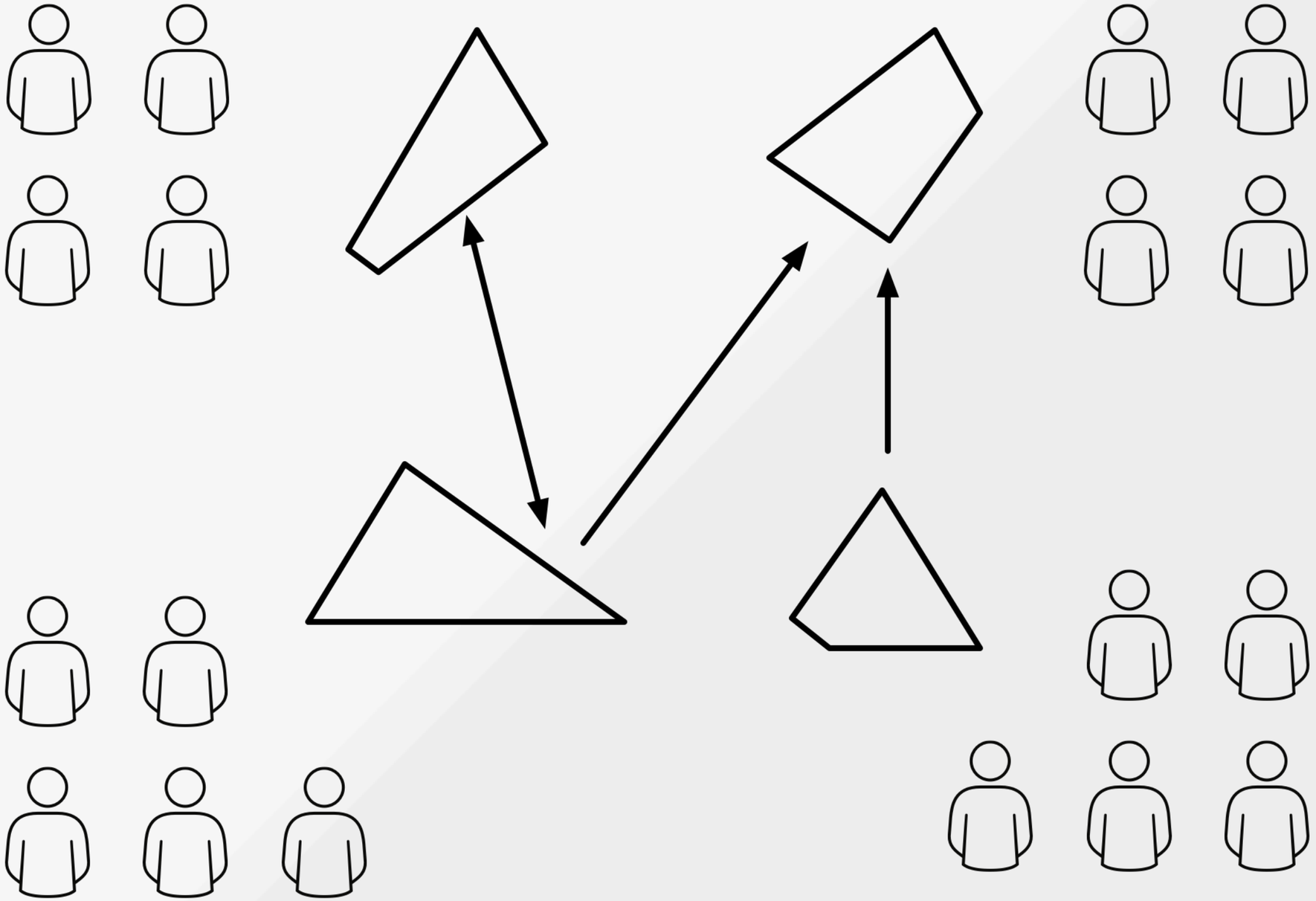

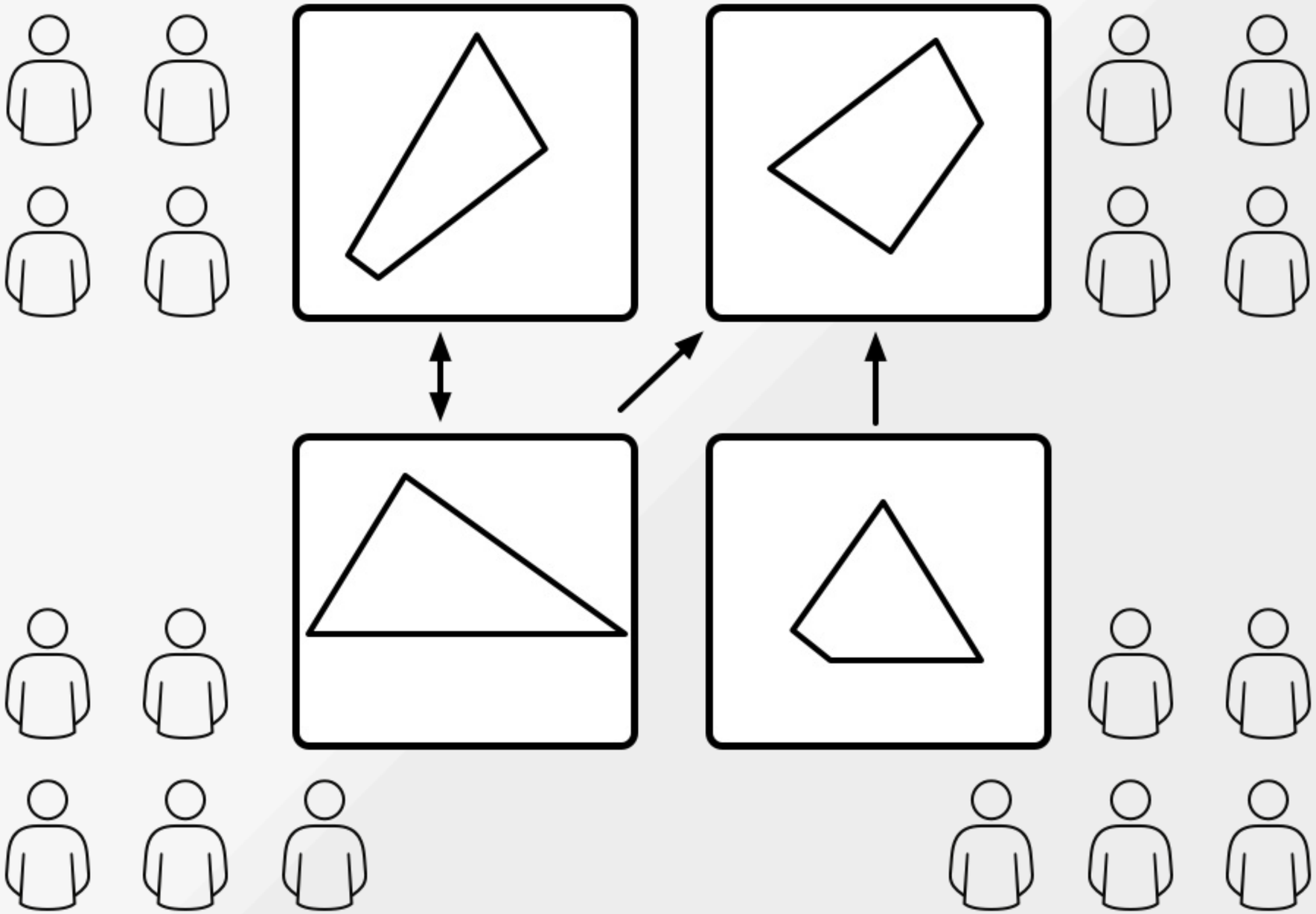

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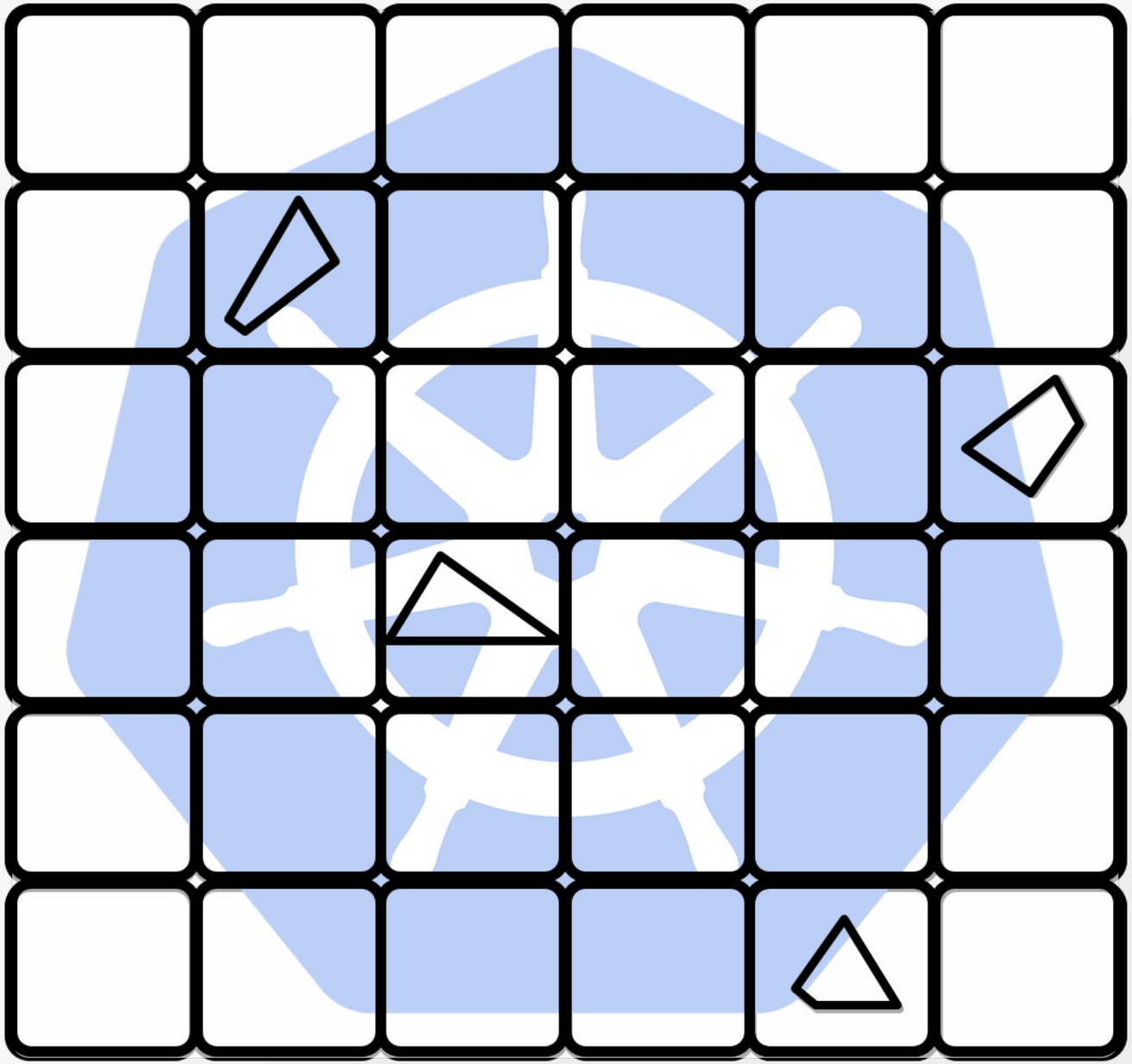

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KUBERNETES

- Open Source container orchestration system
  - Scheduling
  - Horizontal scaling
  - Self-healing
  - Service discovery
  - Automated rollout and rollbacks
- Declarative, resource-centric REST API

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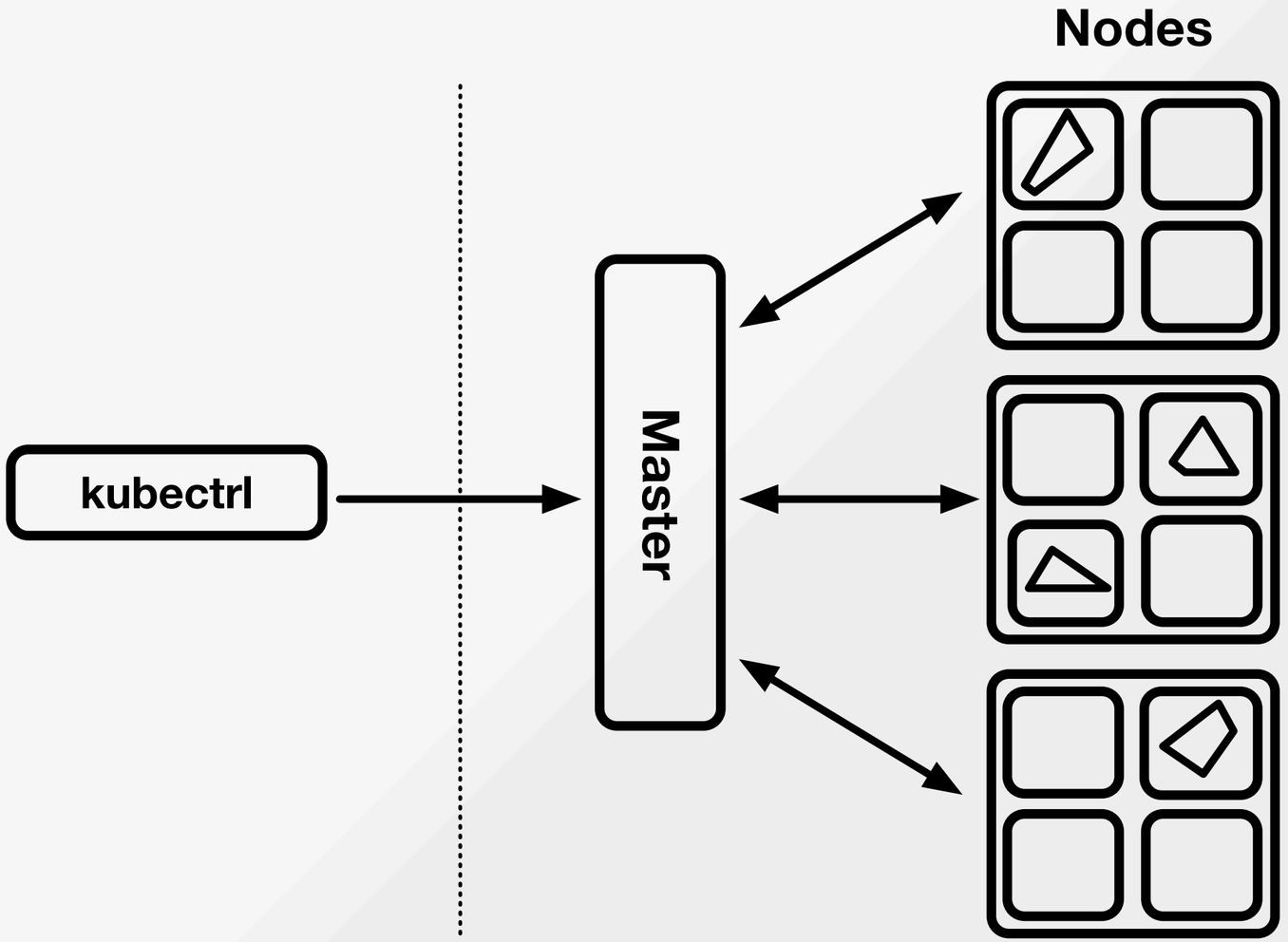
ARCHITECTURE



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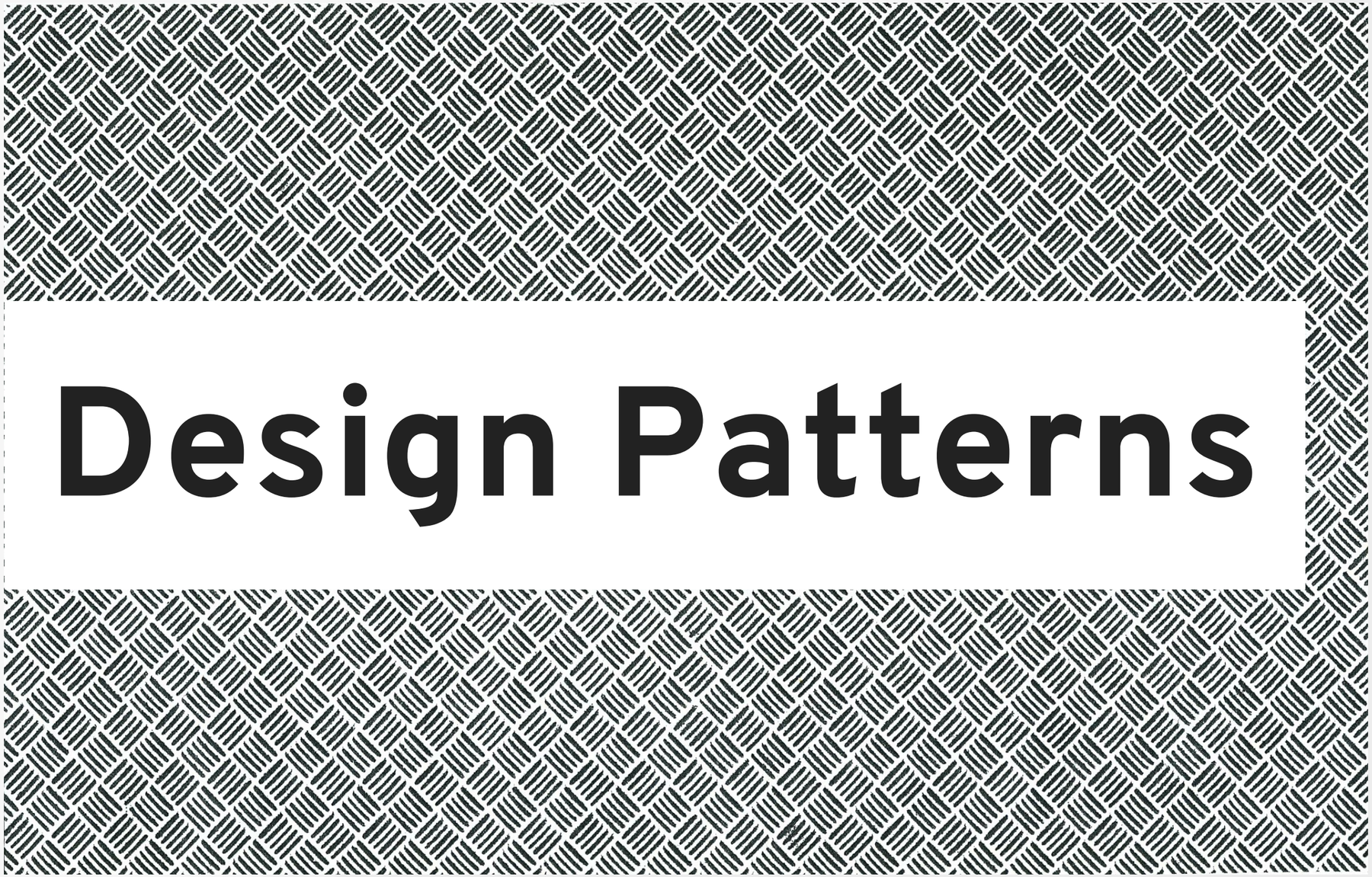

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DESIGN PATTERN

A **Design Pattern** describes a **repeatable solution** to a software engineering **problem**.

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A Pattern Language

Towns · Buildings · Construction

Christopher Alexander
Sara Ishikawa · Murray Silverstein
WITH
Max Jacobson · Ingrid Fiksdahl-King
Shlomo Angel

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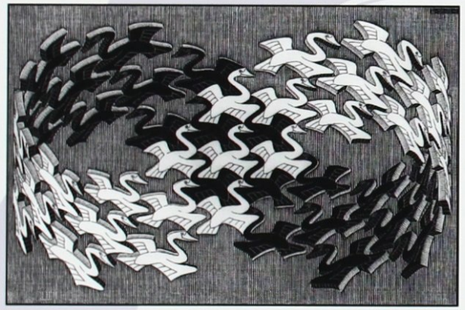
Design Patterns

Elements of Reusable Object-Oriented Software

Erich Gamma
Richard Helm
Ralph Johnson
John Vlissides



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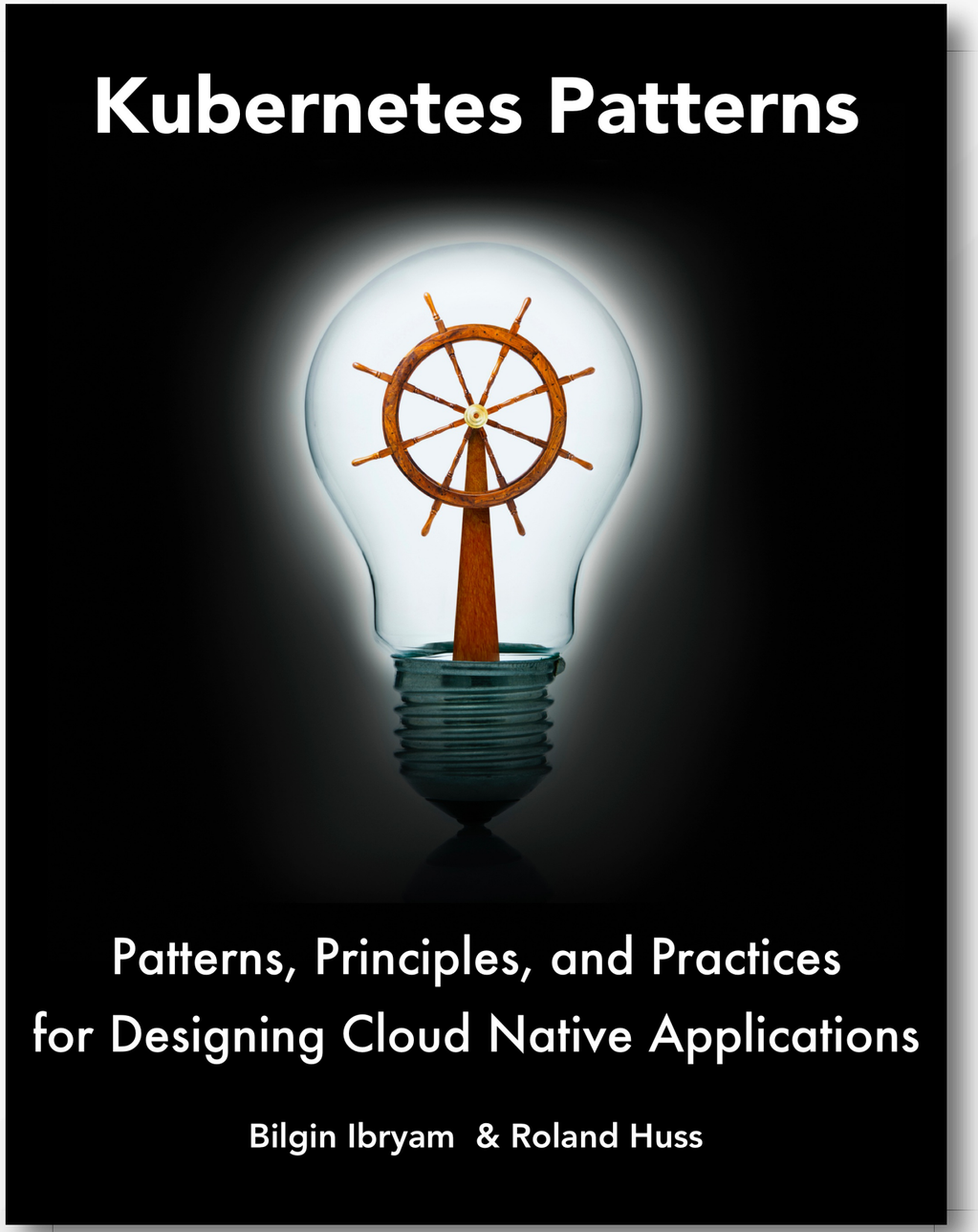
Foreword by Grady Booch

ADDISON-WESLEY PROFESSIONAL COMPUTING SERIES



https://leanpub.com/k8spatterns

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STRUCTURE

- Problem
- Patterns:
  - Name
  - Solution
- http://www.martinfowler.com/articles/writingPatterns.html

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FOUNDATIONAL PATTERNS

Automatable Unit

How can we create and manage applications with Kubernetes ?

- **Pods**: Atomic unit of containers
- **Services**: Entry point to pods
- Grouping via **Labels**, **Annotations**, **Namespaces**

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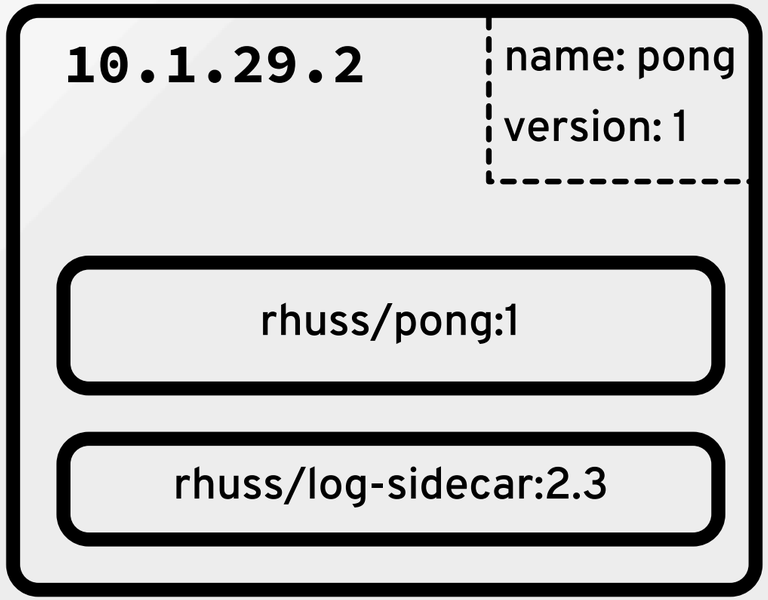
POD

- Kubernetes Atom
- One or more containers sharing:
  - IP and ports
  - Volumes
- Ephemeral IP address



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POD DECLARATION

```
apiVersion: v1
kind: Pod
metadata:
  name: pong
  labels:
    name: pong
    version: "1"
spec:
  containers:
  - image: "rhuss/pong:1"
    name: pong
    ports:
    - containerPort: 8080
  - image: "rhuss/log-sidecar:2.3"
    name: log
```

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REPLICA SET

- Responsible for managing **Pods**
- **replicas** : Number of **Pod** copies to keep
- Label selector chooses **Pods**
- Holds a template for creating new **Pods**

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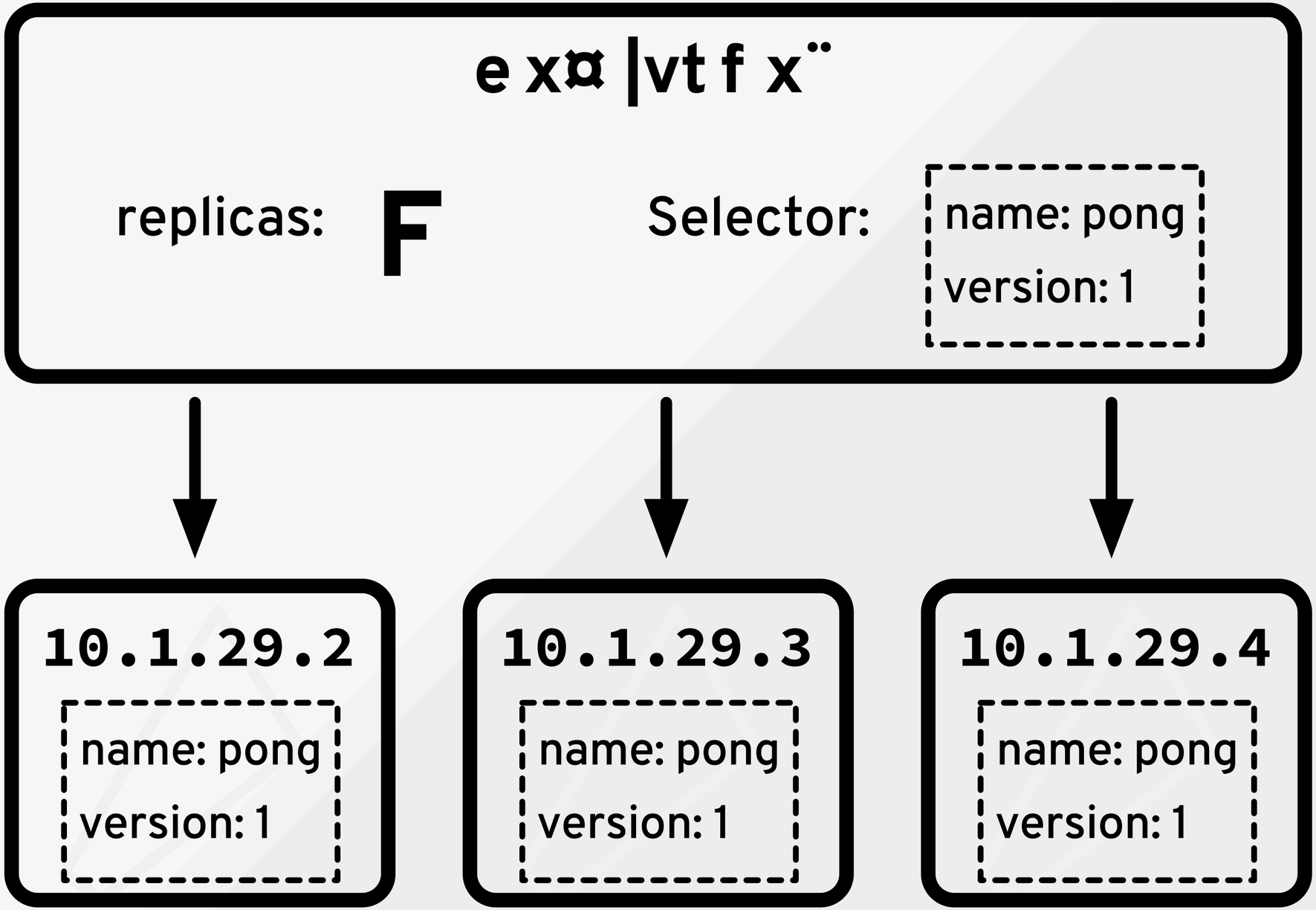
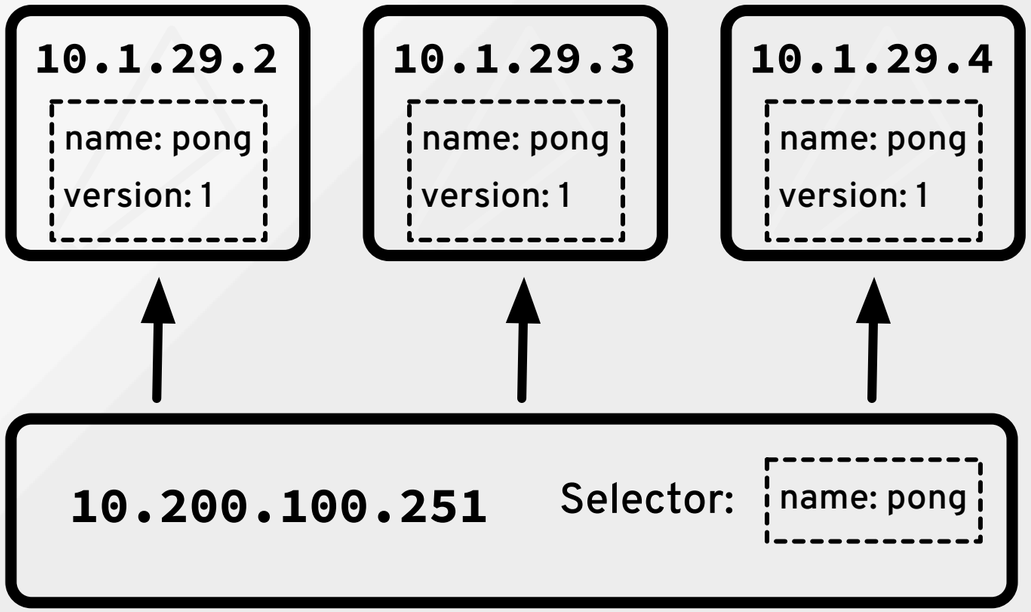

e x¤ |vt f x¨
replicas:
F
Selector:
name: pong
version: 1
10.1.29.2
name: pong
version: 1
10.1.29.3
name: pong
version: 1
10.1.29.4
name: pong
version: 1

SERVICE

- Entrypoint for a set of **Pods**
- **Pods** chosen by **Label** selector
- Permanent IP address



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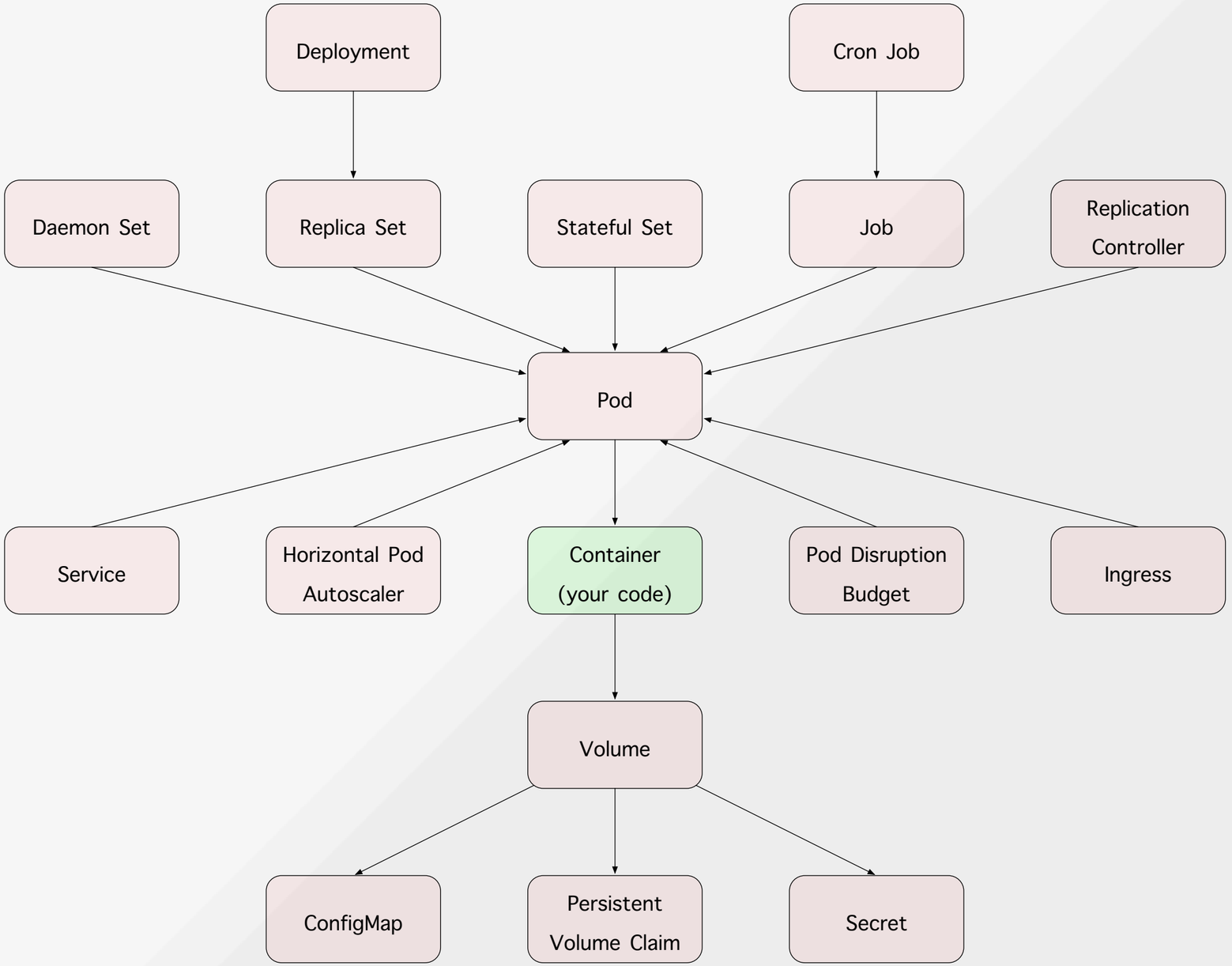
Deployment
Cron Job
Daemon Set
Replica Set
Stateful Set
Job
Replication Controller
Pod
Service
Horizontal Pod Autoscaler
Container (your code)
Pod Disruption Budget
Ingress
Volume
ConfigMap
Persistent Volume Claim
Secret

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Predictable Demands

How can we handle resource requirements deterministically ?

- Requirements should be declared to help in:
  - Matching infrastructure services
  - Scheduling decisions
  - Capacity planning

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RUNTIME DEPENDENCIES

- Persistent Volumes
- Host ports
- Configuration via `ConfigMaps` and `Secrets`

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RESOURCE PROFILES

- Resources:
  - CPU, Network (compressible)
  - Memory (incompressible)
- App: Declaration of resource **requests** and **limits**
- Platform: Resource quotas and limit ranges

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```yaml
apiVersion: v1
kind: Pod
metadata:
  name: http-server
spec:
  containers:
  - image: nginx
    name: nginx
    resources:
      requests:
        cpu: 200m
        memory: 100Mi
      limits:
        cpu: 300m
        memory: 200Mi
```

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QOS CLASSES

- **Best Effort**
  - No `requests` or `limits`
- **Burstable**
  - `requests` < `limits`
- **Guaranteed**
  - `requests` == `limits`

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Declarative Deployment

How can applications be deployed and updated ?

- **Declarative** versus **Imperative** deployment
- Various update strategies

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DEPLOYMENT

- Holds template for `Pod`
- Creates `ReplicaSet` on the fly
- Allows rollback
- Update strategies declarable
- Inspired by `DeploymentConfig` from OpenShift

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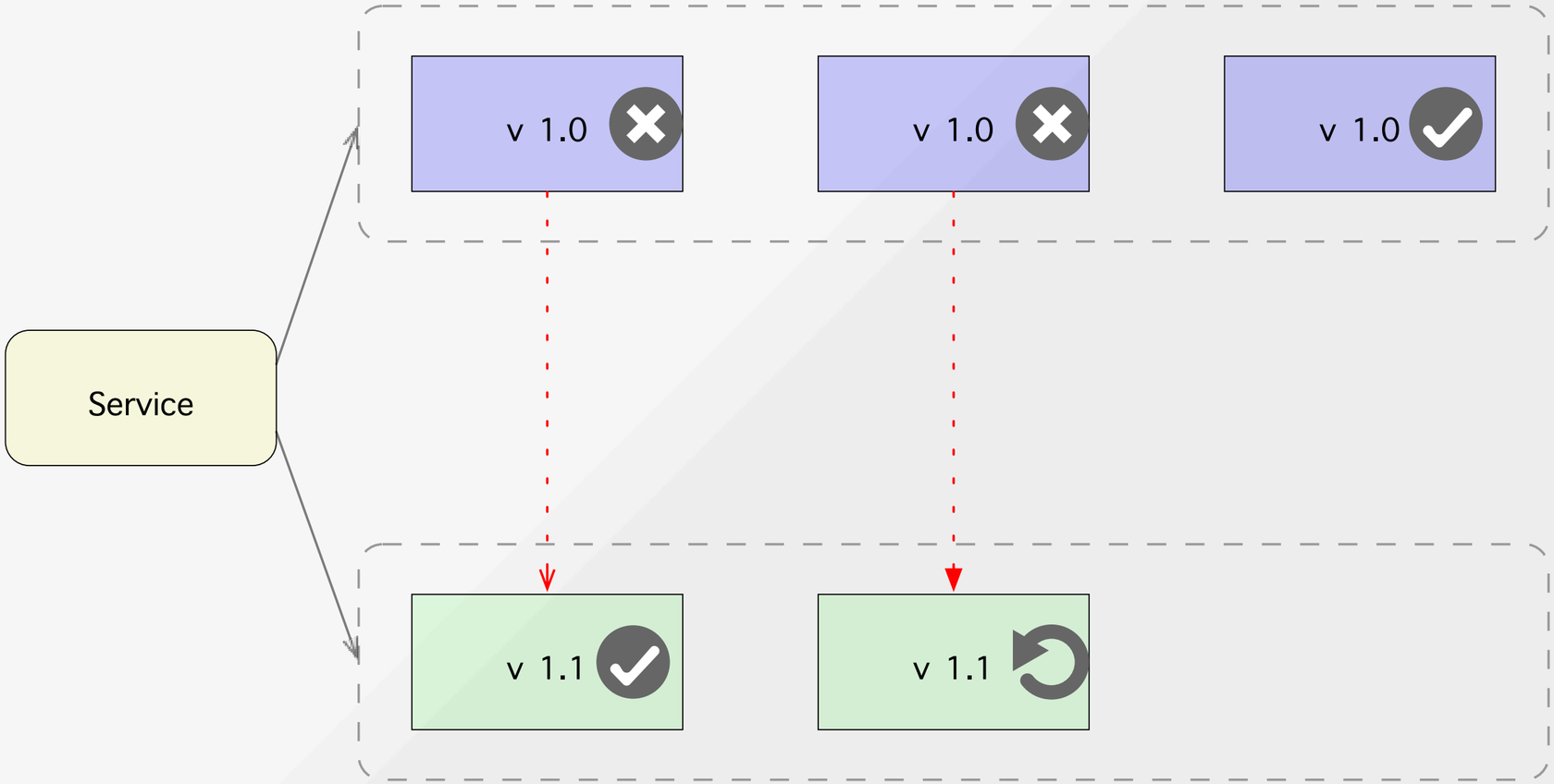
ROLLING



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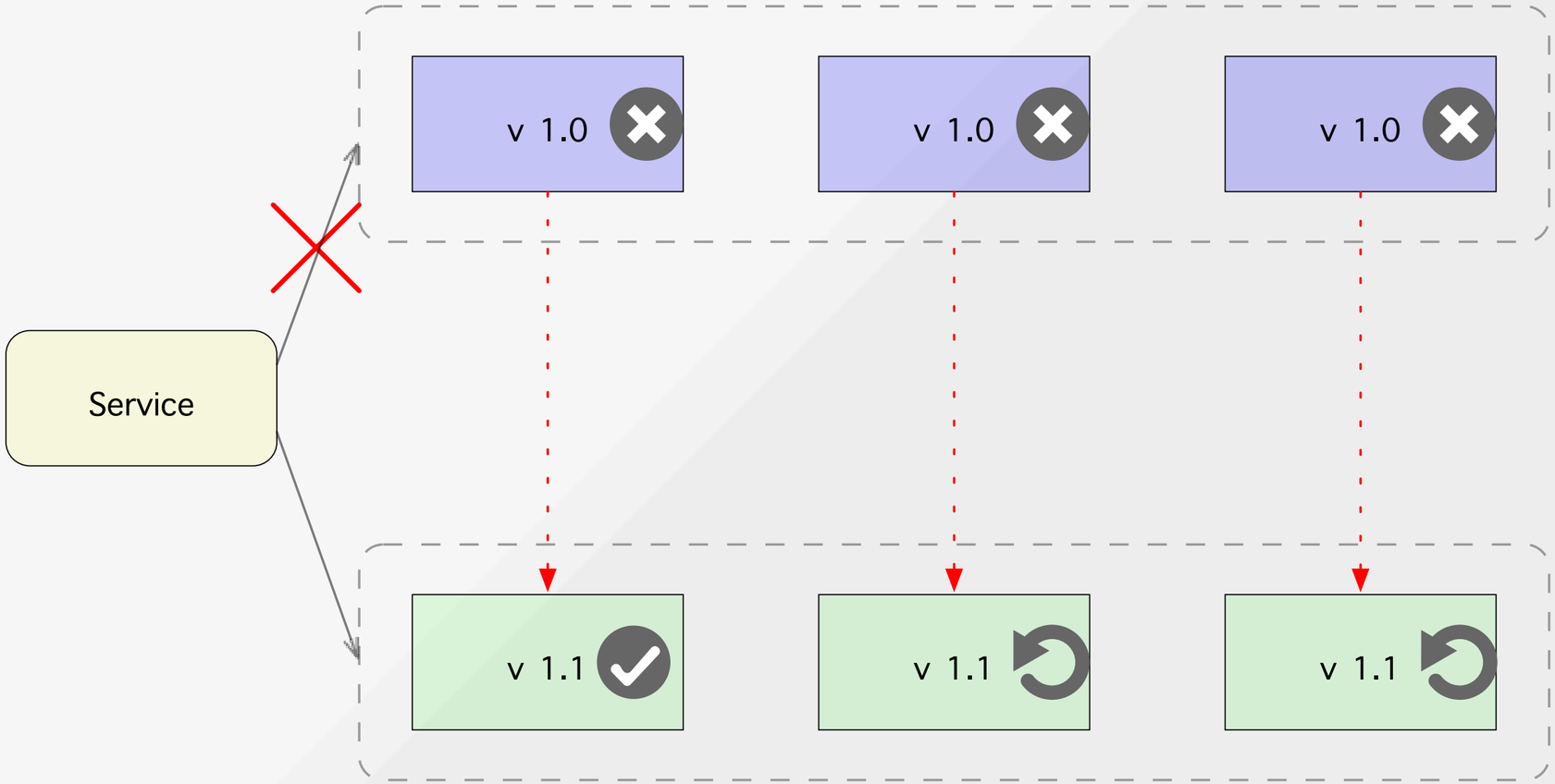
FIXED



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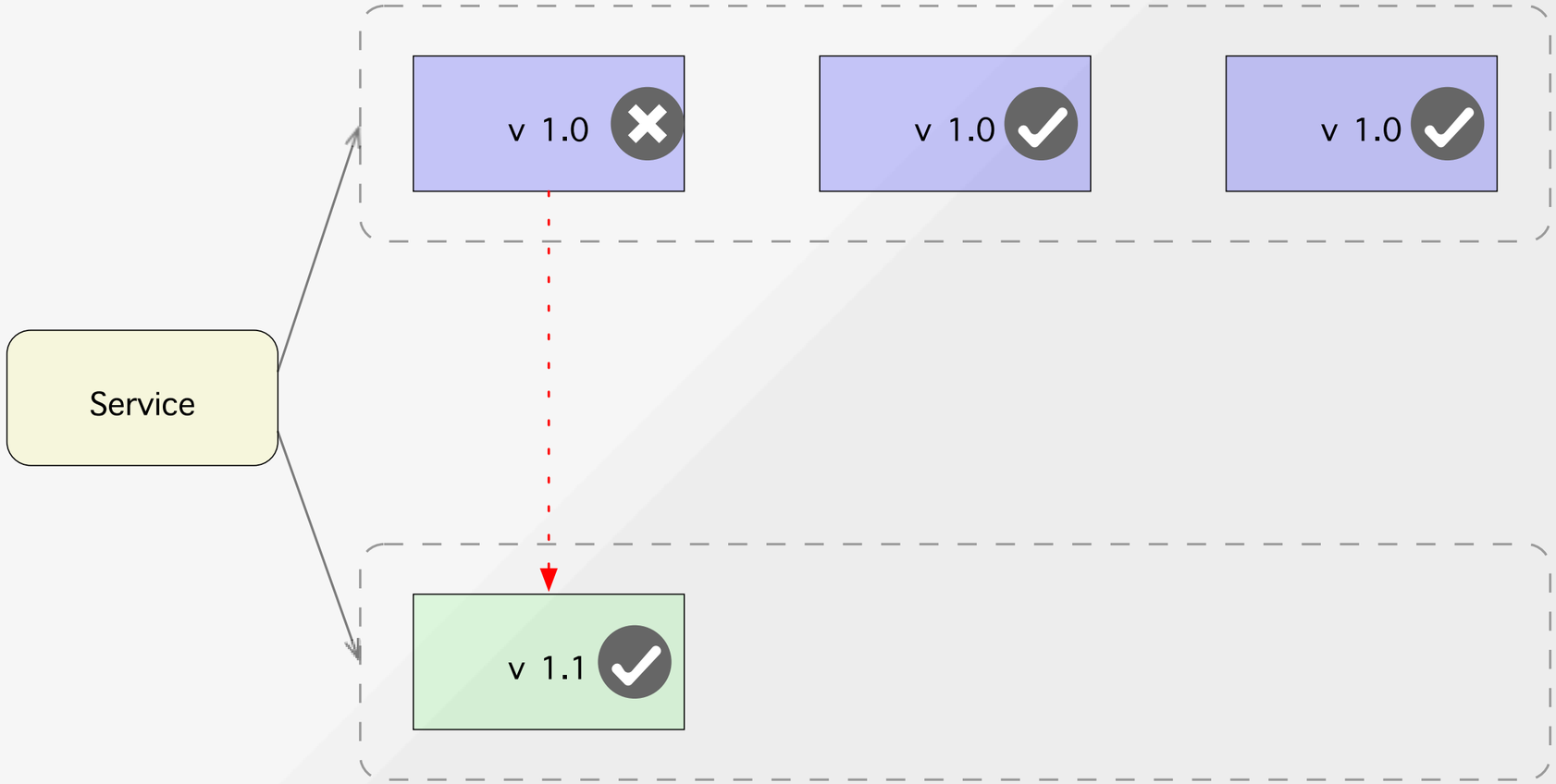
CANARY



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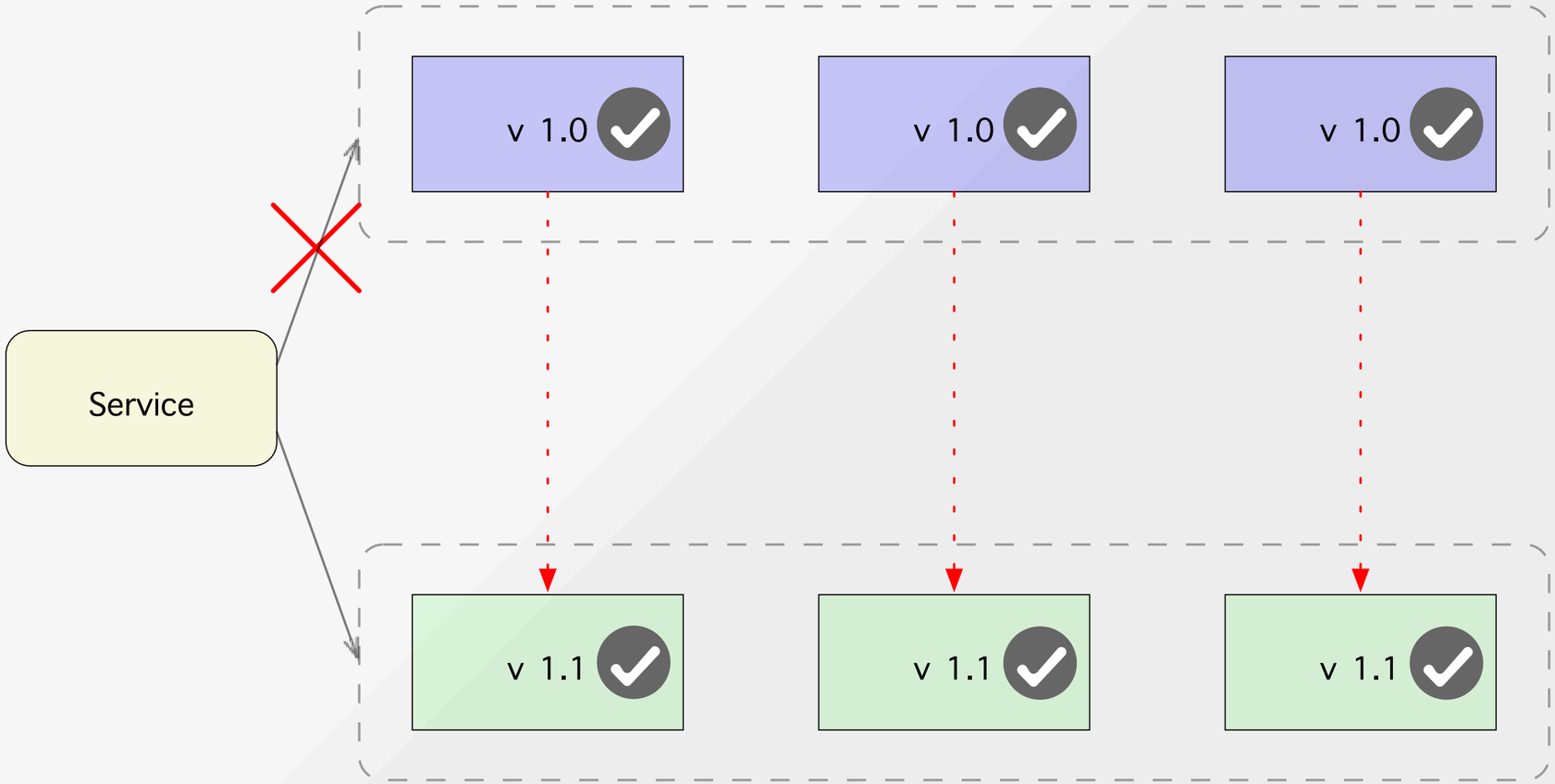
BLUE-GREEN



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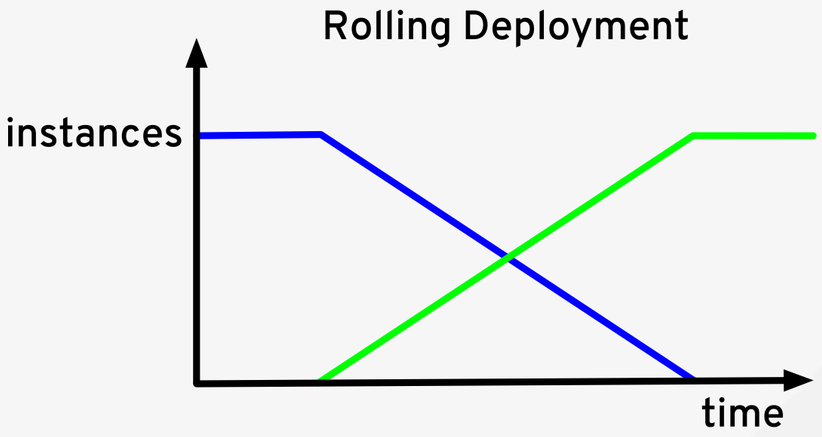
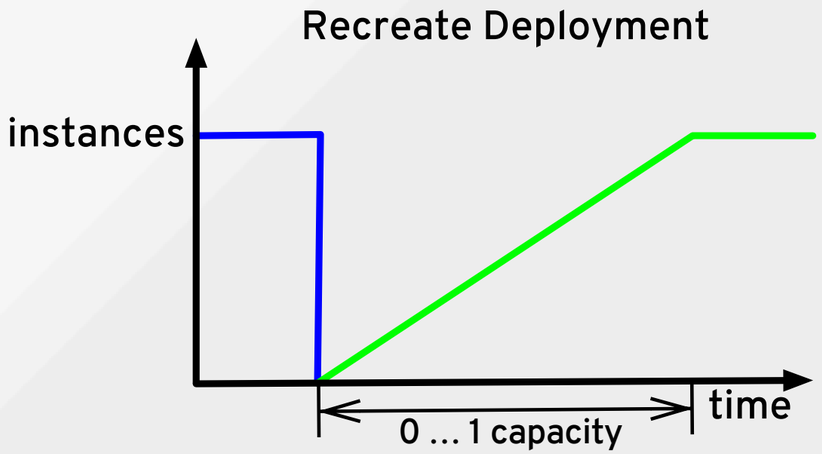
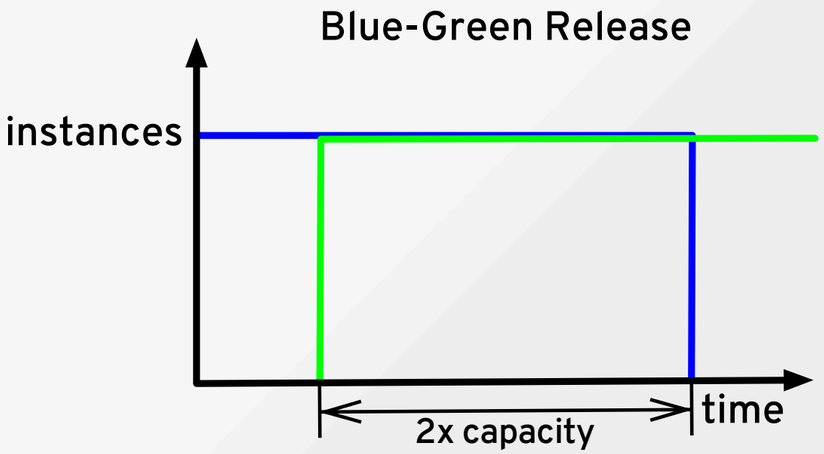
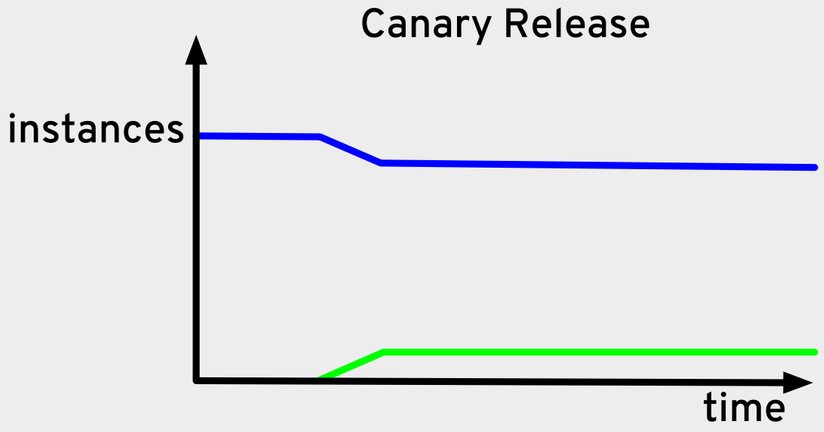
SUMMARY









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STRUCTURAL PATTERNS

Initializer

How can I initialize my containerized applications ?

- Init containers :
  - Part of an Pod
  - One shot action before Pod starts
  - Need to be idempotent
  - Have own resource requirements

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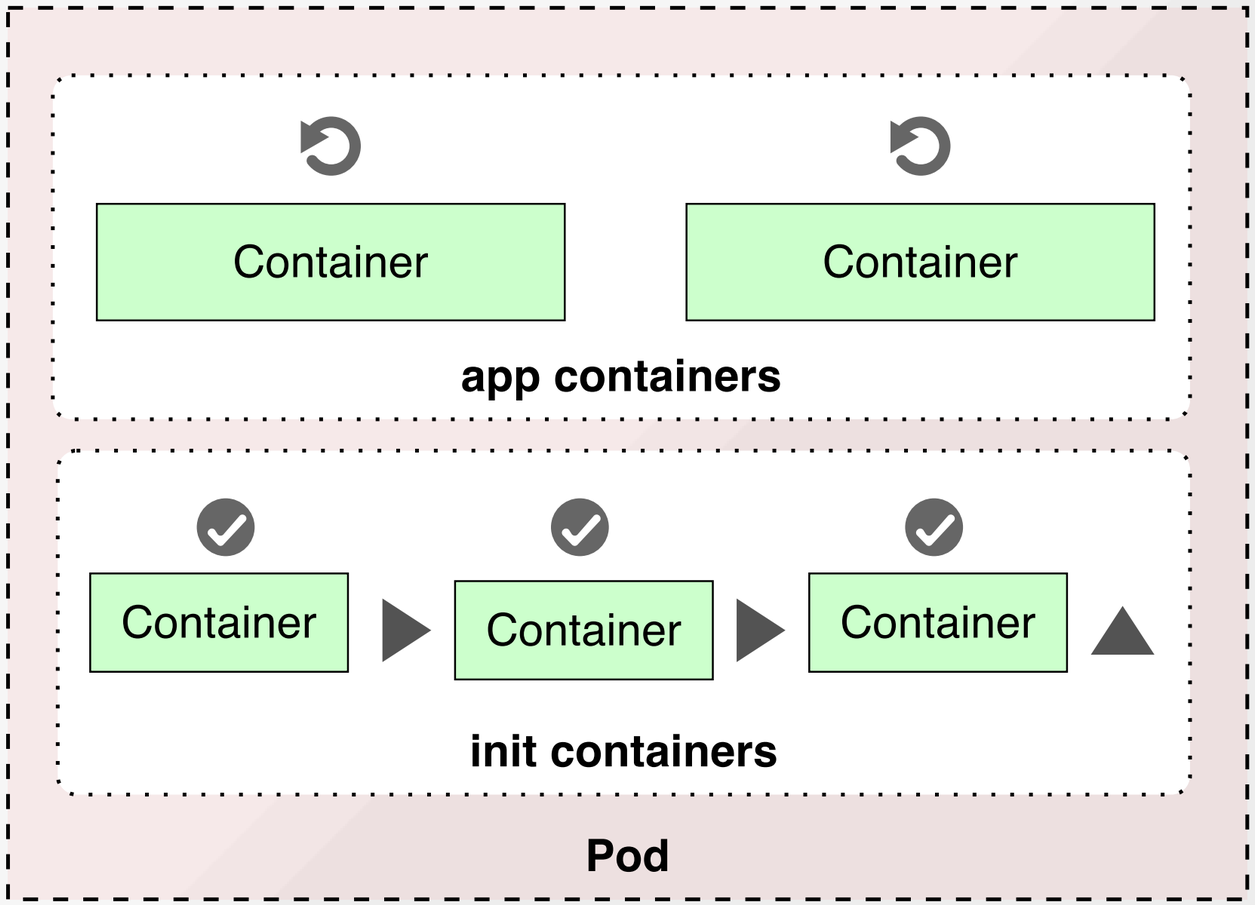
Container
Container
app containers
Container
Container
Container
init containers
Pod

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Sidecar

How can I extend the functionality of an existing container ?

- Runtime collaboration of containers
- Connected via shared resources:
  - Network
  - Volumes

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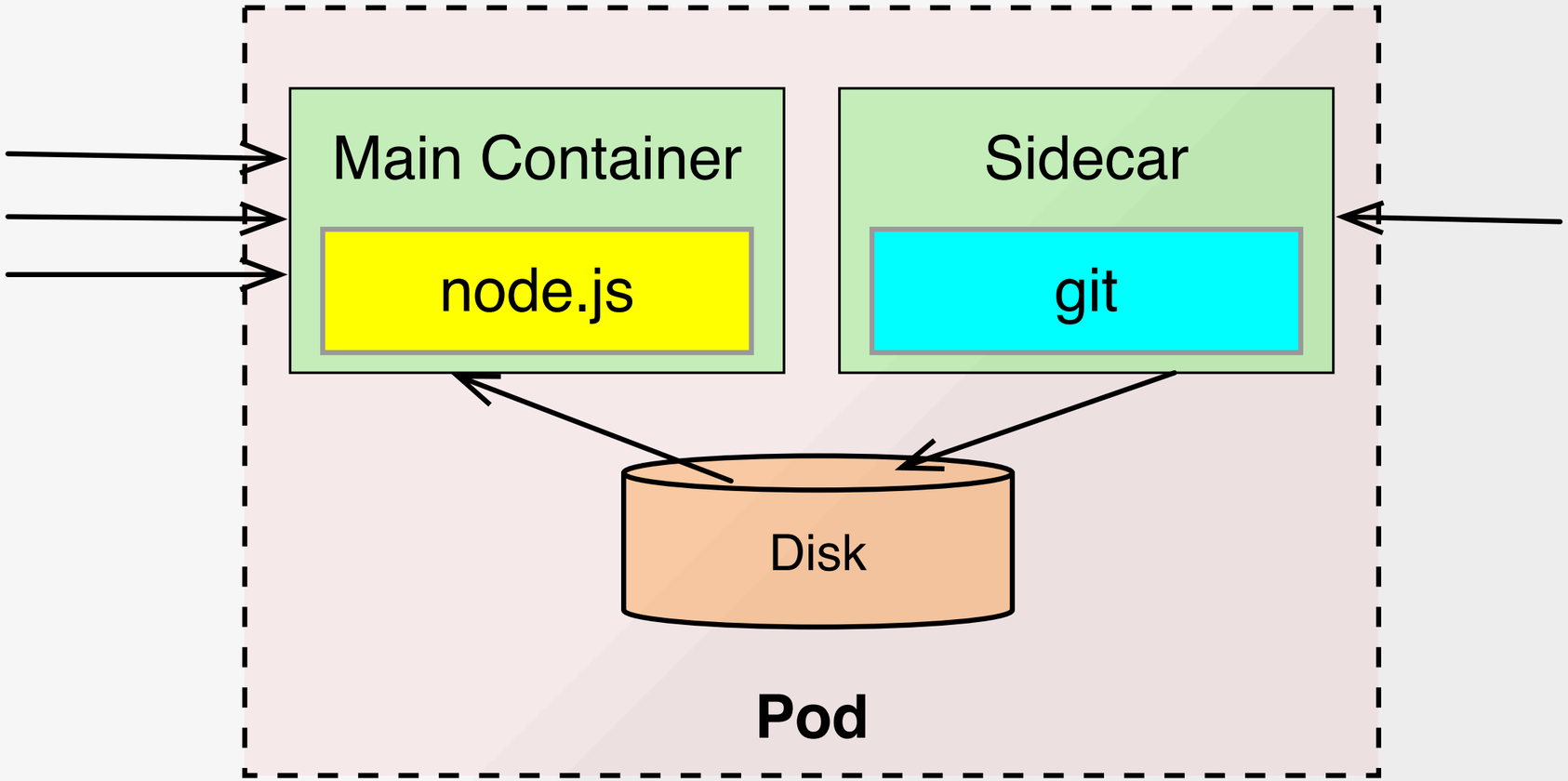
Main Container
node.js
Sidecar
git
Disk
Pod

Ambassador

How to decouple a container's access **to** the outside world ?

- Also known as **Proxy**
- Specialization of a Sidecar
- E.g. infrastructure services
  - Circuit breaker
  - Tracing

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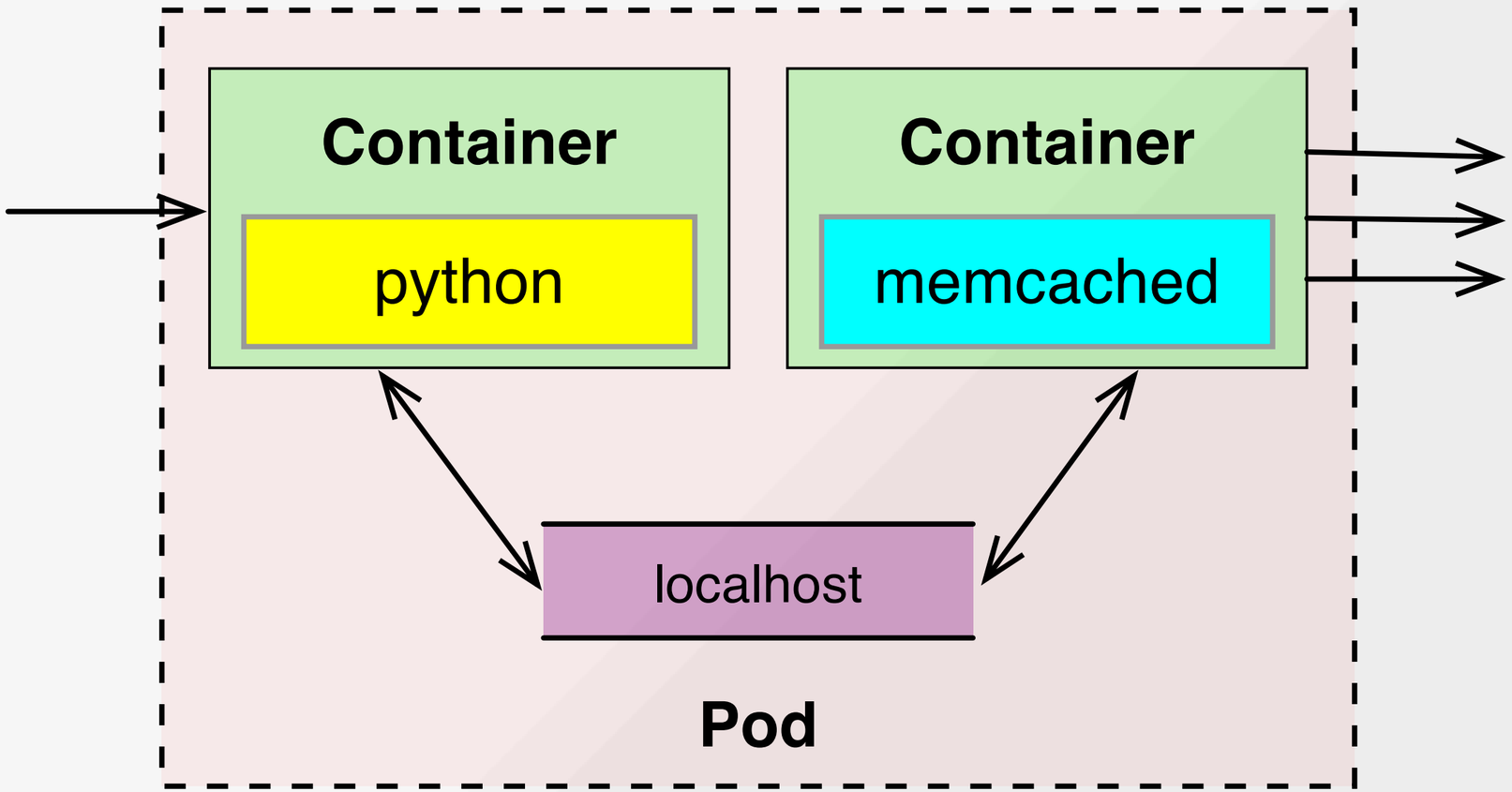

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Adapter

How to decouple access to a container **from** the outside world ?

- Opposite of Ambassador
- Uniform access to application
- Examples:
  - Monitoring
  - Logging

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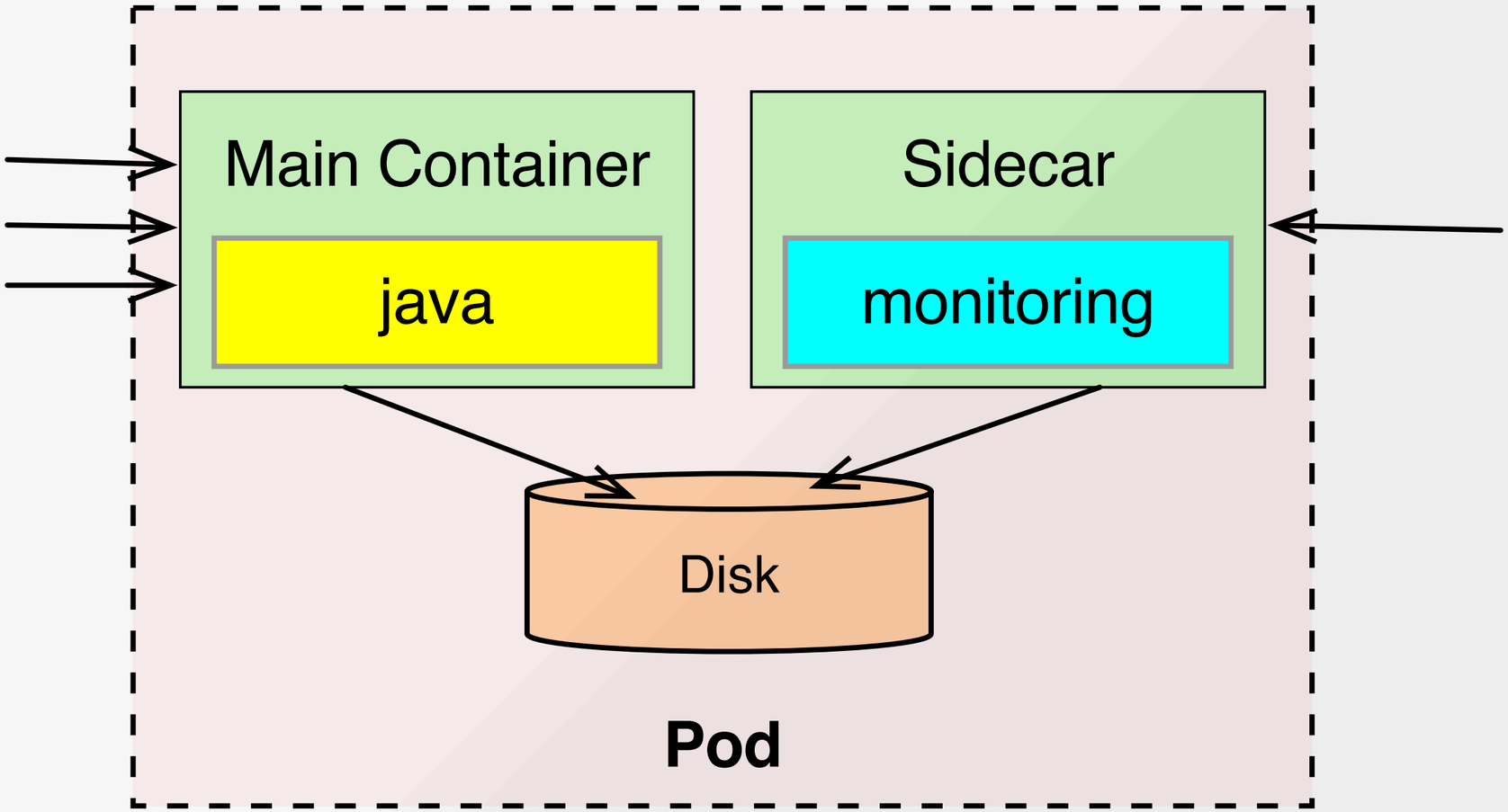
Main Container
java
Sidecar
monitoring
Disk
Pod

CONFIGURATIONAL PATTERNS

How can applications be configured for different environments ?

EnvVar Configuration

- Universal applicable
- Recommended by the Twelve Factor App manifesto
- Can be only set during startup of application

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```
kind: Pod
spec:
 containers:
 - env:
   - name: DB_HOST
     value: "prod-database.prod.intranet"
   - name: DB_PASSWORD
     valueFrom:
       secretKeyRef:
         name: "db-passwords"
         key: "monogdb.password"
   - name: DB_USER
       valueFrom:
         configMapKeyRef:
           name: "db-users"
           key: "mongodb.user"
   image: acme/bookmark-service:1.0.4
```

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Configuration Resource

- `ConfigMap` and `Secret` : Intrinisic K8s resources
- Can be used in two ways:
  - Reference for environment variables
  - Files mapped to a volume

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```
kind: ConfigMap
metadata:
  name: spring-boot-config
data:
  JAVA_OPTIONS: "-Xmx512m"
  application.properties: |
    welcome.message=Hello !!!
    server.port=8080
```

```
kind: Pod
spec:
  containers:
  - name: web
    volumeMounts:
    - name: config-volume
      mountPath: /etc/config
    # ...
  volumes:
    - name: config-volume
      configMap:
        name: spring-boot-config
```

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Configuration Template

- `ConfigMap` not suitable for large configuration
- Managing similar configuration
- Ingredients:
  - Init-container with template processor and templates
  - Parameters from a `ConfigMap` Volume

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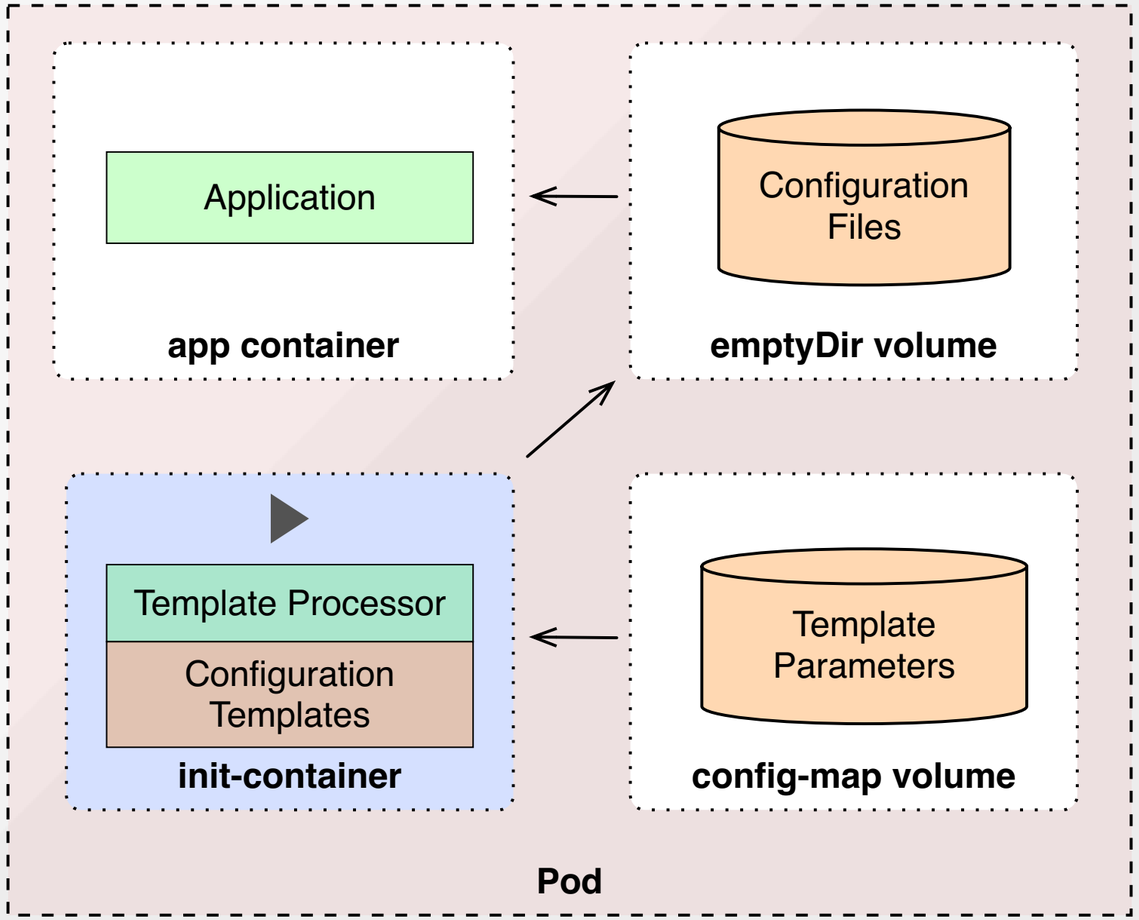
CONFIGURATION TEMPLATE



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DISCUSSION

- Good for large, similar configuration sets per environment
- Parameterisation via ConfigMaps easy
- More complex

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Immutable Configuration

- Configuration is put into a container itself
- Configuration container is linked to application container during runtime

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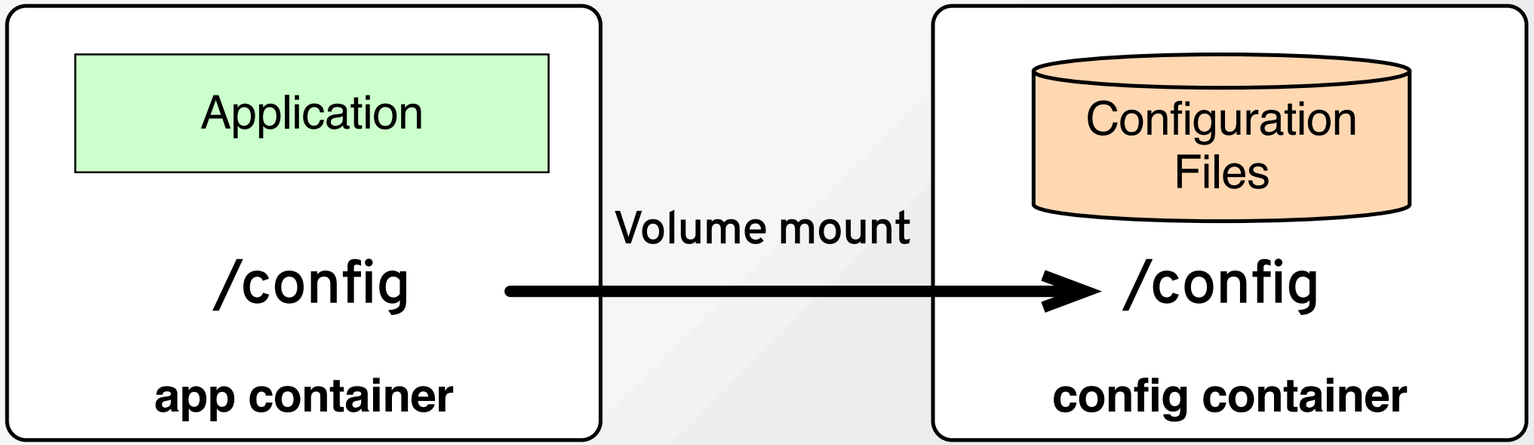
CONTAINER VOLUMES



- Not directly supported by K8s
- docker-flexvol : K8s FlexVolume driver for Docker volumes

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```
kind: Pod
metadata:
  name: nginx
spec:
  containers:
  - name: nginx
    image: nginx
    volumeMounts:
    - name: test
      mountPath: /data
    ports:
    - containerPort: 80
  volumes:
  - name: test
    flexVolume:
      driver: "dims.io/docker-flexvol"
      options:
        image: "my-container-image"
        name: "/data-store"
```

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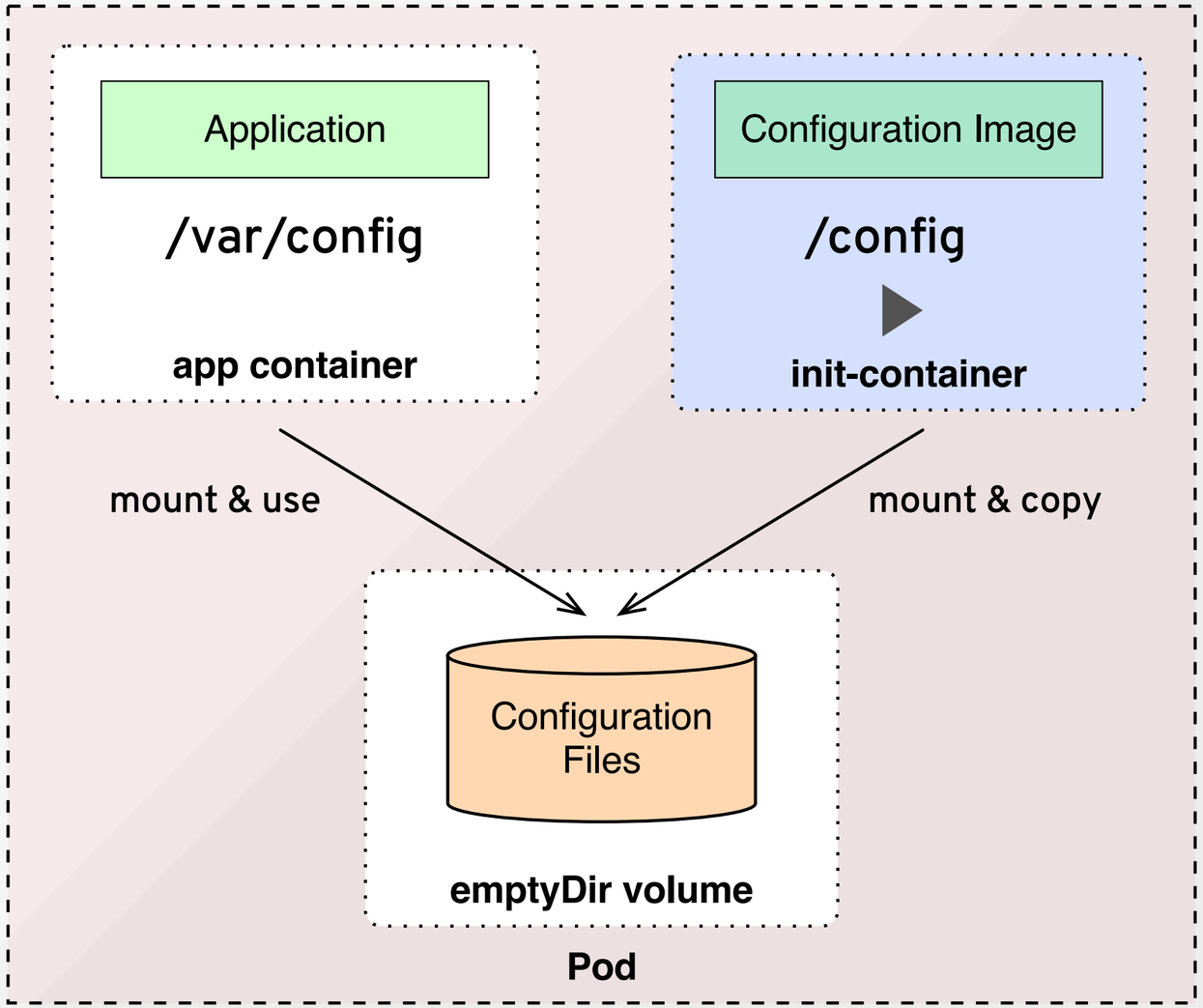
INIT CONTAINER



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- Dockerfile for init container:

```
FROM busybox

ADD dev.properties /config-src/demo.properties
# ... add more to /config-src

# Using a shell here in order to resolve wildcards
ENTRYPOINT [ "sh", "-c", \
        "cp /config-src/* $1", "--" ]
```

- Build config image:

```
docker build -t k8spatterns/config-dev:1 .
```

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```
spec:
 initContainers:
 - image: k8spatterns/config-dev:1
   name: init
   args:
   - "/config"
   volumeMounts:
   - mountPath: "/config"
     name: config-directory

 containers:
 - image: k8spatterns/demo:1
   name: demo
   volumeMounts:
   - mountPath: "/config"
     name: config-directory

 volumes:
 - name: config-directory
   emptyDir: {}
```

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DISCUSSION

- Immutable Configuration ...
  - can be versioned
  - can be distributed via a registry
  - is immutable
  - can be arbitrary large
- Parameterisation via OpenShift Templates

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WRAP UP

- Kubernetes offers a rich feature set to manage containerised applications.
- Patterns can help in solving recurring Kubernetes challenges.
- More and more patterns are emerging.

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QUESTIONS ?

Twitter	ro14nd
Book	https://leanpub.com/k8spatterns
Slides	http://bit.ly/kubernetes-patterns-javazone-2017

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