



KUBERNETES PATTERNS

JAX 2018, Mainz

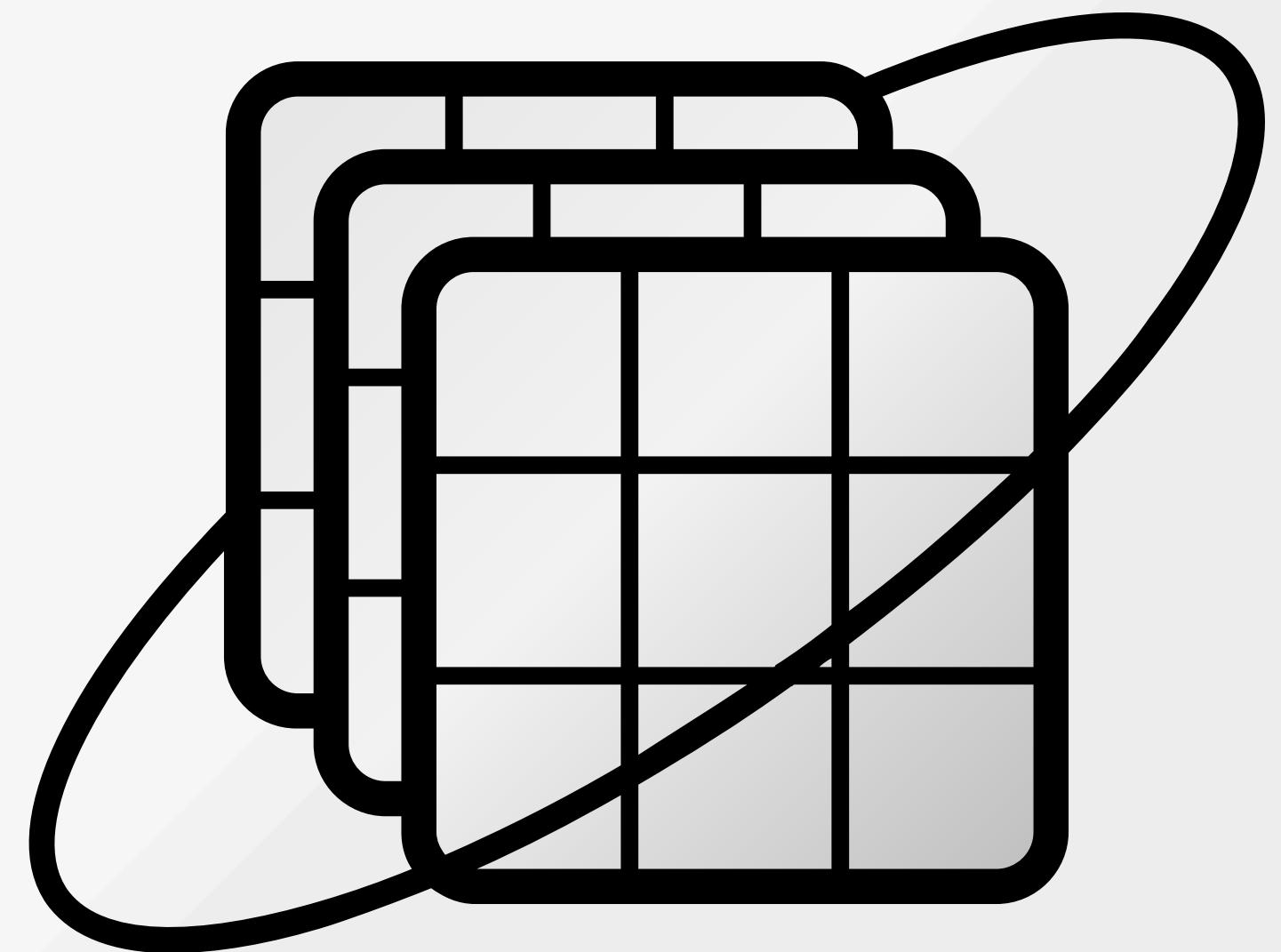
Roland Huß, Red Hat, @ro14nd

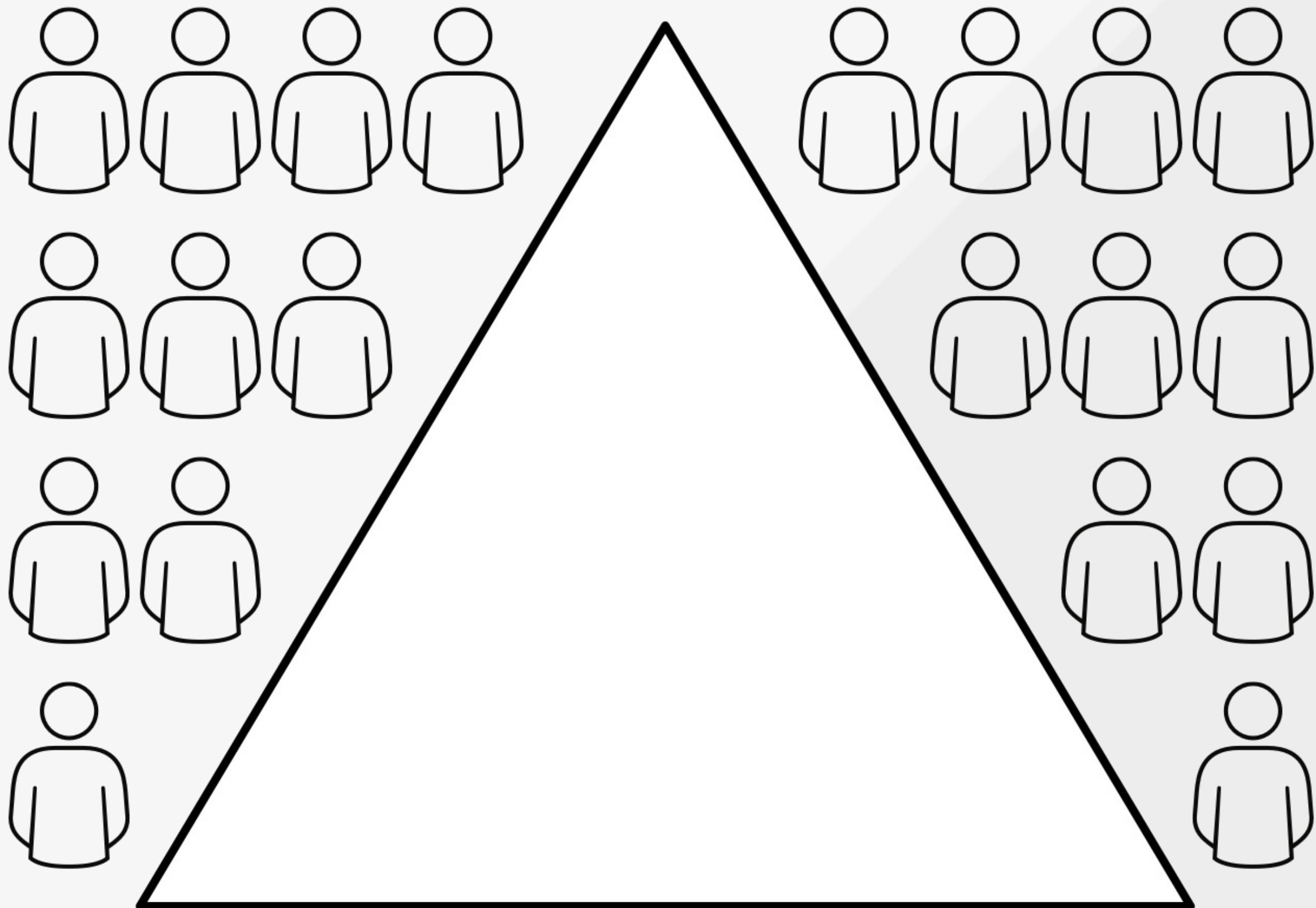


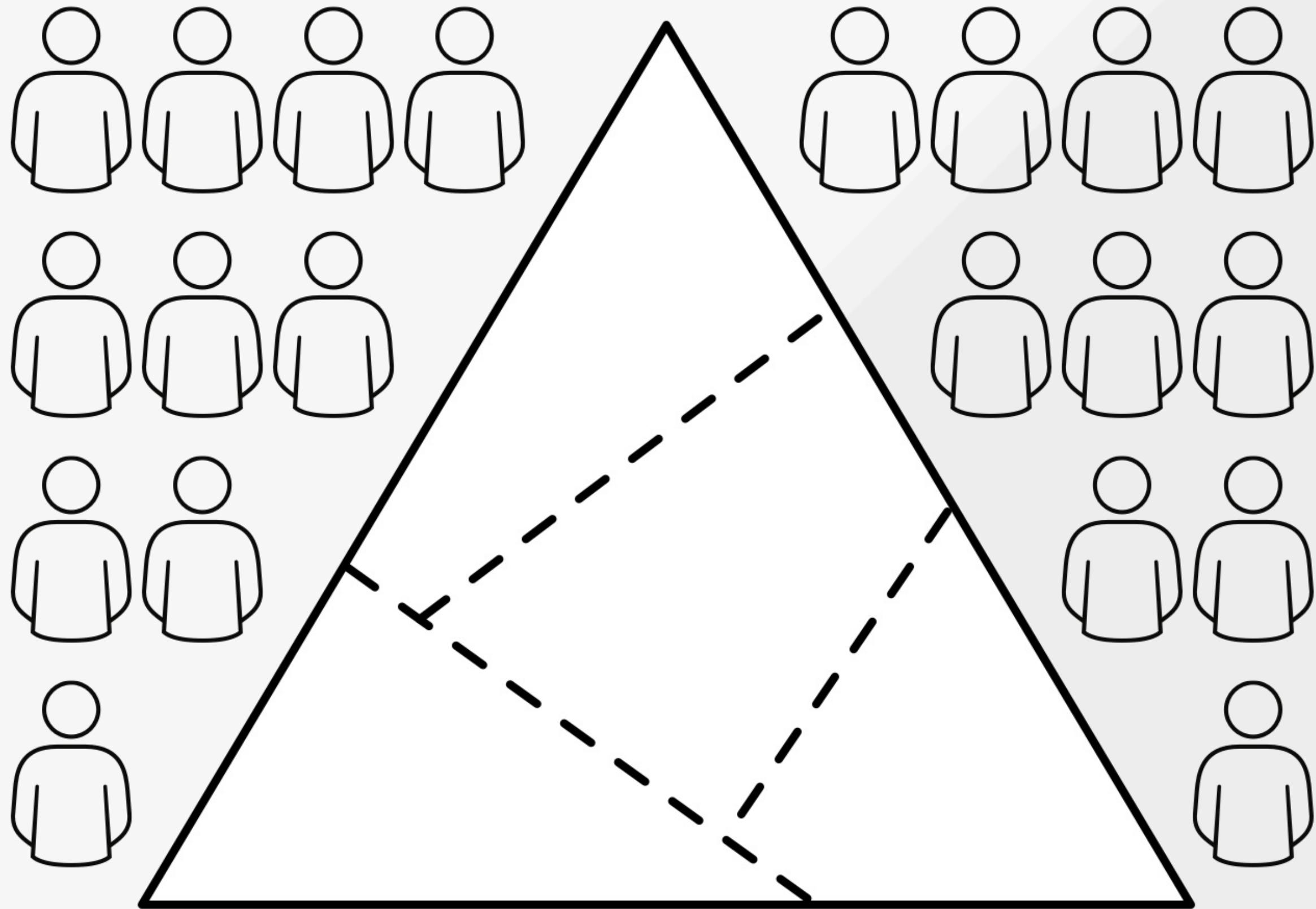
"m" for menu, "?" for other shortcuts

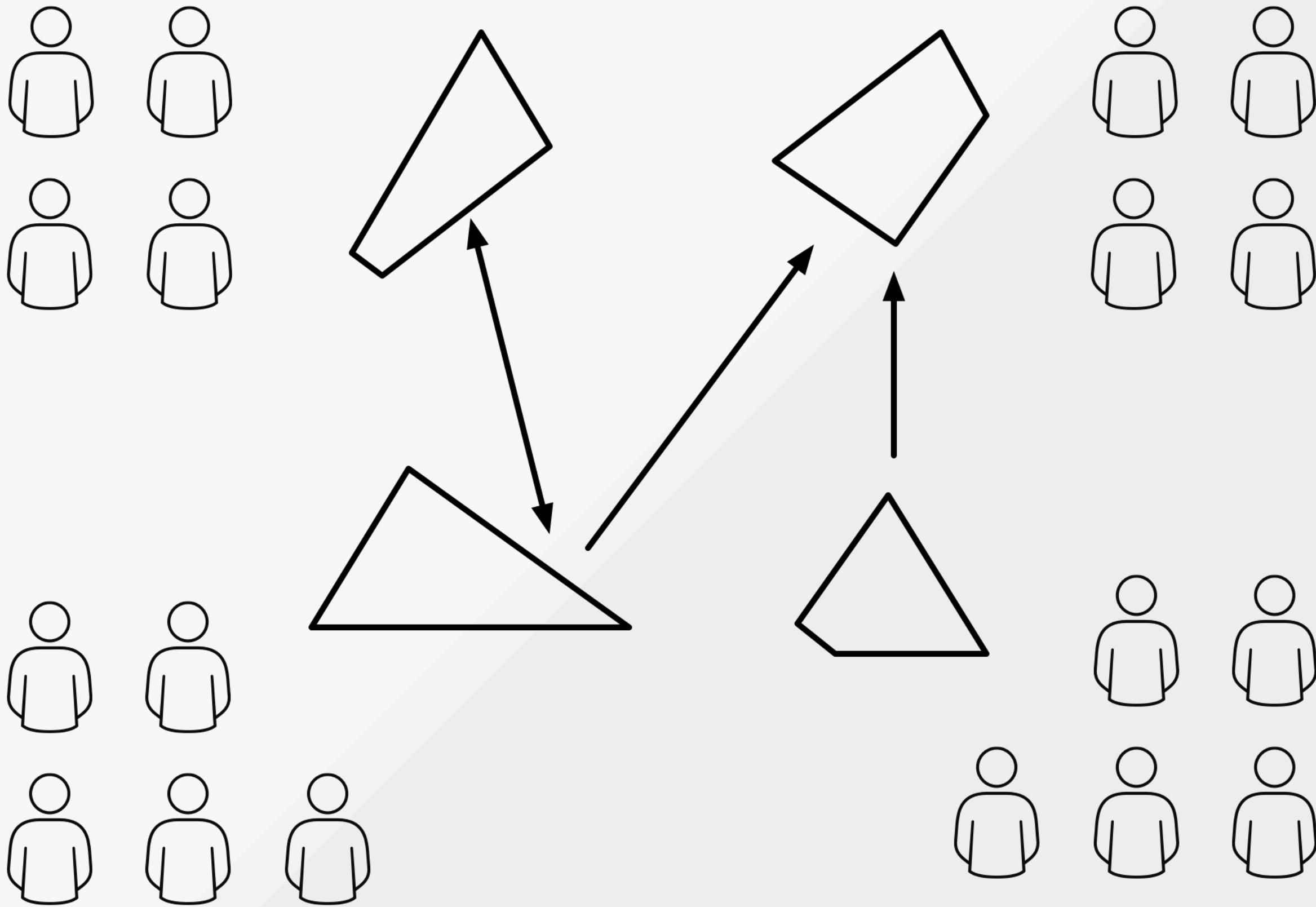
AGENDA

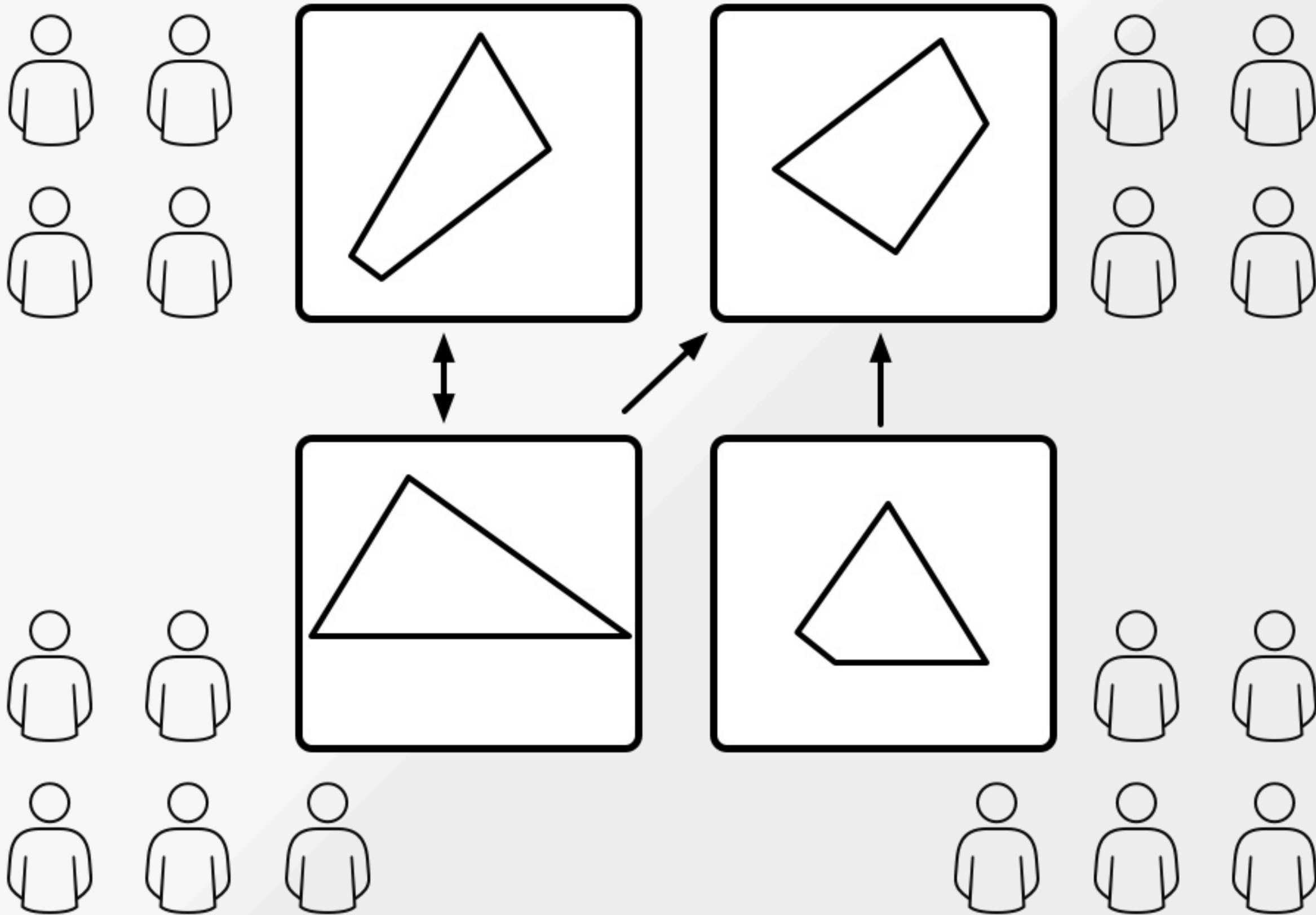
- Kubernetes
- Patterns
- Categories:
 - Foundational Patterns
 - Structural Patterns
 - Configurational Patterns

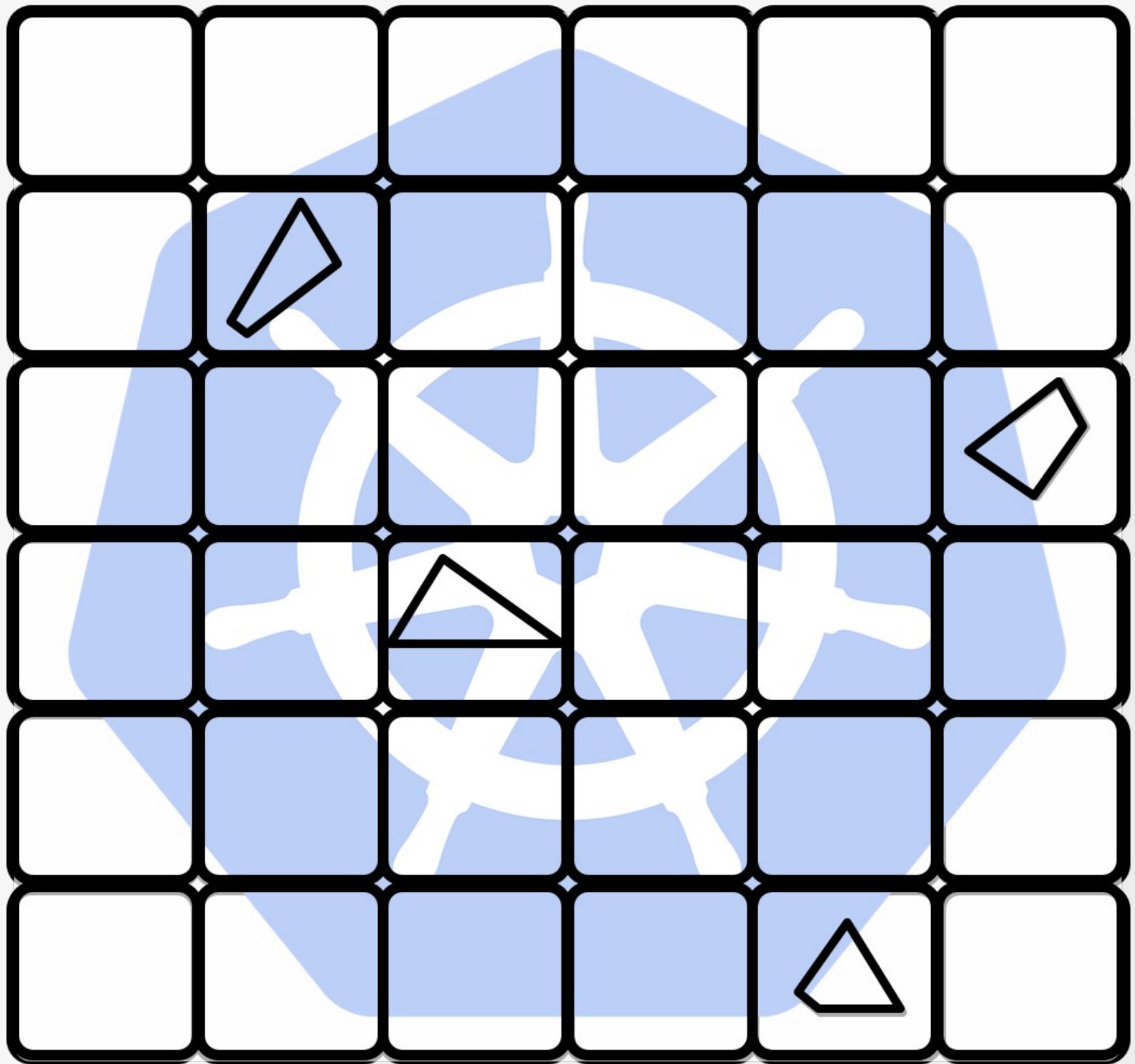










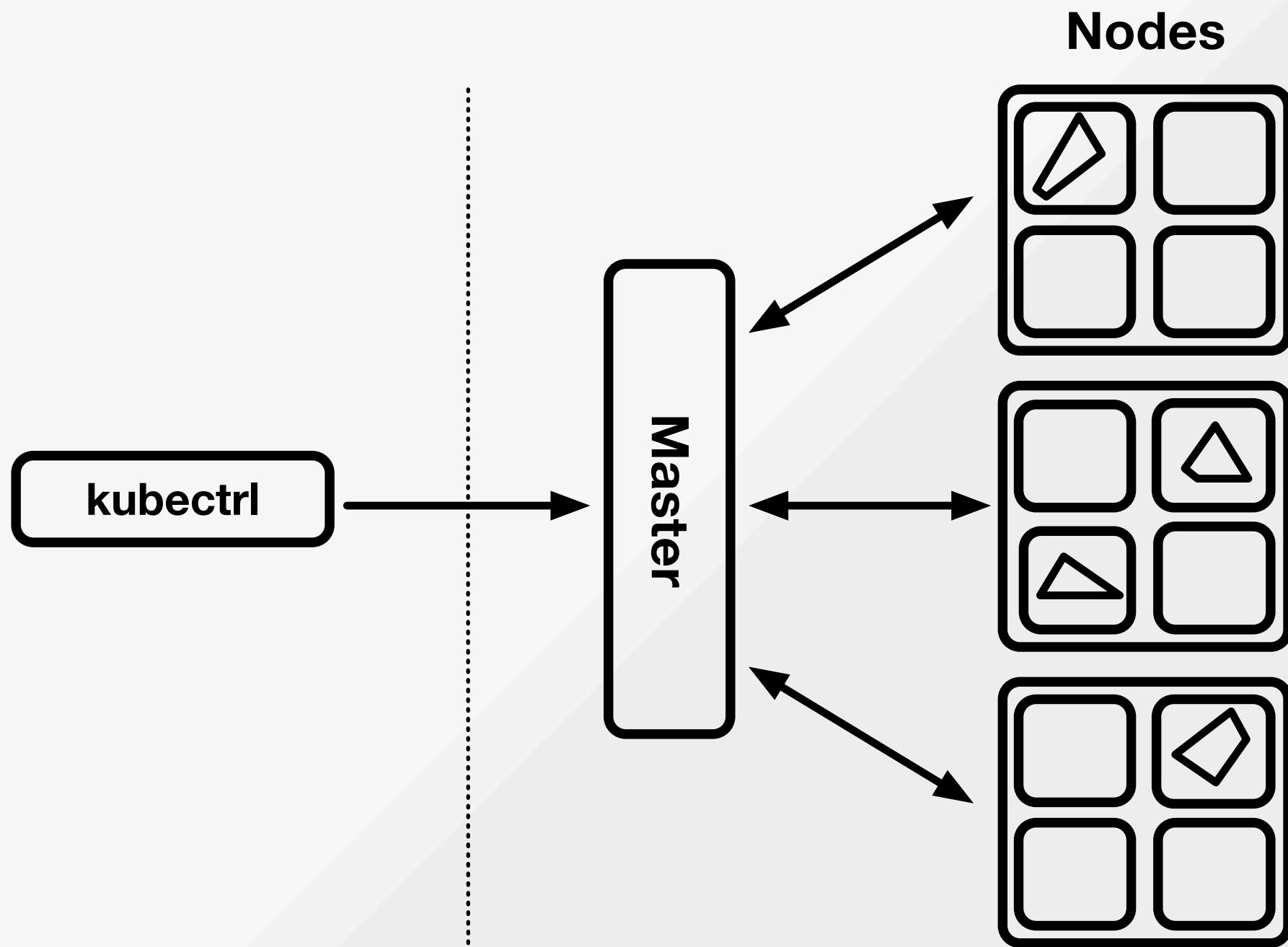




KUBERNETES

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

ARCHITECTURE



Design Patterns

DESIGN PATTERN

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

A Pattern Language

Towns • Buildings • Construction



Christopher Alexander

Sara Ishikawa • Murray Silverstein

WITH

Max Jacobson • Ingrid Fiksdahl-King

Shlomo Angel

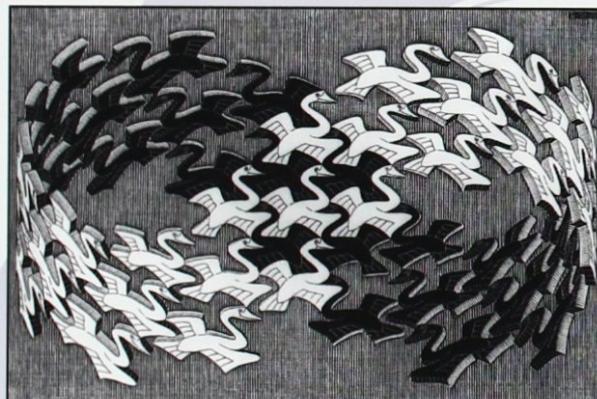


redhat

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



Kubernetes Patterns



Patterns, Principles, and Practices
for Designing Cloud Native Applications

Bilgin Ibryam & Roland Huss

<https://leanpub.com/k8spatterns>



STRUCTURE

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

FOUNDATIONAL PATTERNS

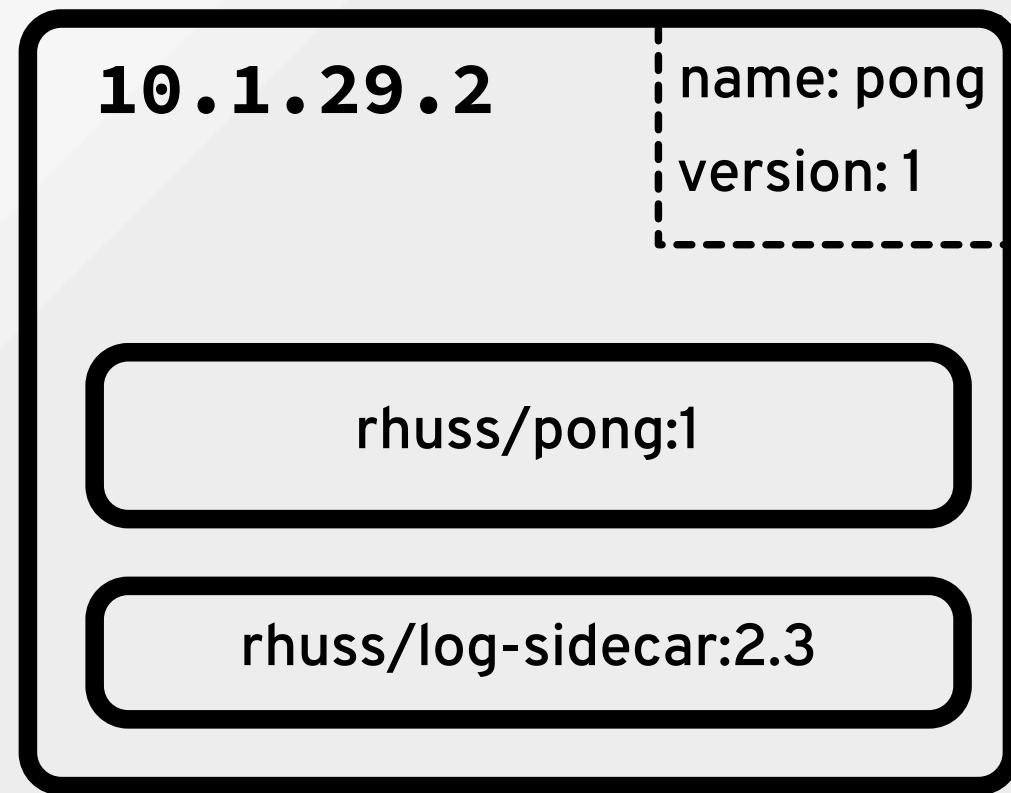
Automatable Unit

How can we create and manage applications with Kubernetes ?

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

POD

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



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
```

REPLICA SET

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

e x@ |vt f x"

replicas: F

Selector:

name: pong
version: 1

10.1.29.2
name: pong
version: 1

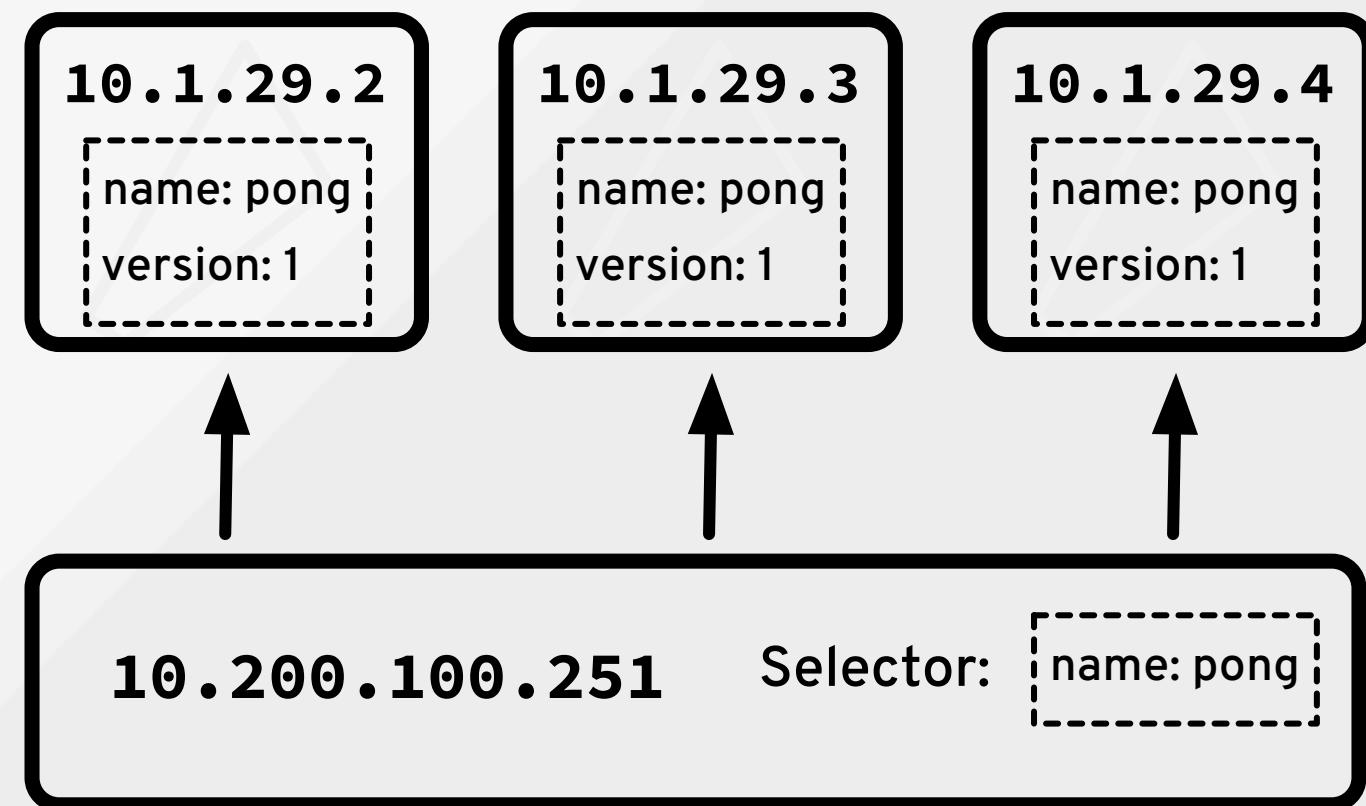
10.1.29.3
name: pong
version: 1

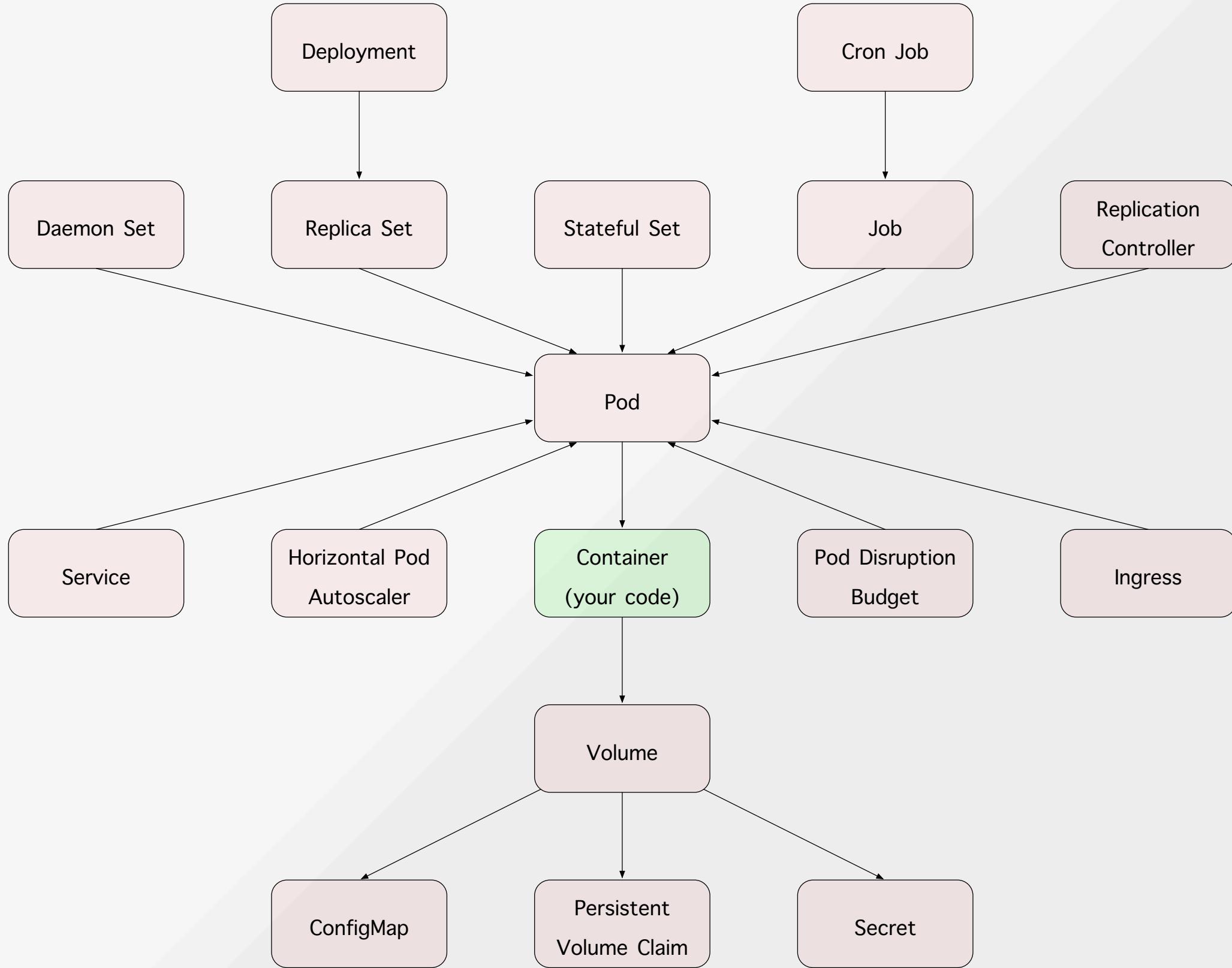
10.1.29.4
name: pong
version: 1



SERVICE

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





Predictable Demands

How can we handle resource requirements deterministically ?

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

RUNTIME DEPENDENCIES

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

RESOURCE PROFILES

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

```
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
```

QOS CLASSES

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

Declarative Deployment

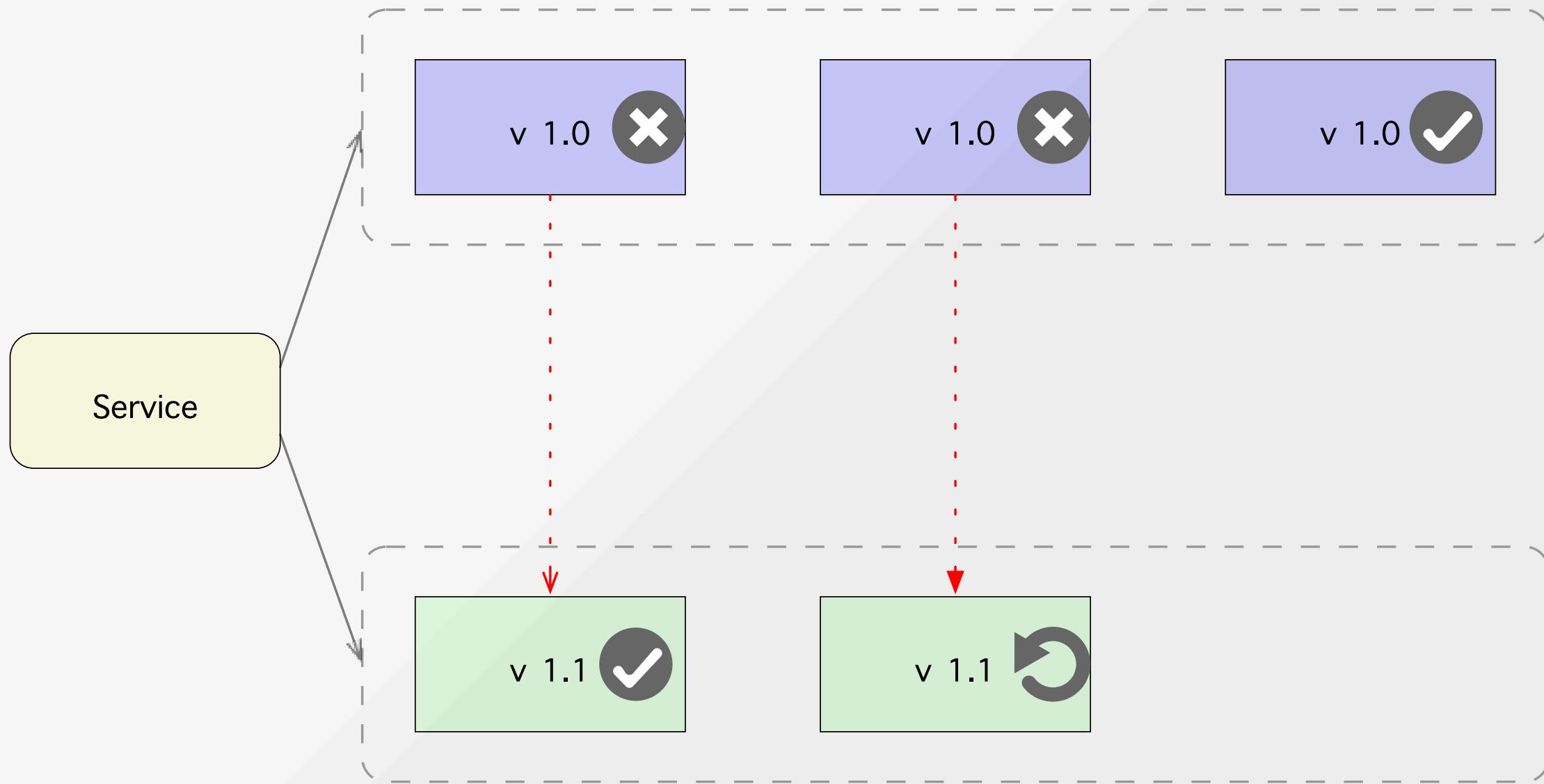
How can applications be deployed
and updated ?

- Declarative versus Imperative deployment
- Various update strategies

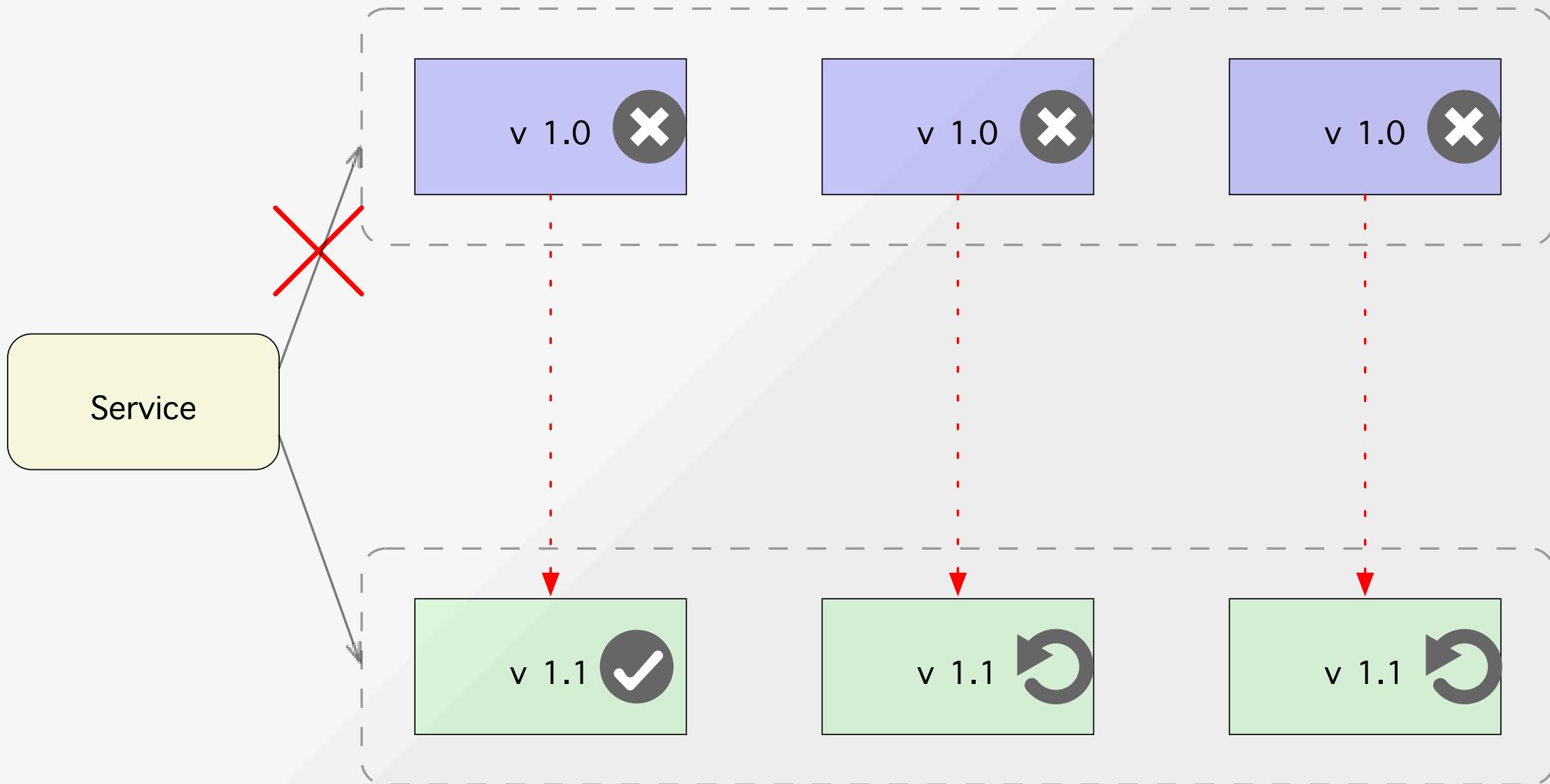
DEPLOYMENT

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

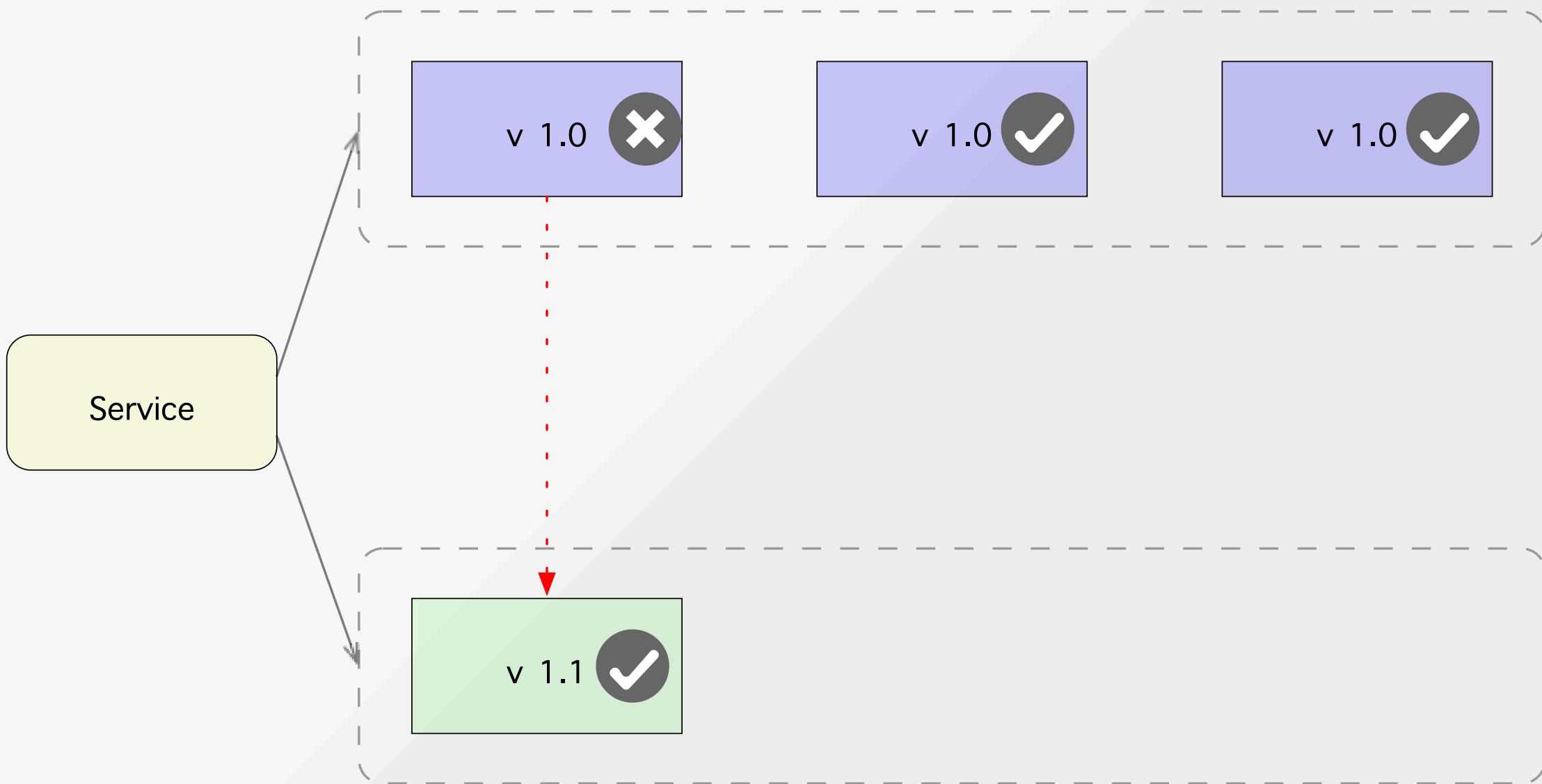
ROLLING



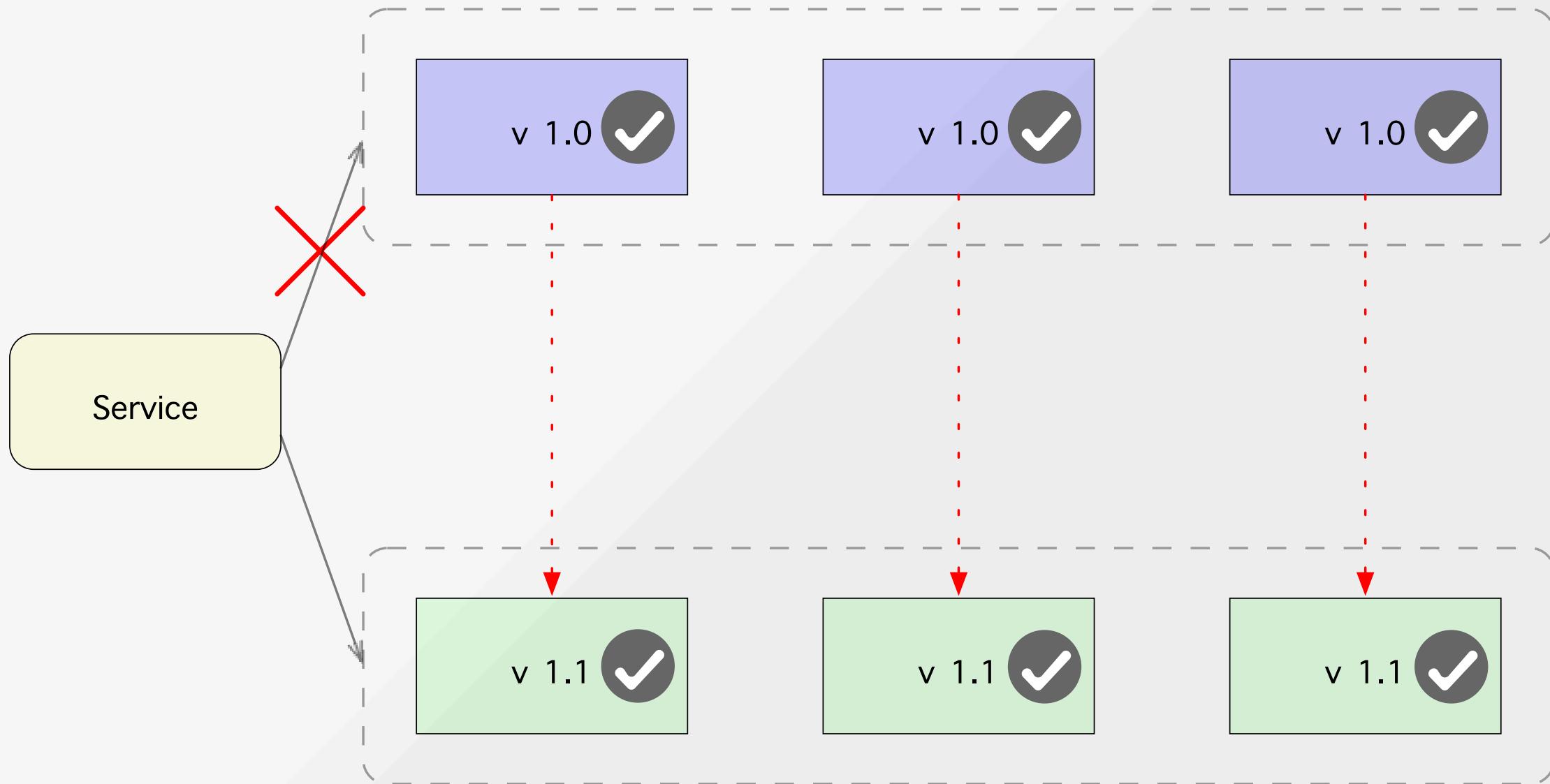
FIXED



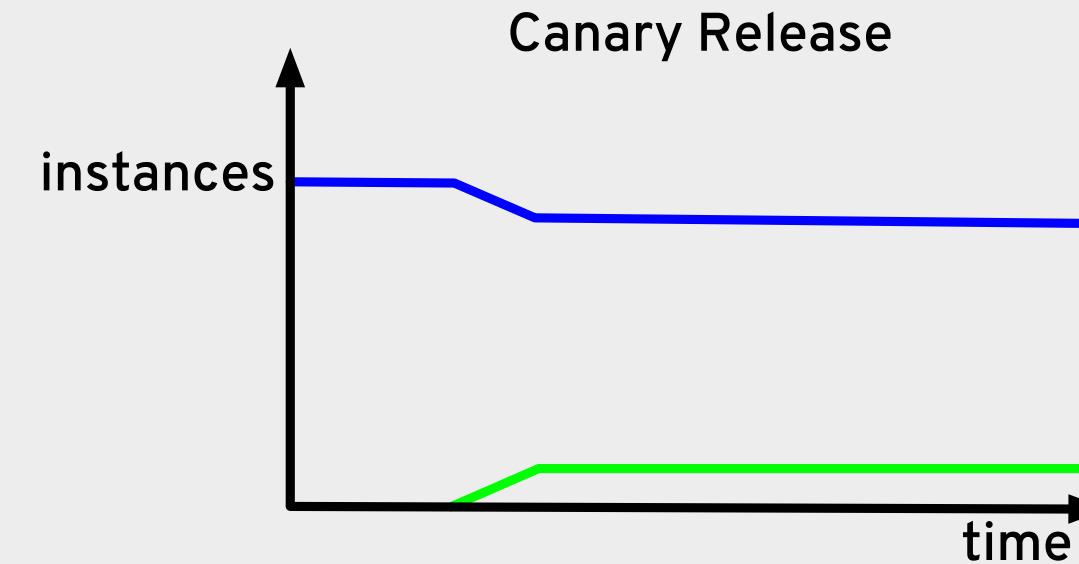
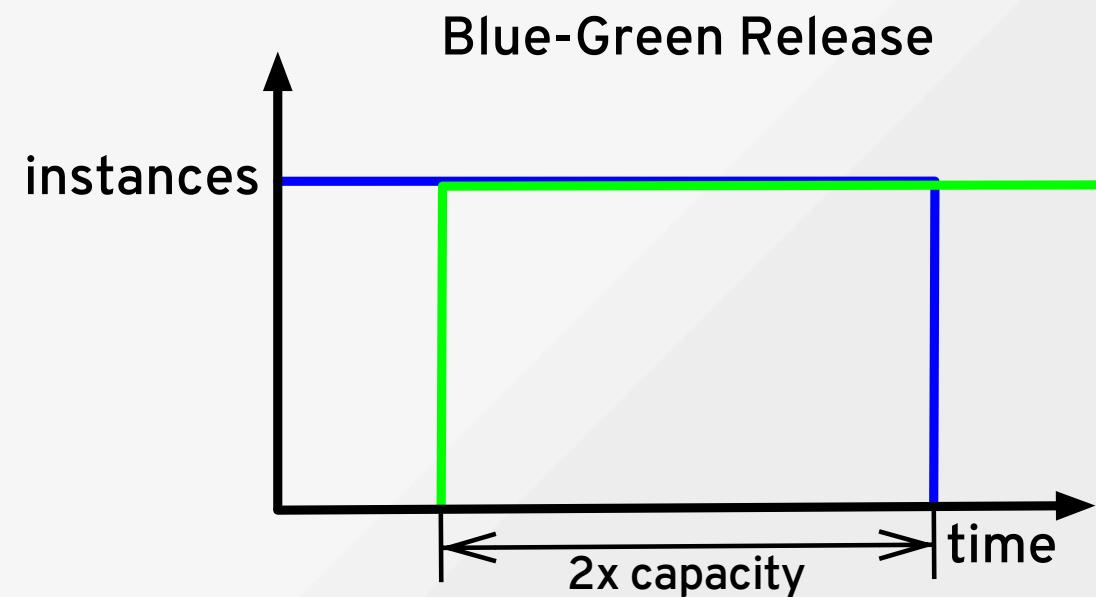
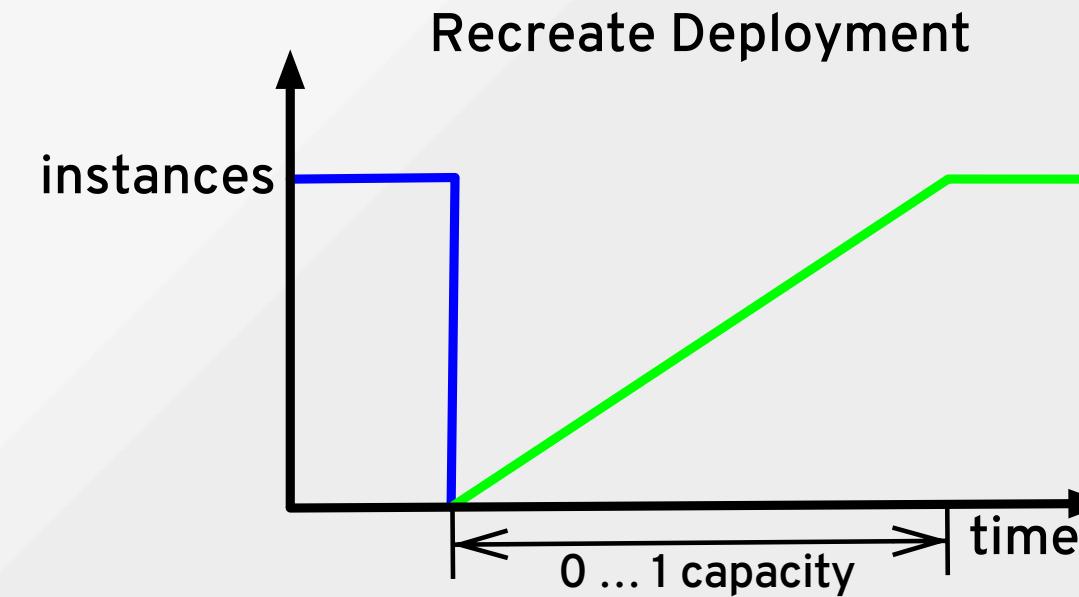
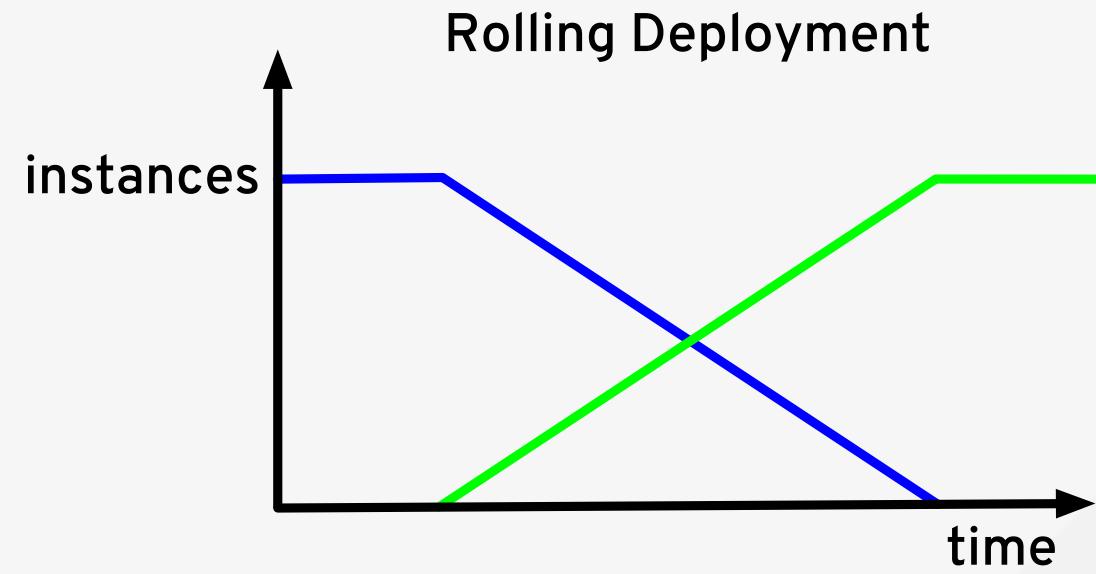
CANARY



BLUE-GREEN



SUMMARY

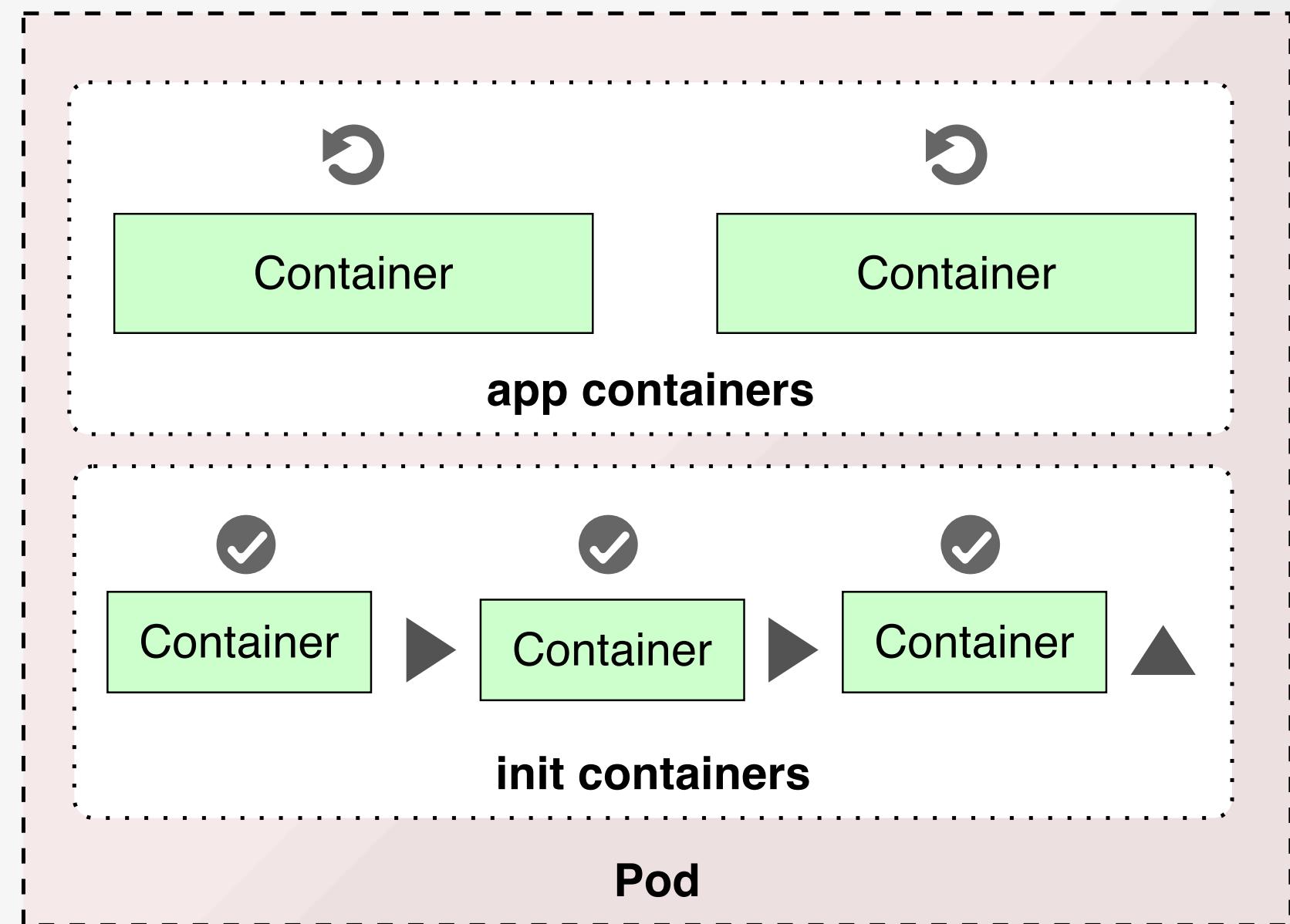


STRUCTURAL PATTERNS

Initializer

How can I initialize my containerized applications ?

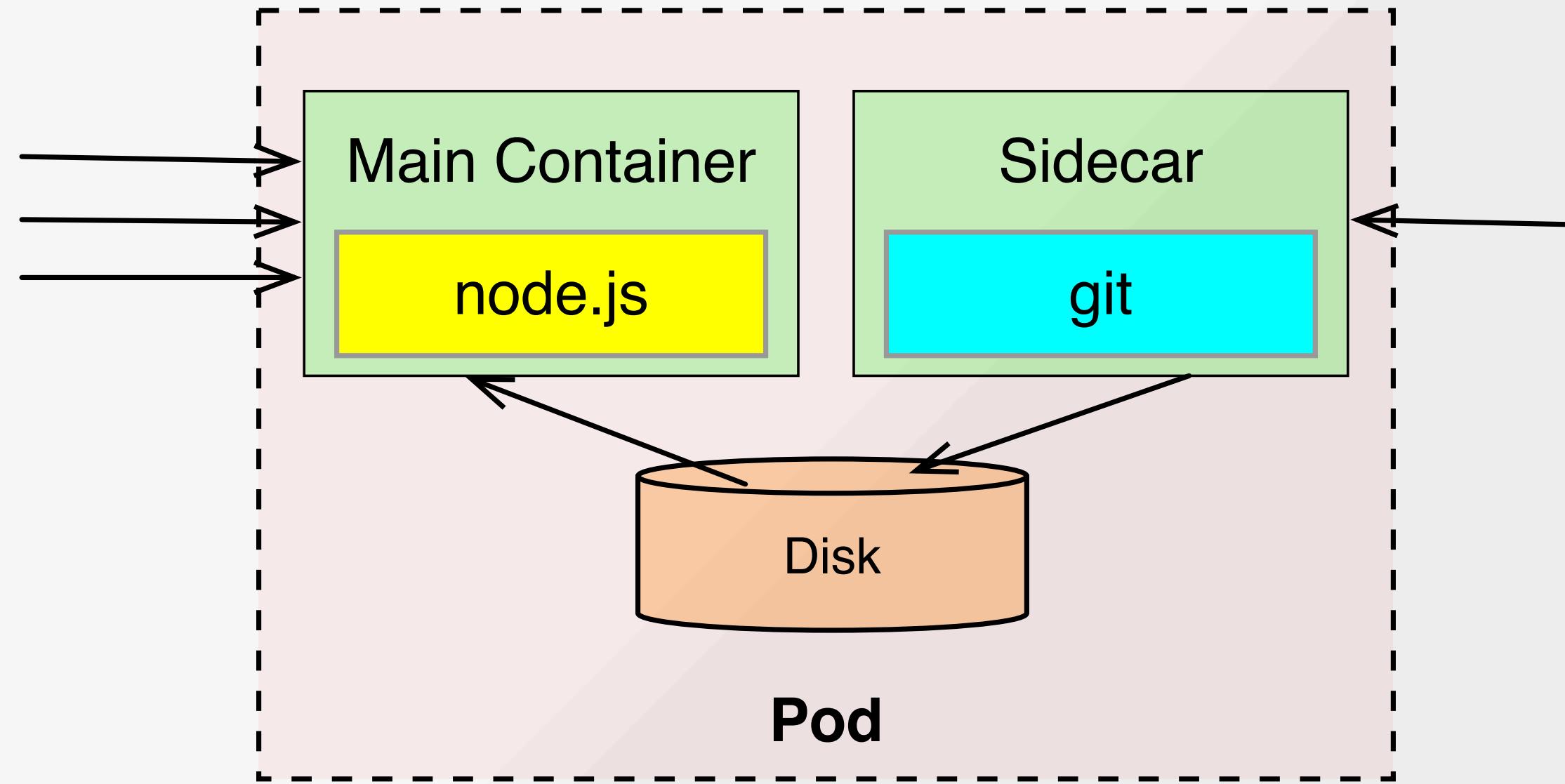
- Init containers :
 - Part of a Pod
 - One shot action before Pod starts
 - Need to be idempotent
 - Have own resource requirements



Sidecar

How can I extend the functionality of
an existing container ?

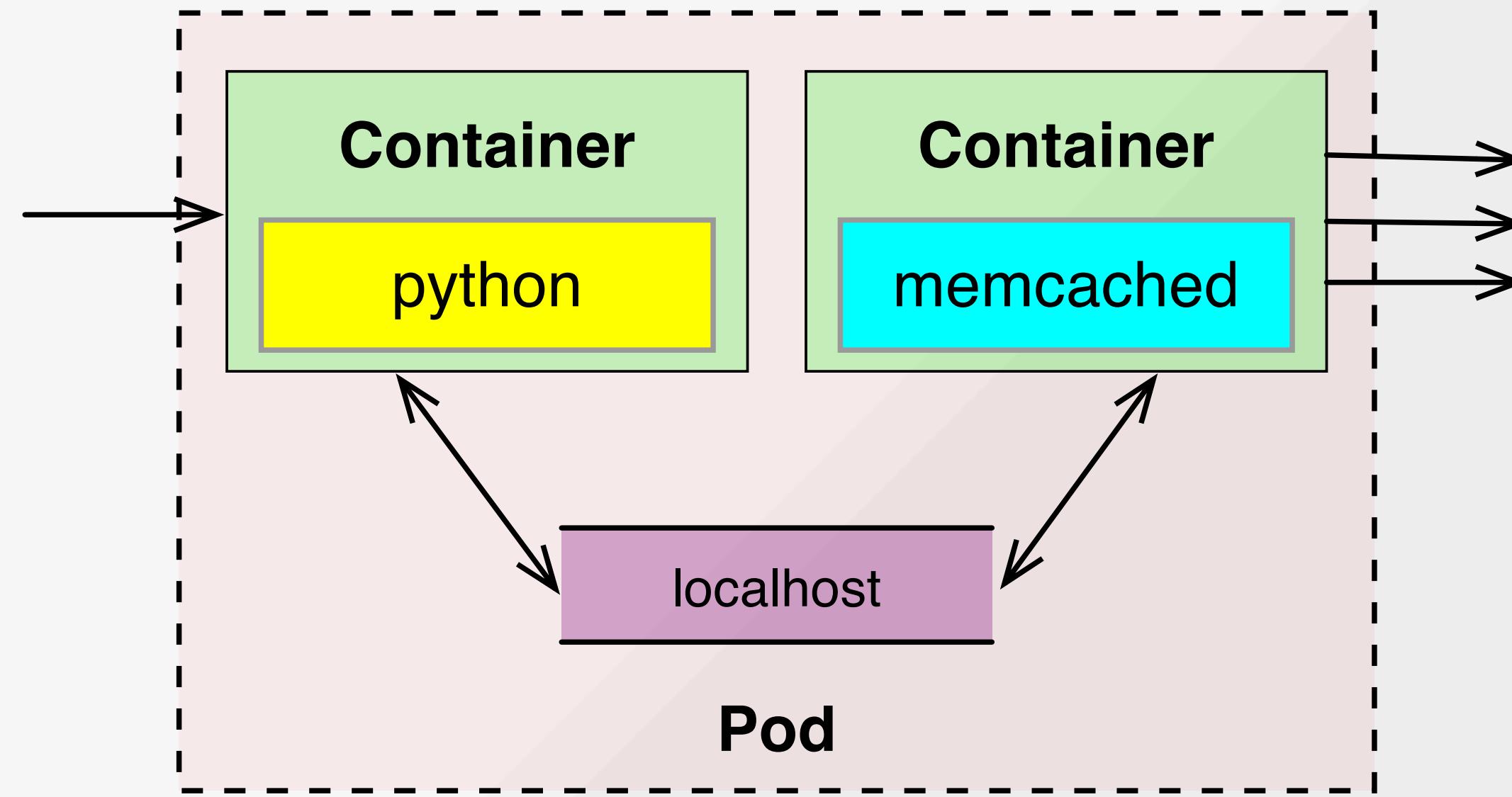
- Runtime collaboration of containers
- Connected via shared resources:
 - Network
 - Volumes



Ambassador

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

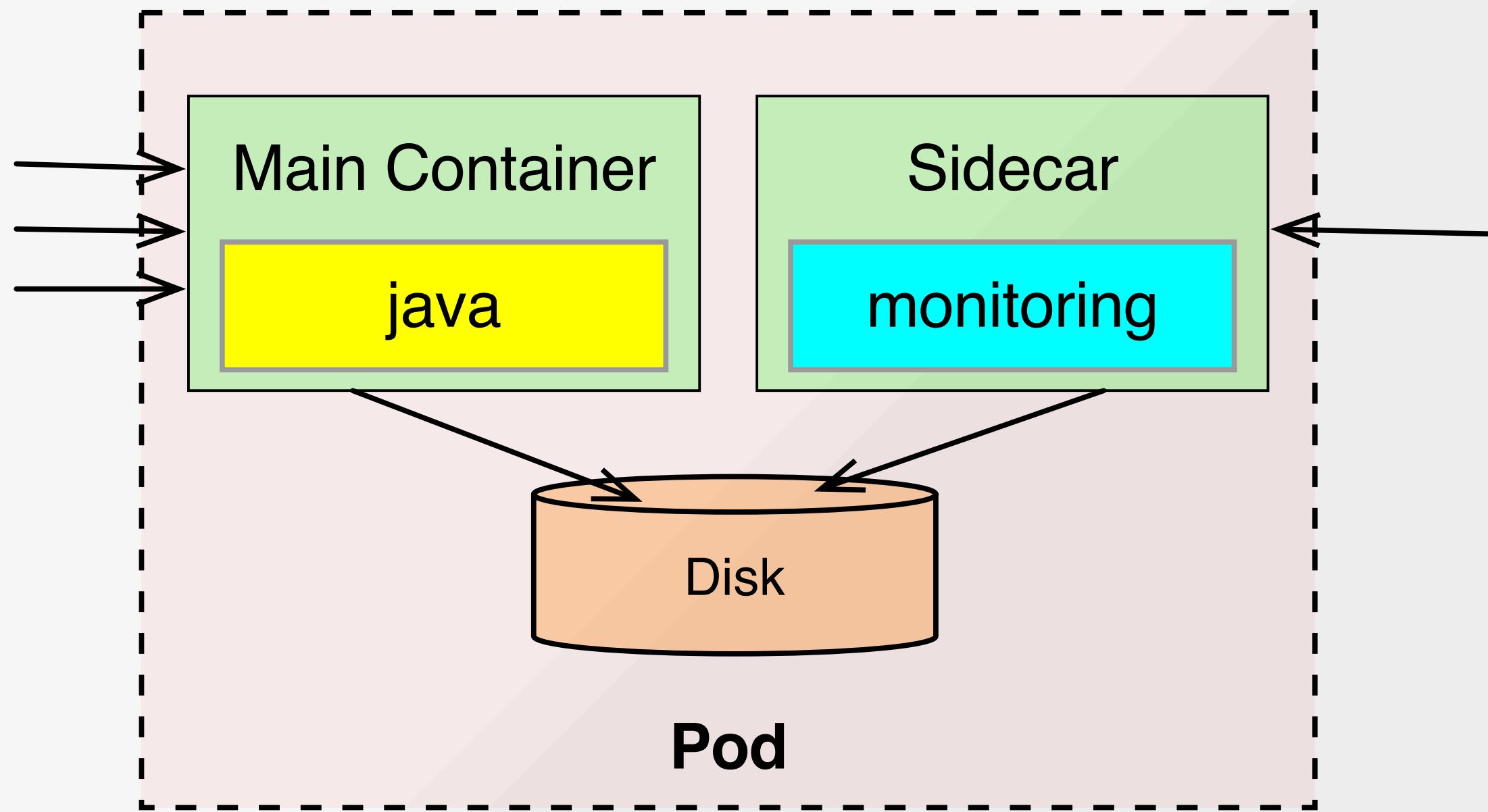
- Also known as **Proxy**
- Specialization of a Sidecar
- E.g. infrastructure services
 - Circuit breaker
 - Tracing



Adapter

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

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



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

```
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
```

Configuration Resource

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

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

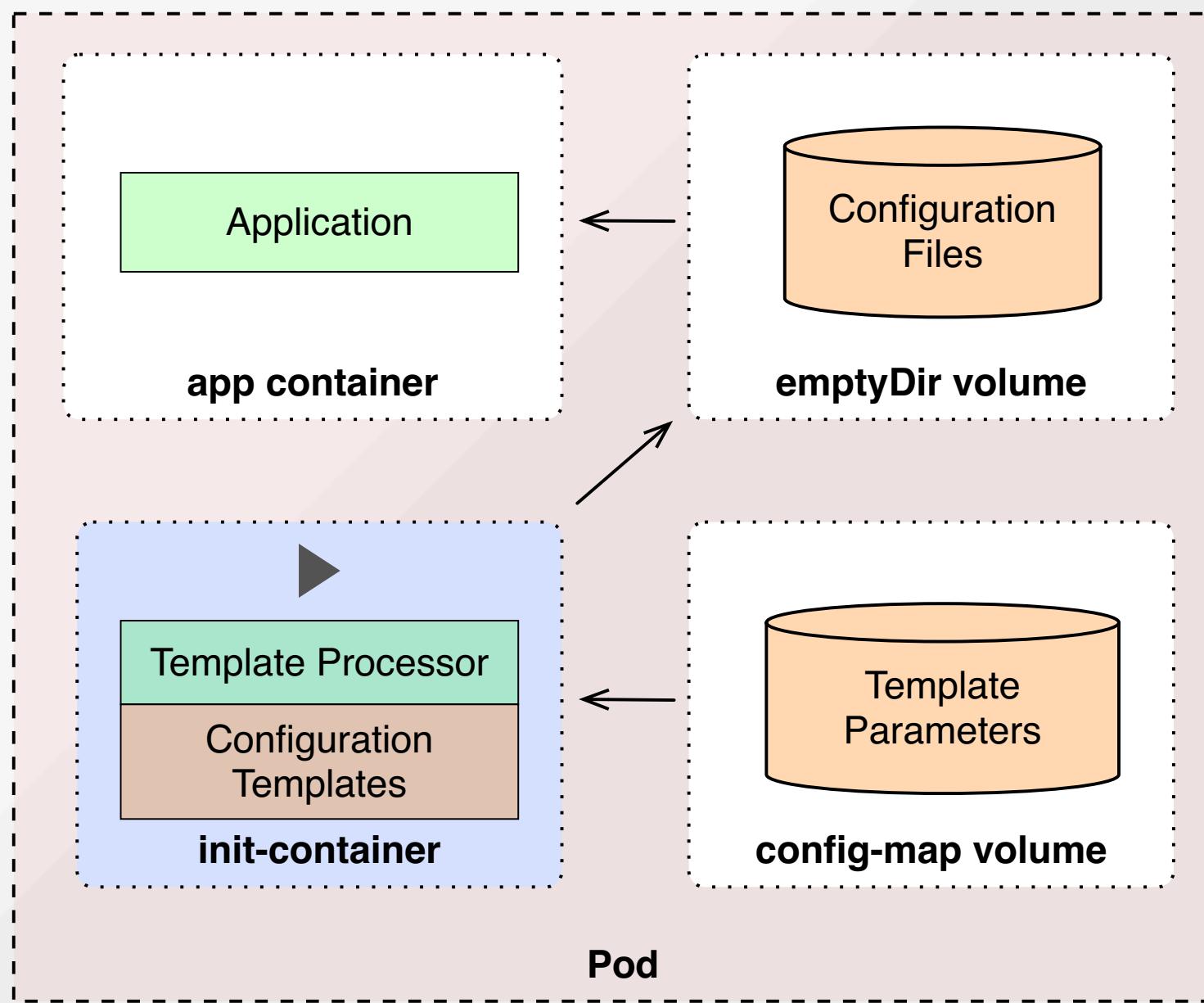
```
kind: Pod
spec:
  containers:
  - name: web
    volumeMounts:
    - name: config-volume
      mountPath: /etc/config
    # ...
  volumes:
  - name: config-volume
    configMap:
      name: spring-boot-config
```



Configuration Template

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

CONFIGURATION TEMPLATE



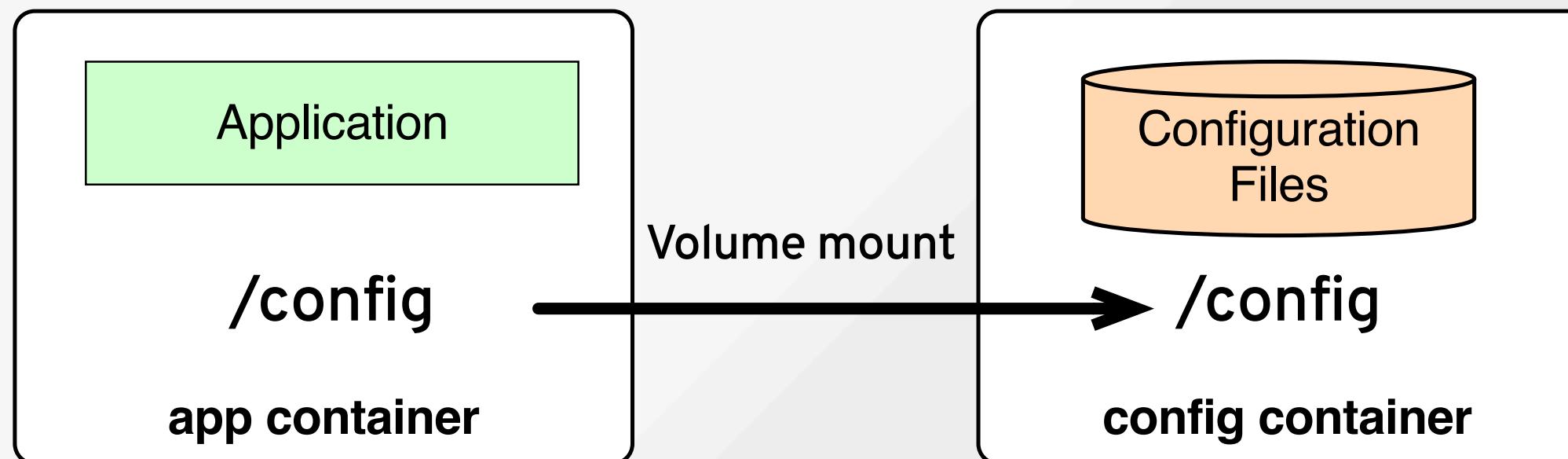
DISCUSSION

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

Immutable Configuration

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

CONTAINER VOLUMES

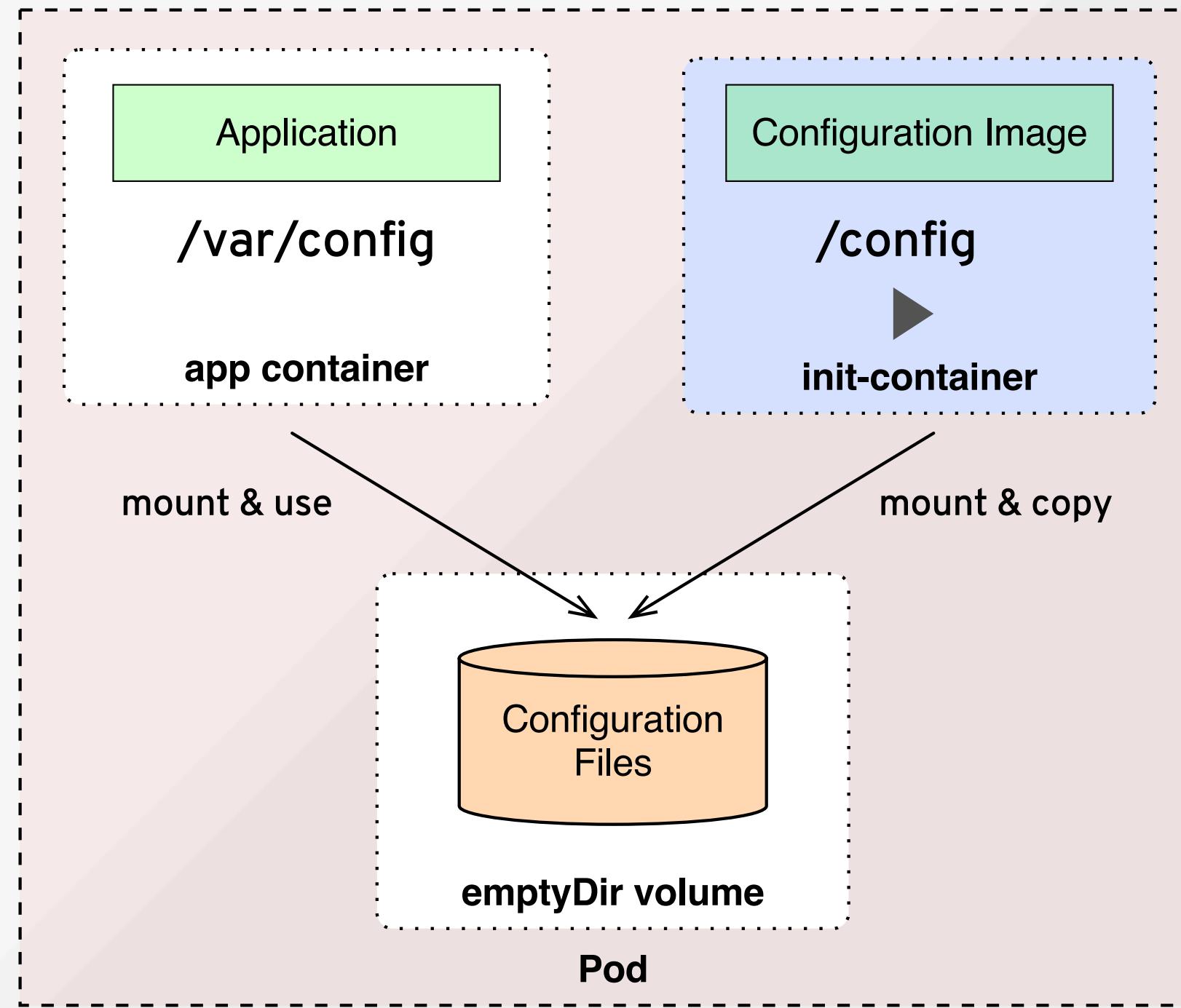


- Not directly supported by K8s
- docker-flexvol : K8s FlexVolume driver for Docker volumes

```
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"
```



INIT CONTAINER



- 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 .
```

```
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: {}
```

DISCUSSION

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

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.



QUESTIONS ?

Twitter ro14nd

Book <https://leanpub.com/k8spatterns>

Slides <https://github.com/ro14nd-talks/kubernetes-patterns>