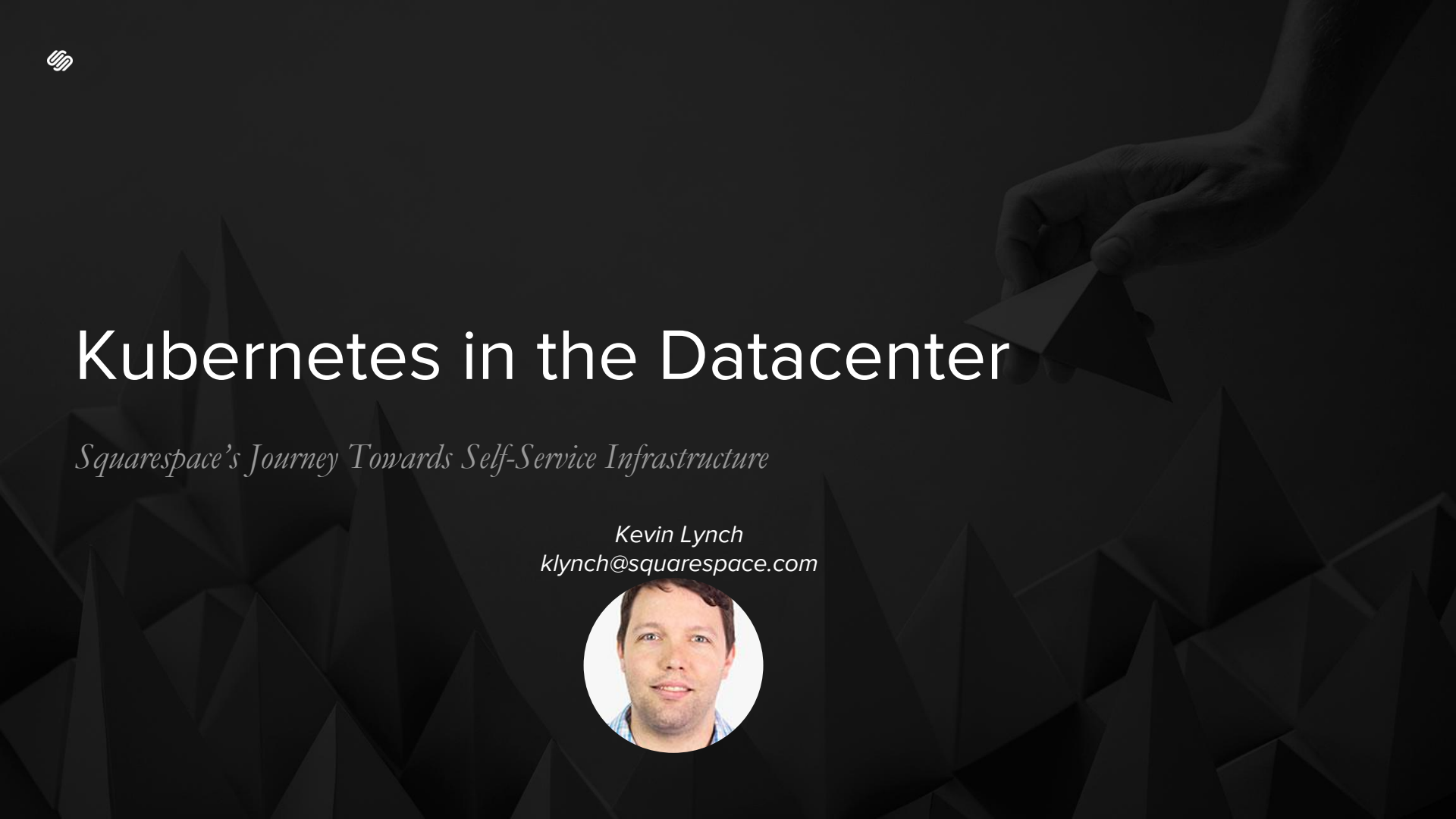


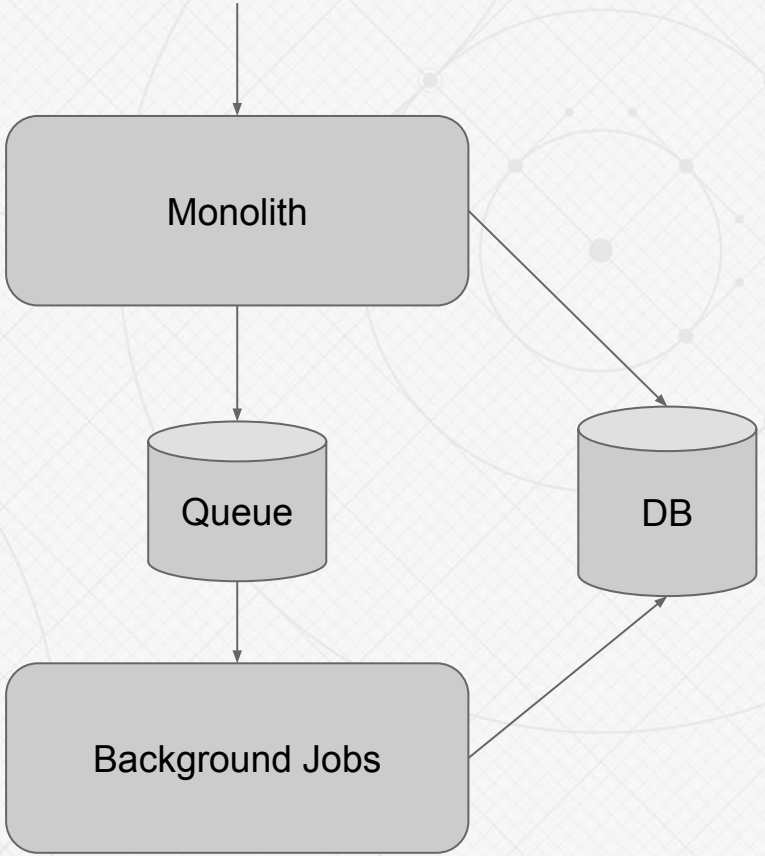
Kubernetes in the Datacenter

Squarespace's Journey Towards Self-Service Infrastructure

Kevin Lynch
klynch@squarespace.com

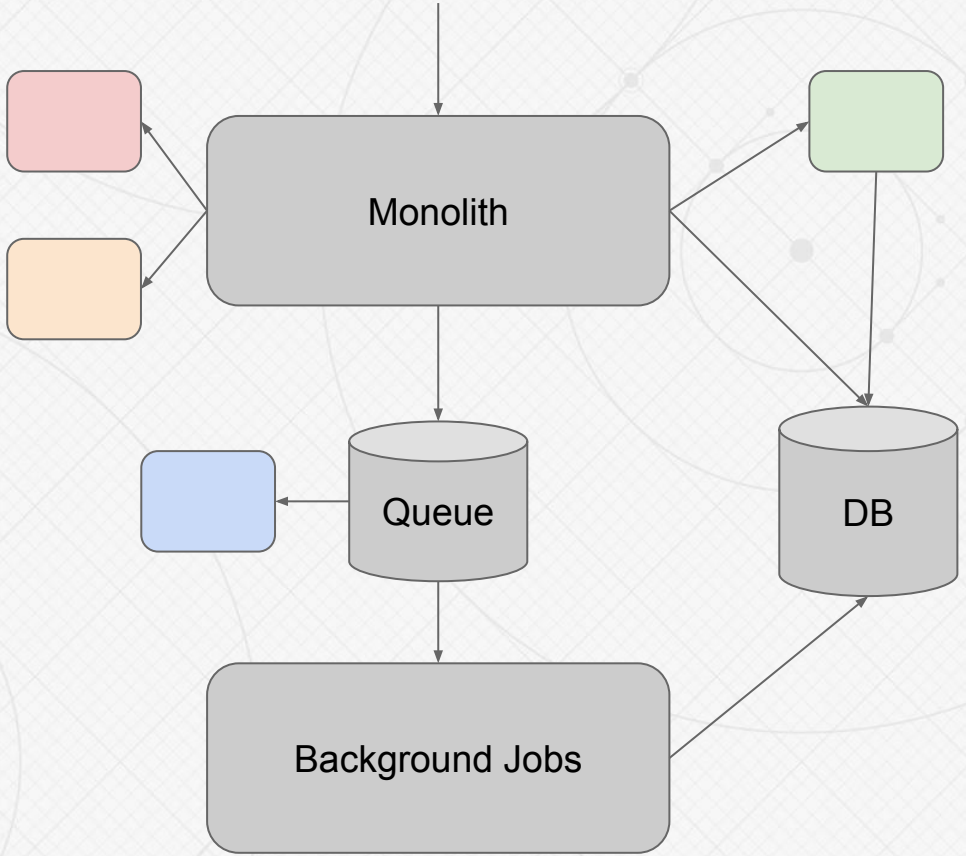
2013: <50 engineers

- “Whatever works”
- Build product
- Grow fast



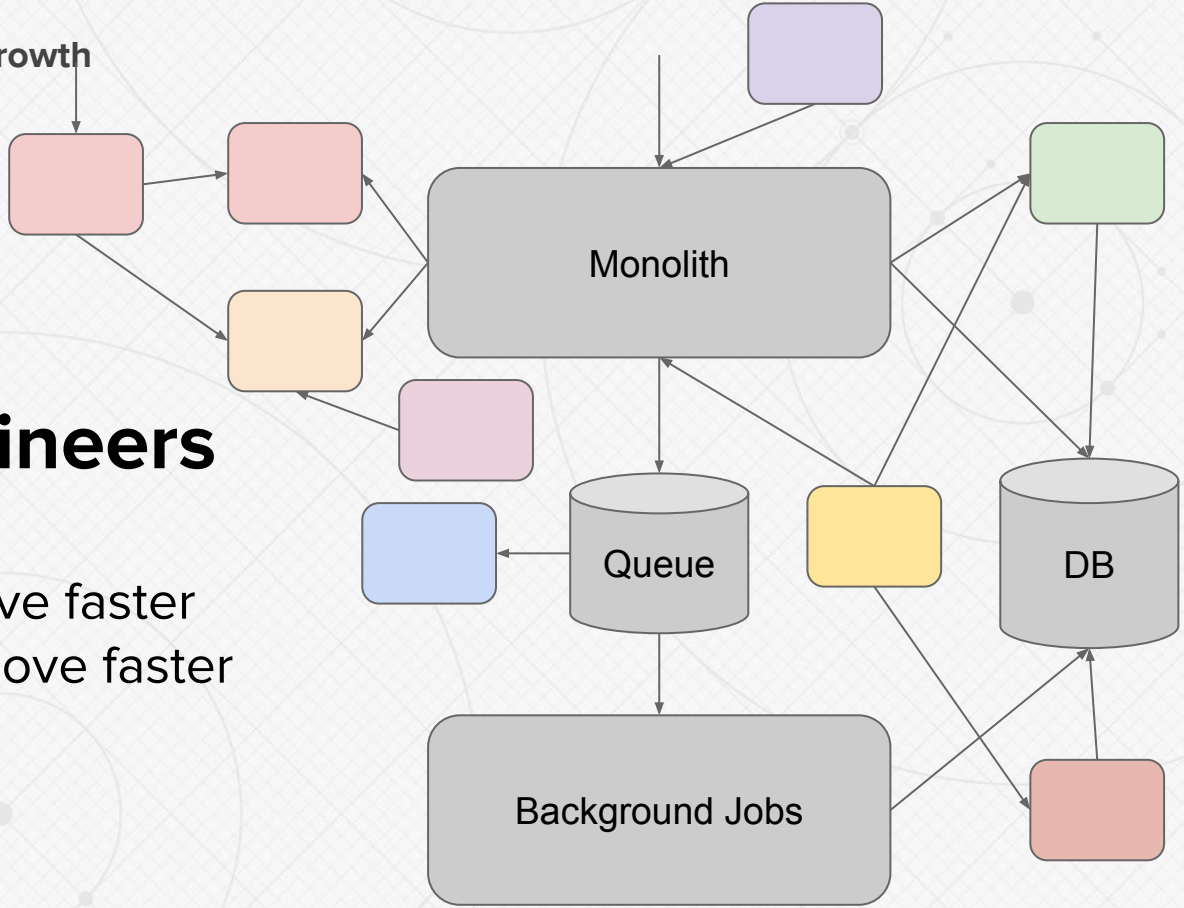
2014: ~75 engineers

- ~~“Whatever works”~~
- Too much firefighting
- Not enough new features
- Microservices FTW!



2016: 100+ engineers

- Scalable + Reliable
- Developers can move faster
- Squarespace can move faster



Traditional Provisioning Process

Manual

- Find Resources (CPU, RAM, Disk)
- Find IP
- Configure VLAN
- Configure Firewall
- Update Ansible Inventory

DNS Updates

PXE Boot

Install OS

Configure OS

Configure Monitoring

Install App Dependencies

Install App!

Static infrastructure and microservices do not mix!

- Difficult to find resources
- Slow to provision and scale
- Shoehorning “Cattle” into “Pets” mentality
- System was too complex for new engineers

2017: 200+ engineers

- Self-Service Infrastructure
- Operations can move faster
- Squarespace can move faster

Compute

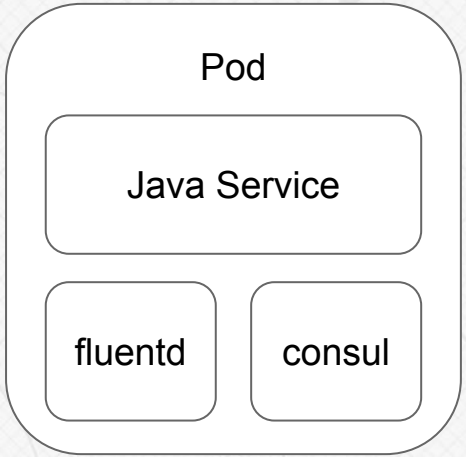
Network

Metrics

Storage


```
kubectl apply -f app.yaml
```

- Java Spring Boot
- FluentD
  - Logging
- Consul
  - Service Discovery
  - K/V




```
resources:
  requests:
    cpu: 2
    memory: 4Gi
  limits:
    cpu: 2
    memory: 4Gi
```

- CGroup assigned to each pod
- Completely Fair Scheduler (CFS)
  - Schedules a task based on CPU Shares
  - Throttles a task once it hits CPU Quota
- OOM Killed when memory limit exceeded

```
resources:
  requests:
    cpu: 2
    memory: 4Gi
  limits:
    cpu: 2
    memory: 4Gi
```

- Shares = CPU Request * 1024
- Total Kubernetes Shares = # Cores * 1024
- Quota = CPU Limit * 100ms
- Period = 100ms

```
resources:
  requests:
    cpu: 2
    memory: 4Gi
  limits:
    cpu: 2
    memory: 4Gi
```

- Shares = 2048
- Total Kubernetes Shares = 65536
- Quota = 200ms
- Period = 100ms

```
resources:
  requests:
    cpu: 2
    memory: 4Gi
  limits:
    cpu: 2
    memory: 4Gi
```

- GC Threads were using up most of the CPU Quota
  - 64 GC Threads
  - 128 Jetty Threads
  - 64 ForkJoin Threads

- Libraries call **`Runtime.getRuntime.availableProcessors()`**
  - Jetty
  - ForkJoinPool
  - GC Threads
  - ???
- JVM detects cores via **`sysconf(_SC_NPROCESSORS_ONLN)`**
- CGroups does not limit **`_SC_NPROCESSORS_ONLN`**

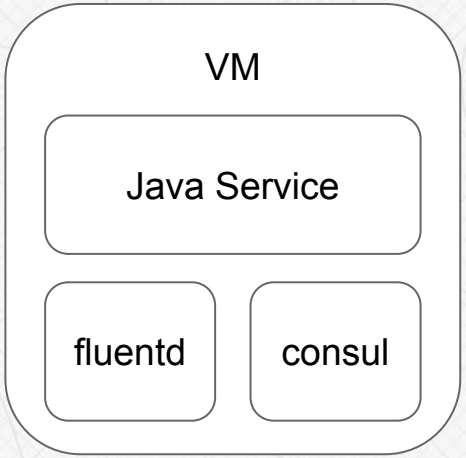
- Provide a base Java container to calculate resources
- Detect maximum # of “cores” assigned
  - `/sys/fs/cgroup/cpu/cpu.cfs_quota_us` divided by `/sys/fs/cgroup/cpu/cpu.cfs_period_us`
- Automatically tune the JVM
  - `-XX:ParallelGCThreads=${core_limit}`
  - `-XX:ConcGCThreads=${core_limit}`
  - `-Djava.util.concurrent.ForkJoinPool.common.parallelism=${core_limit}`

- Use Linux **`LD_PRELOAD`** to override **`availableProcessors()`**

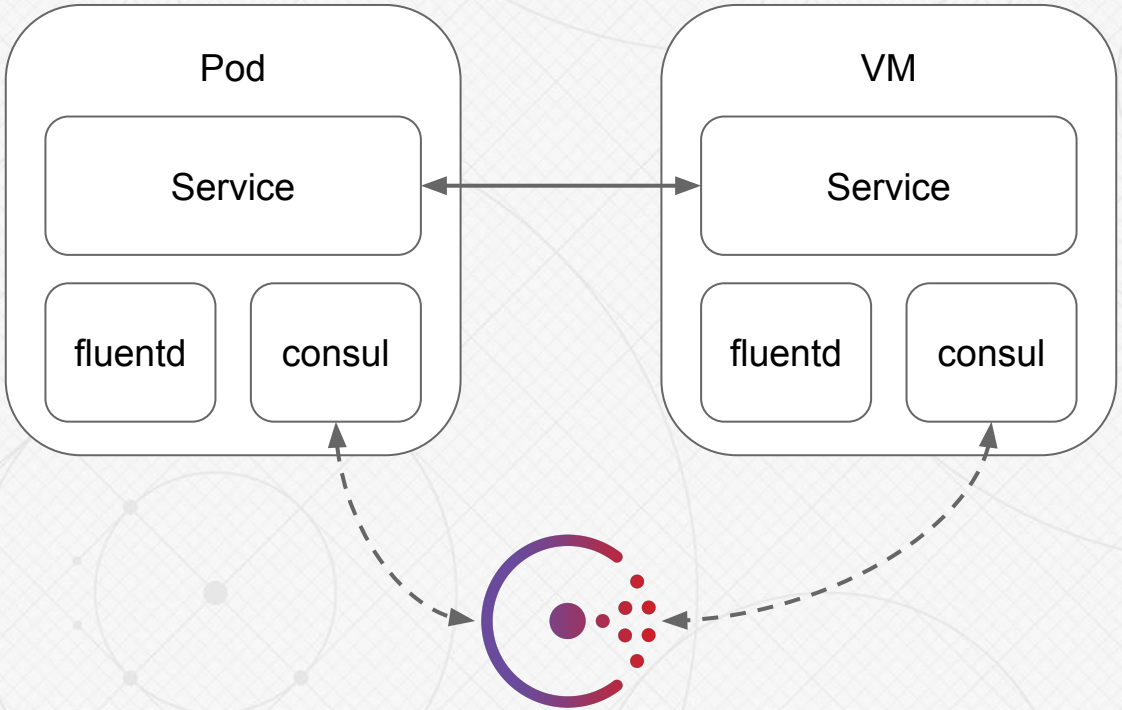
```
#include <stdlib.h>
#include <unistd.h>

int JVM_ActiveProcessorCount(void) {
    char* val = getenv("CONTAINER_CORE_LIMIT");
    return val != NULL ? atoi(val) : sysconf(_SC_NPROCESSORS_ONLN);
}
```

https://engineering.squarespace.com/blog/2017/understanding-linux-container-scheduling

- Java Spring Boot
- Netflix Ribbon
  - Automatic Retries
  - Client Side Load Balancing
- Netflix Hystrix
  - Circuit Breaking
- Consul
  - Service Discovery



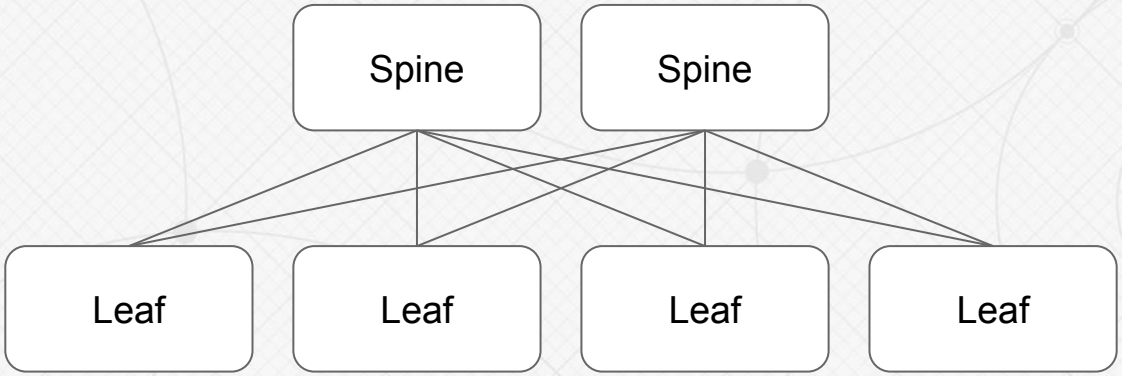
Self-Service Networking



- Kubernetes CNI (Container Network Interface) is pluggable
- Different plugins for different network topologies
  - Flannel
  - Calico
  - Weave
  - Kubenet
  - VXLan

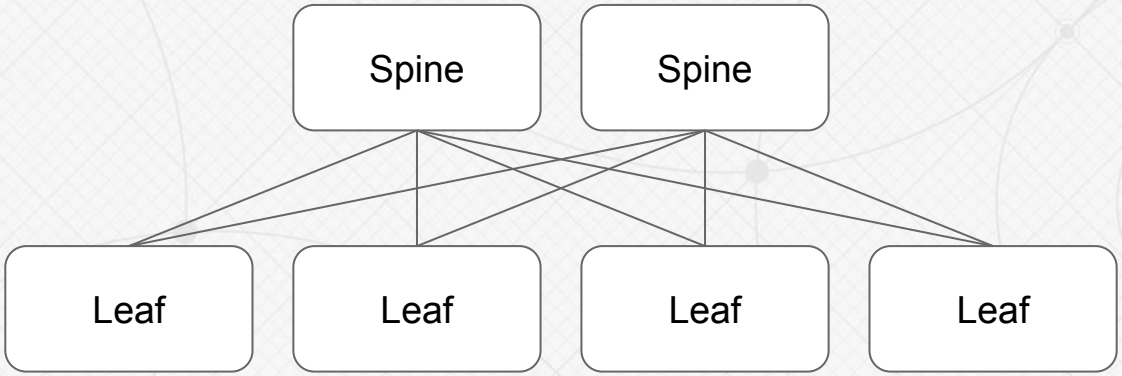
- Project Calico
- No network overlay required!
  - No MTU issues
  - No performance impact
  - No ingress/egress issues
- Communicates directly with existing Layer 3 network
- BGP Peering with Top of Rack switch

Spine and Leaf Layer 3 Clos Topology



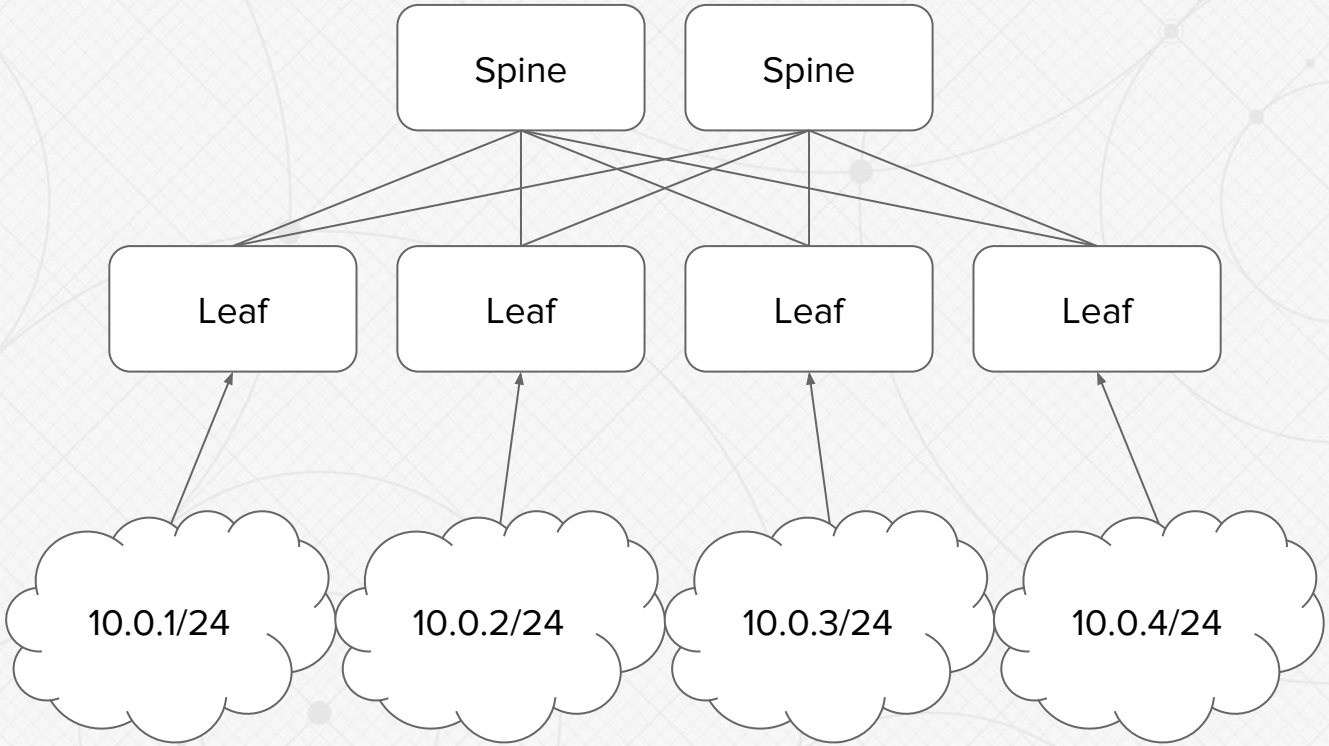
- Simple to understand
- Easy to scale
- Predictable and consistent latency (hops = 2)
- Anycast support

Spine and Leaf Layer 3 Clos Topology



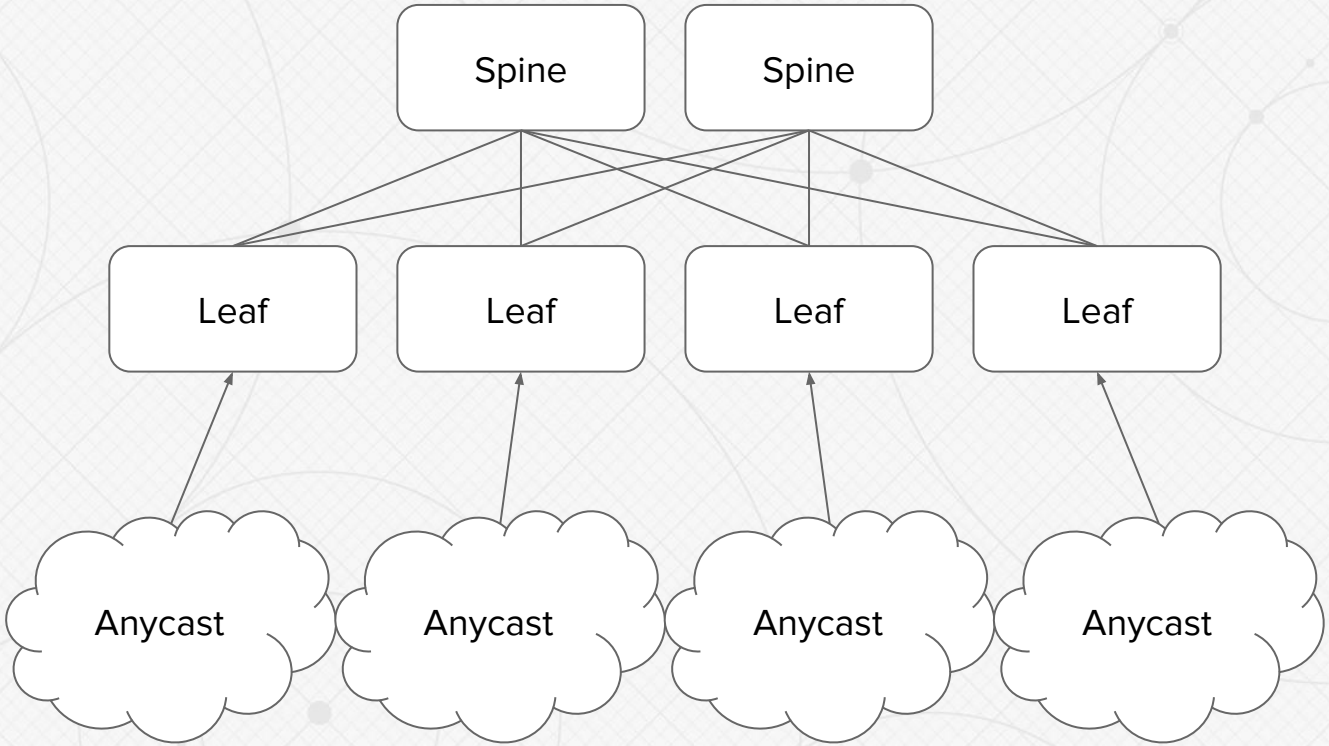
- All work is performed at the leaf/ToR switch
- Each leaf switch is separate Layer 3 domain
- Each leaf is a separate BGP domain (ASN)
- No Spanning Tree Protocol issues seen in L2 networks (convergence time, loops)

Spine and Leaf Layer 3 Clos Topology



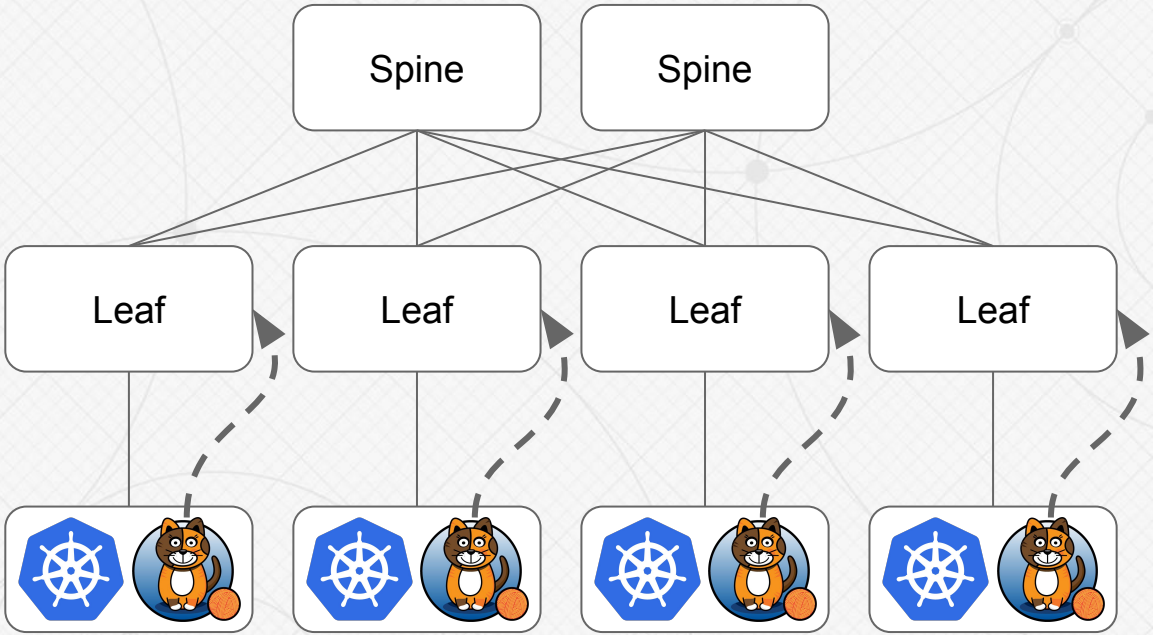
Network

Spine and Leaf Layer 3 Clos Topology

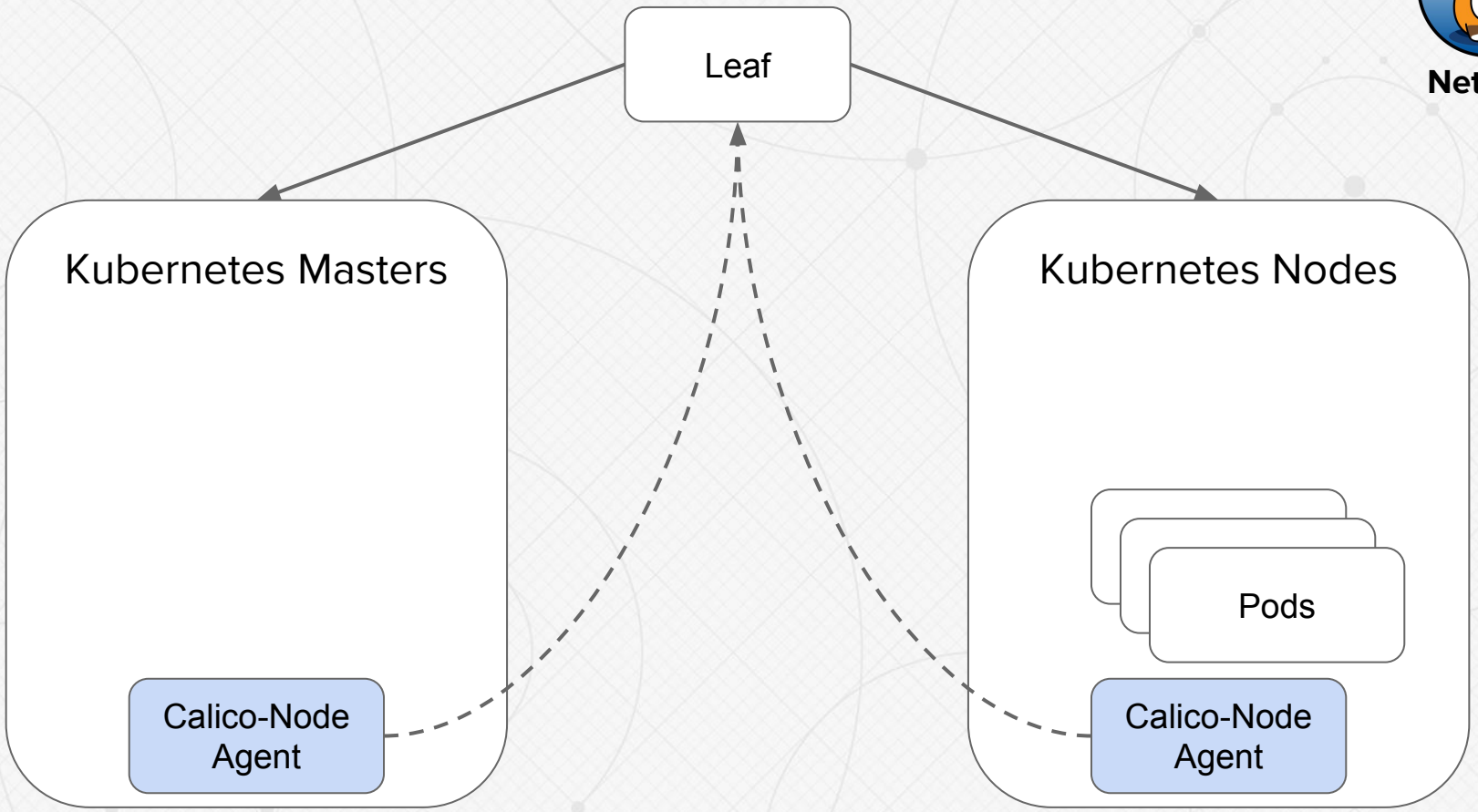


Network

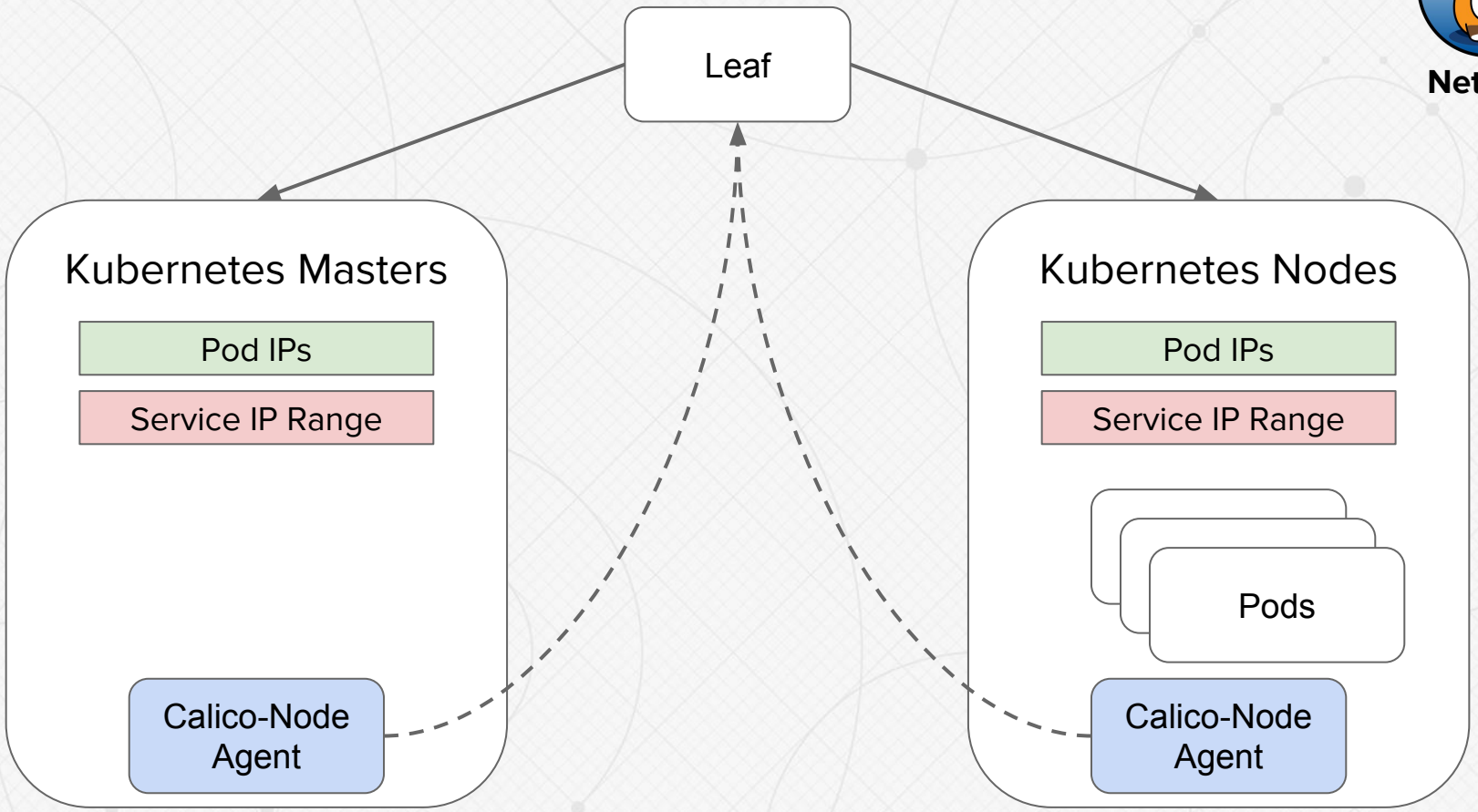
Spine and Leaf Layer 3 Clos Topology



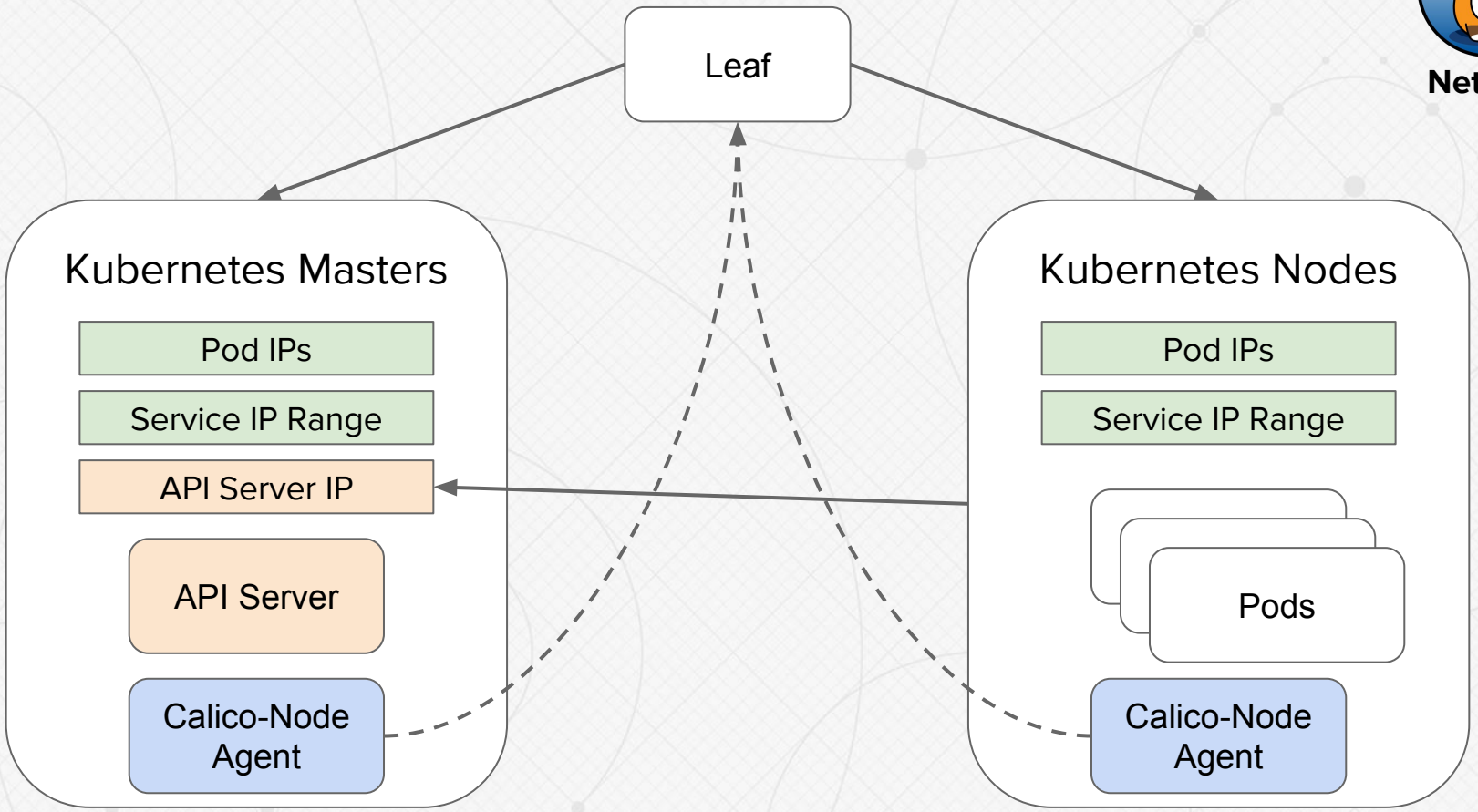
Network


Leaf
Kubernetes Masters
Kubernetes Nodes
Pods
Calico-Node Agent
Calico-Node Agent

Network


Leaf
Kubernetes Masters
Pod IPs
Service IP Range
Calico-Node Agent
Kubernetes Nodes
Pod IPs
Service IP Range
Pods
Calico-Node Agent

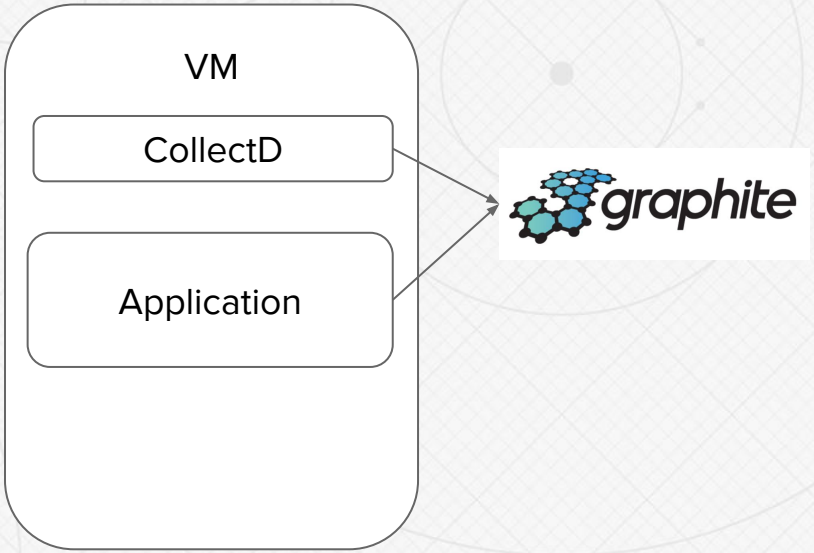
Network


Leaf
Kubernetes Masters
Pod IPs
Service IP Range
API Server IP
API Server
Calico-Node Agent
Kubernetes Nodes
Pod IPs
Service IP Range
Pods
Calico-Node Agent

Network

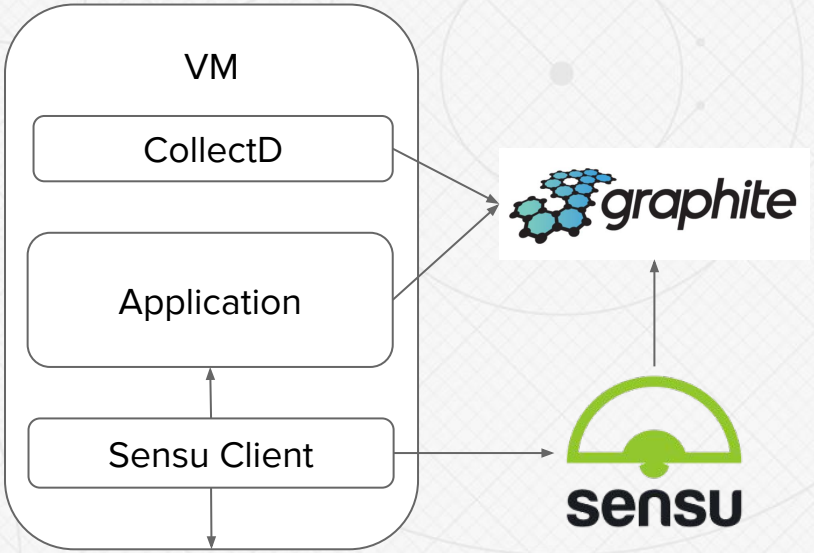
Metrics

- Inefficient aggregations
- Loss of precision
- Ephemeral instances are expensive
- How much is too much?
  - Combinatoric Explosion



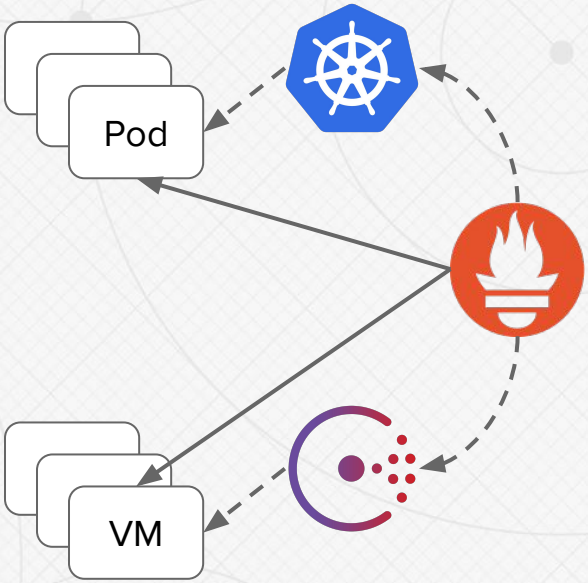
Metrics

- Host based alerting
  - App and system tightly coupled
- Difficult to route alerts
  - Application?
  - System?
  - Hypervisor?
- Difficult to create alerts on SLAs
  - Confusing to create
  - Expensive queries

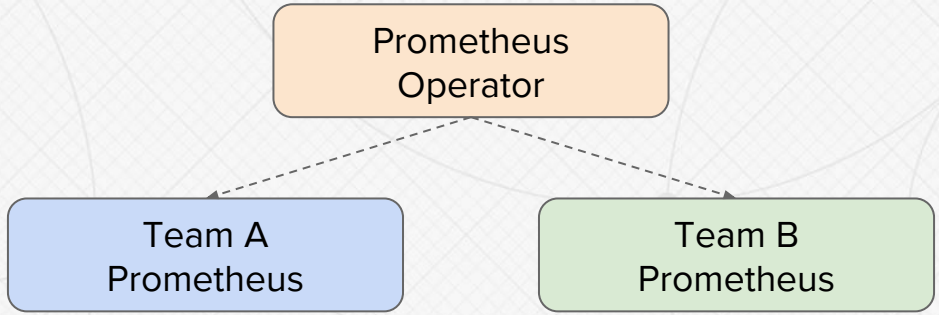


Metrics

- Automatic discovery
- No loss of precision
- Arbitrary time intervals
- Stores tagged data
  - Service
  - Pod
  - Endpoint
- Efficient for ephemeral instances

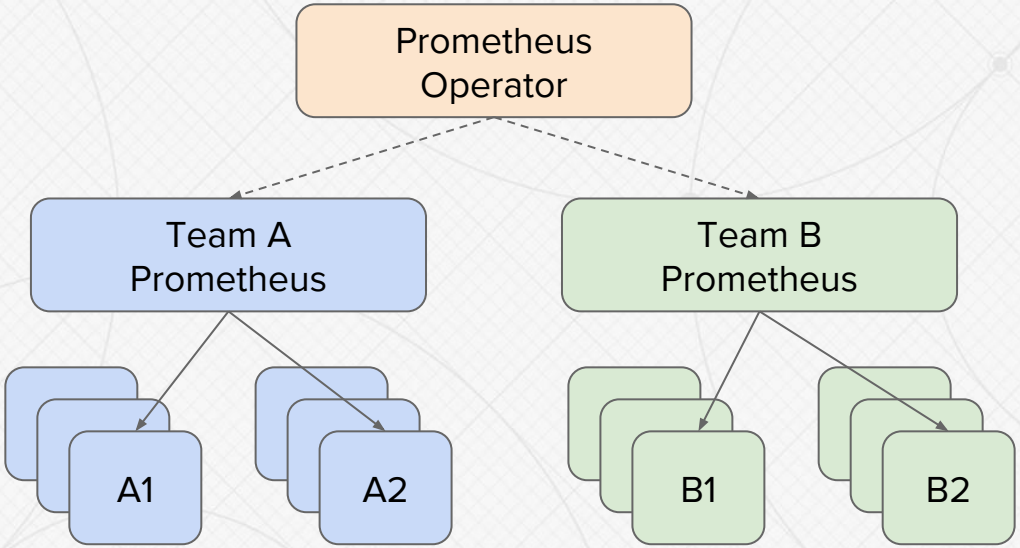


Prometheus Operator



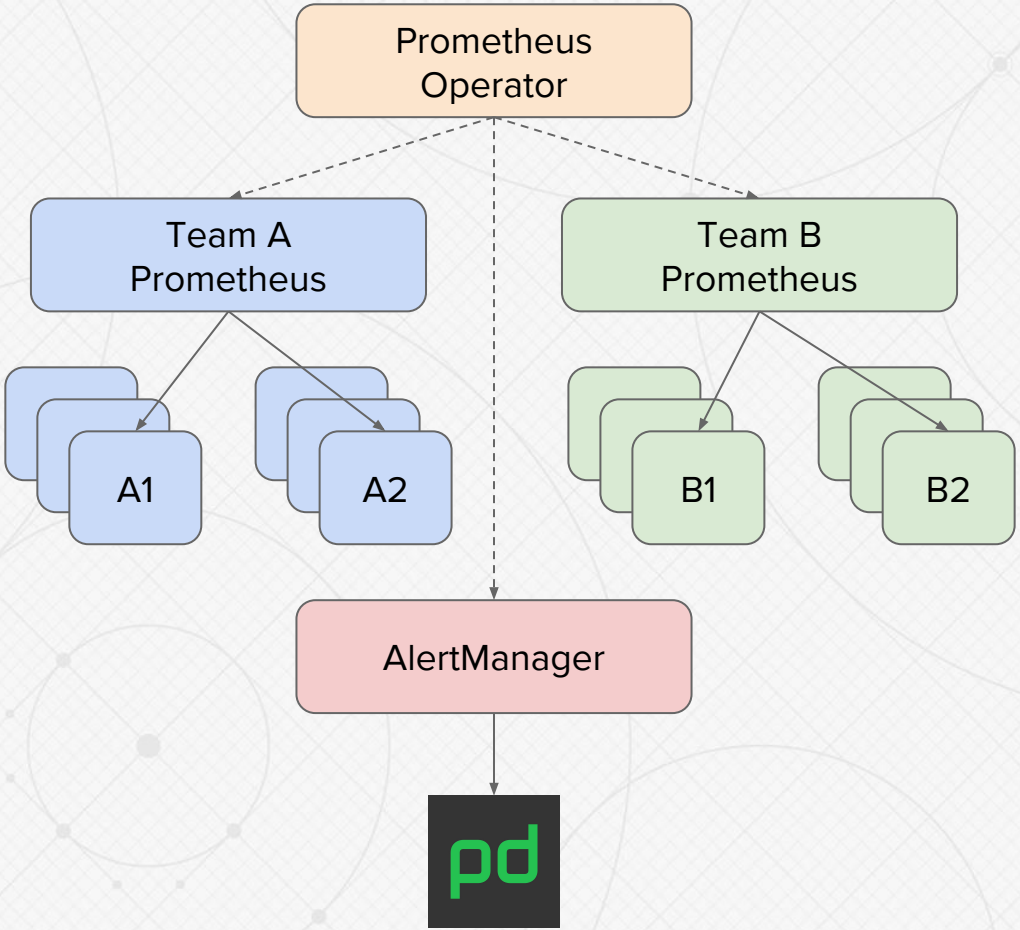
Metrics

Prometheus Operator



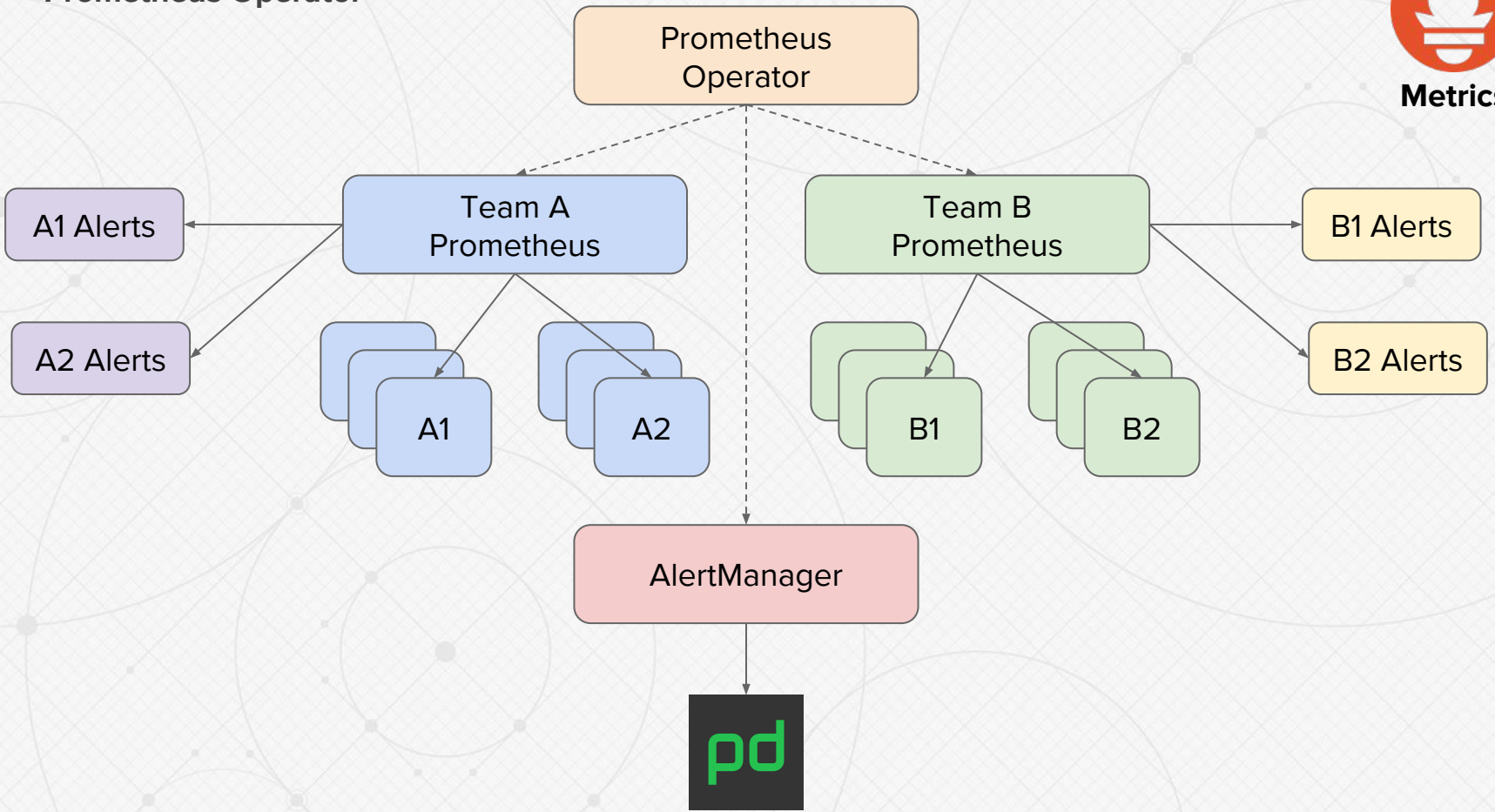
Metrics

Prometheus Operator

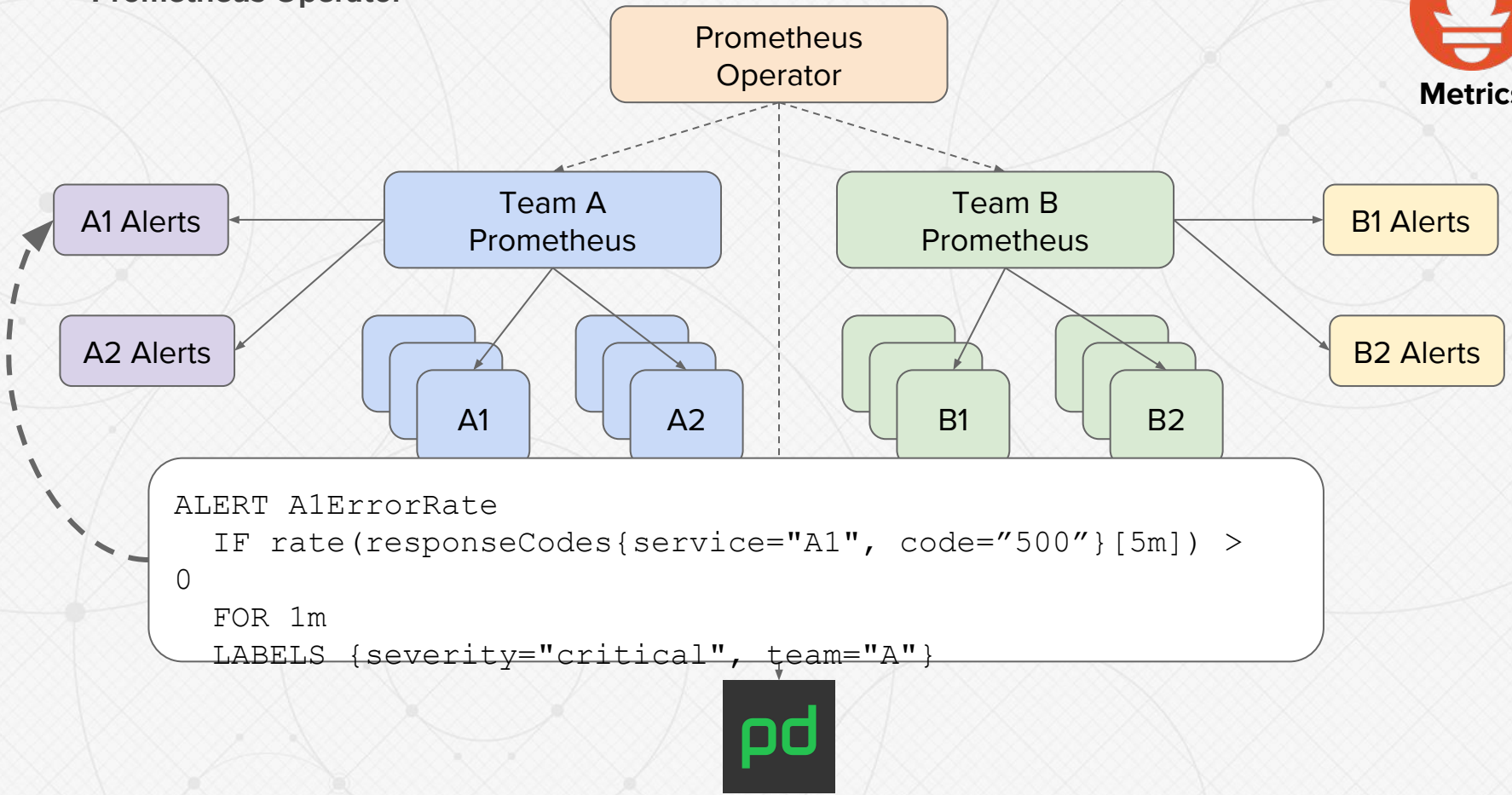


Metrics

Prometheus Operator



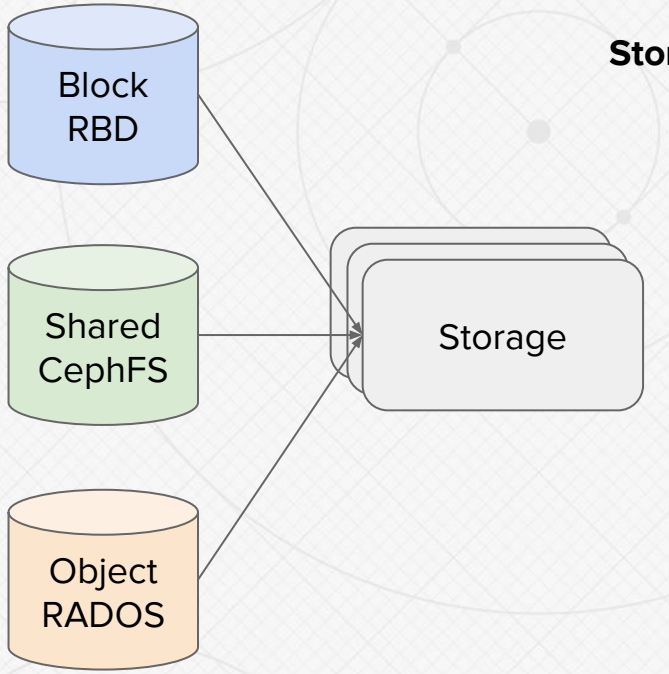
Prometheus Operator



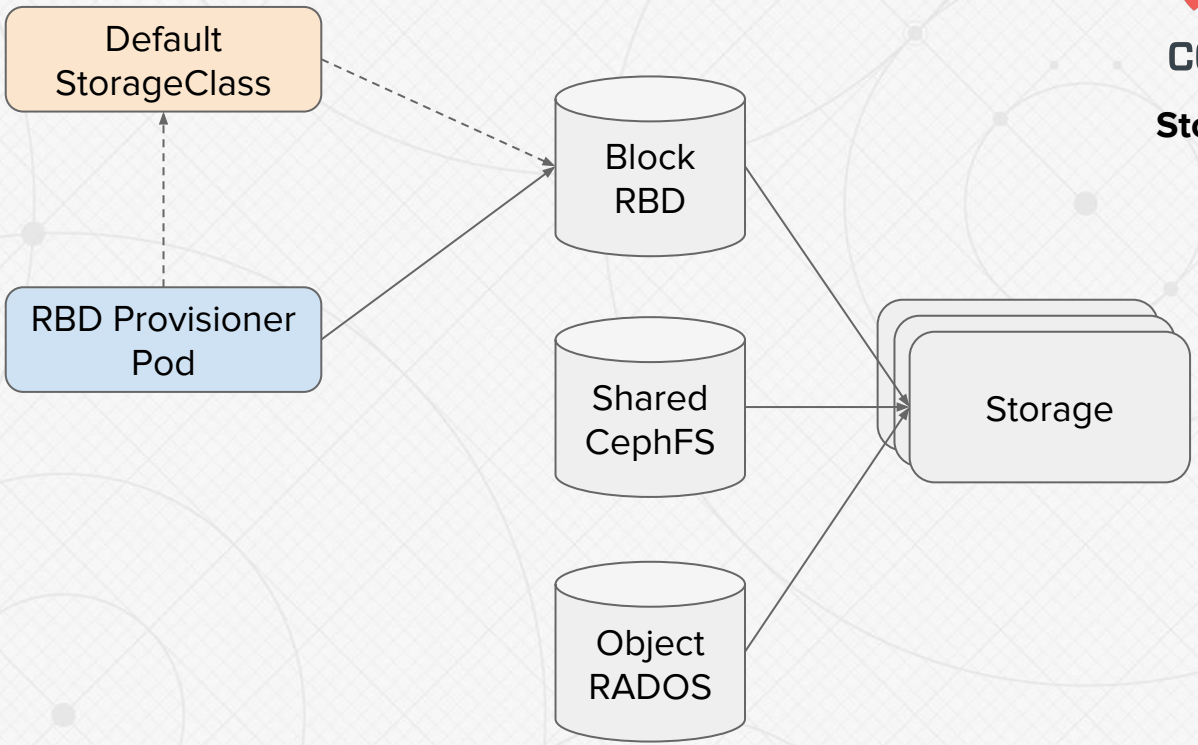
ceph

Storage

- Multiple Access Patterns
  - Block
  - Shared
  - Object
- Simple to scale
- Commodity hardware
- Automatic replication
- Independent of Kubernetes



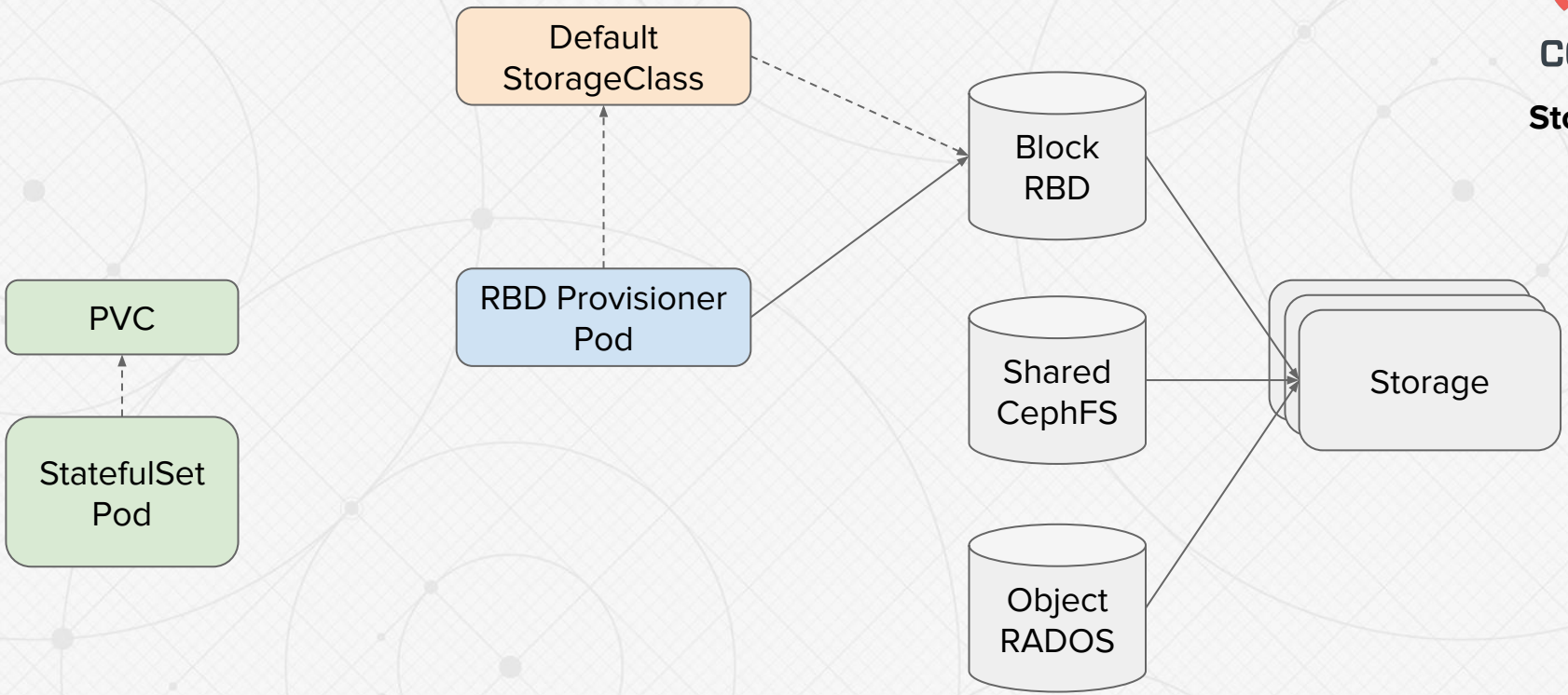
Self Service Storage



ceph

Storage

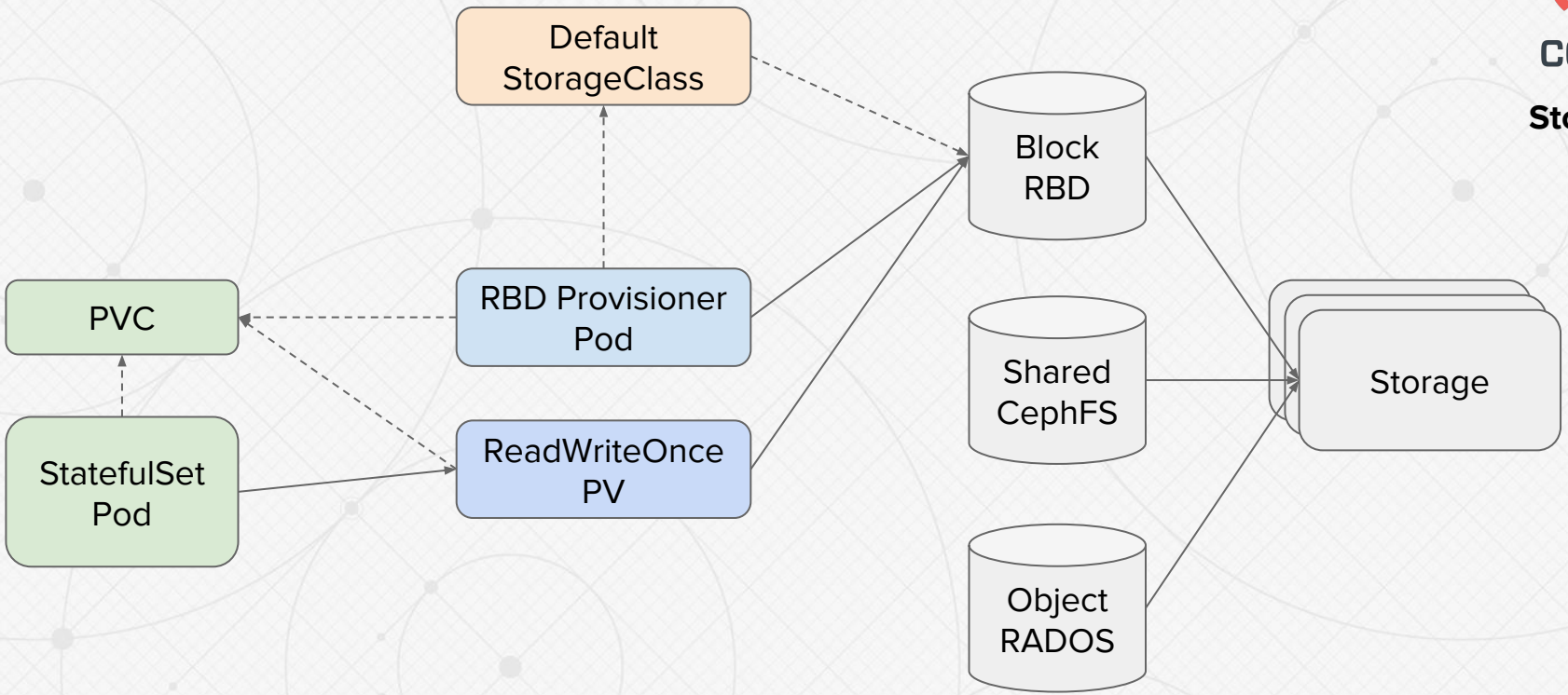
Self Service Storage



ceph

Storage

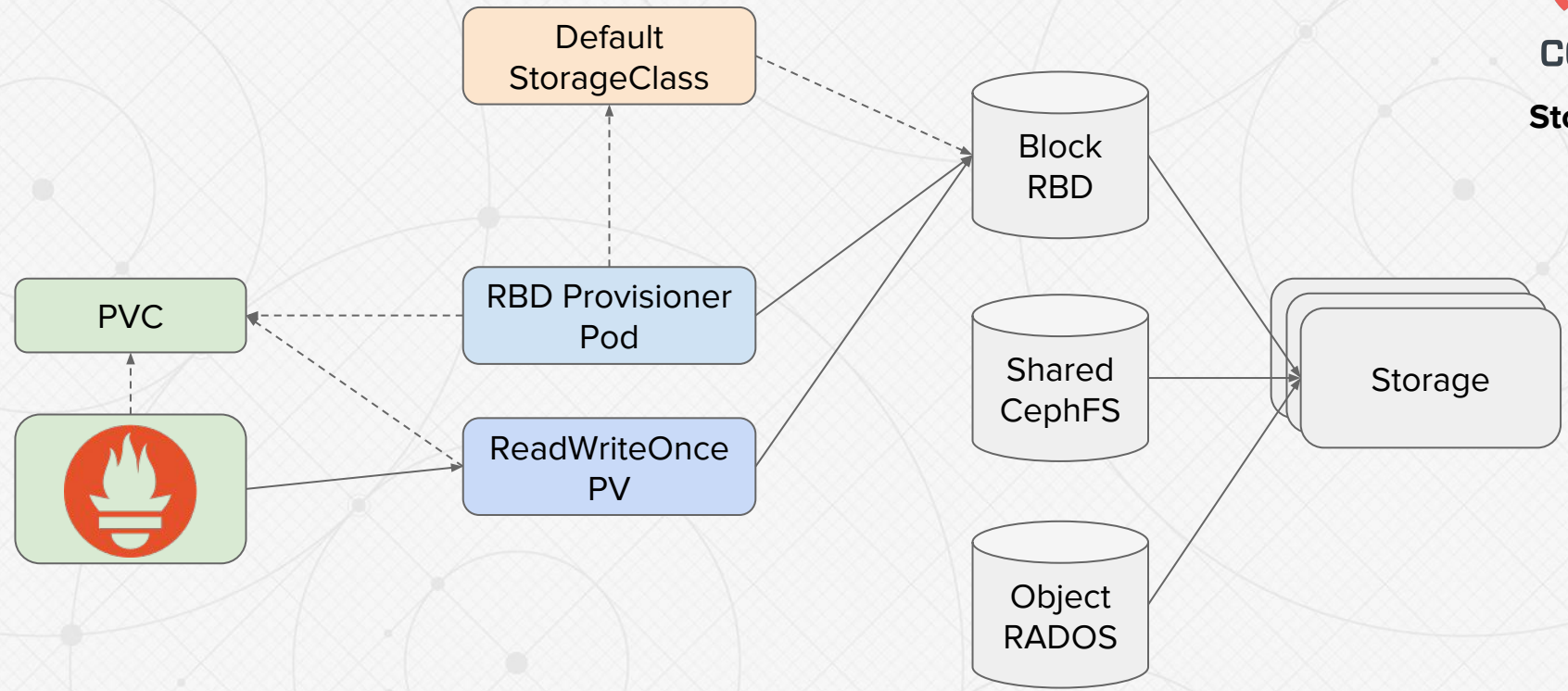
Self Service Storage



ceph

Storage

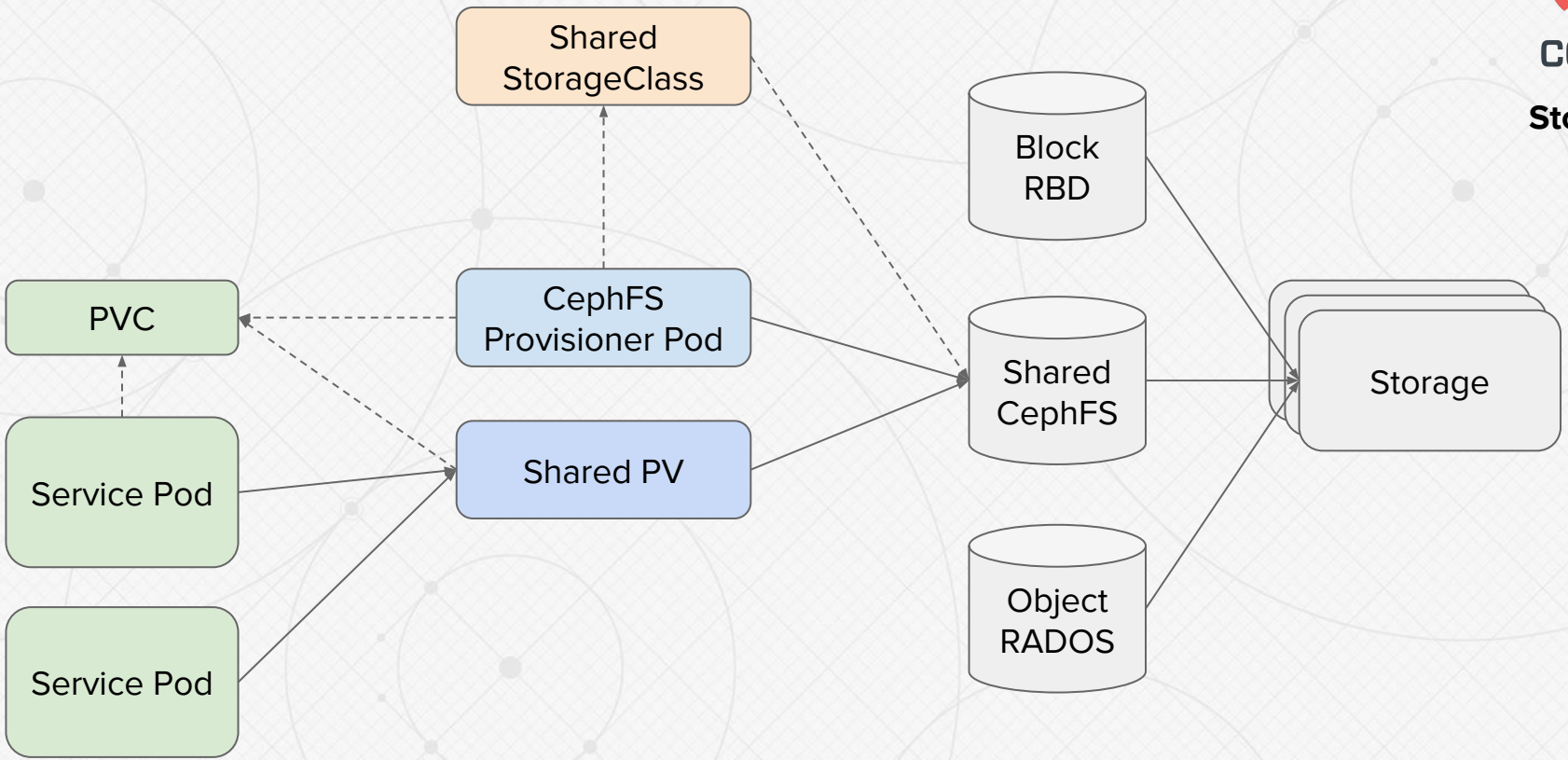
Self Service Storage



ceph

Storage

Self Service Storage



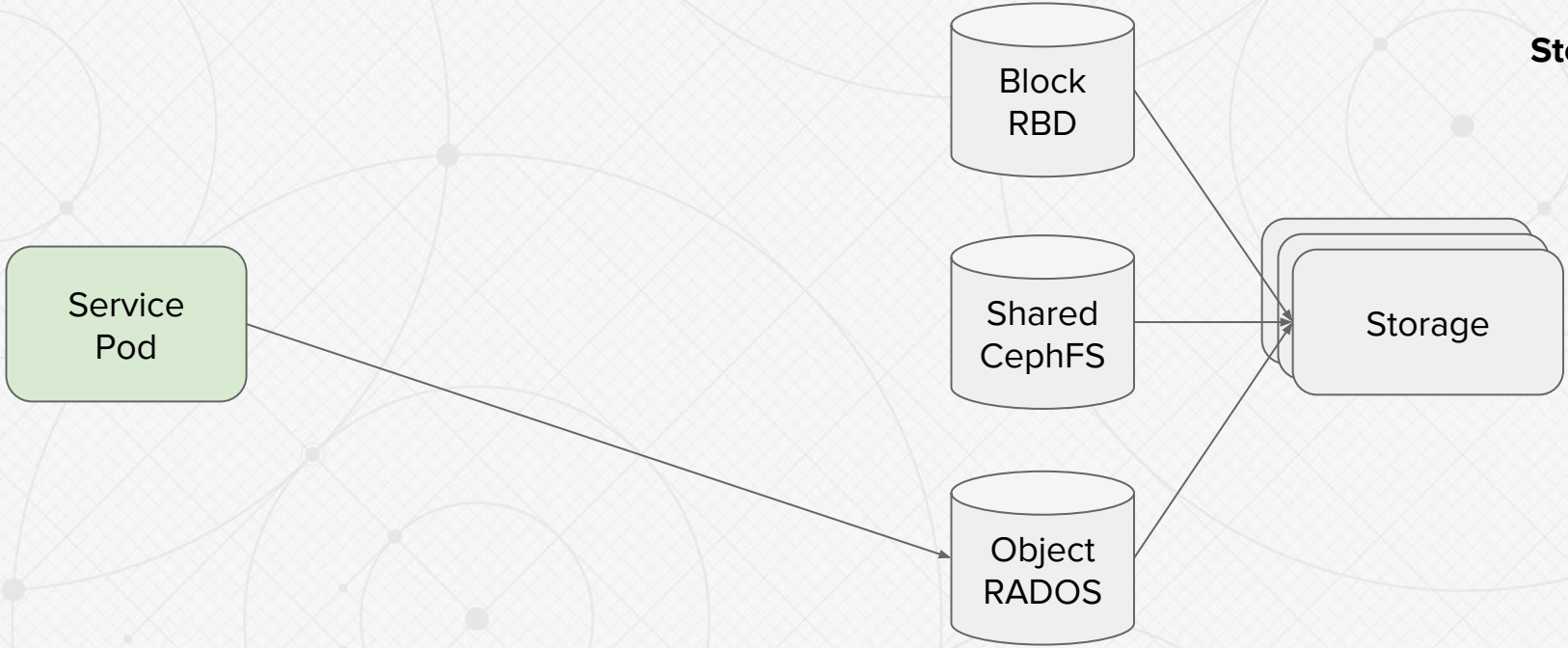
ceph

Storage

Self Service Storage

ceph

Storage



- 20+ new services planned for Q1
- True “micro” services
  - Small
  - Experimental
- VM services migrated quickly

Compute

Network

Metrics

Storage

QUESTIONS?

Thank you!

Kevin Lynch
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squarespace.com/careers