Persistent Storage with Kubernetes in Production

Which solution and why?

ContainerDays, Hamburg, 19 June 2018

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Objectives

- Why is state so tricky?
- How do I compare storage?
- What storage should I use with Kubernetes?

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- How do I compare storage?
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Anti-objective:

- Should I use a database/message queue/key-value store... for my app?

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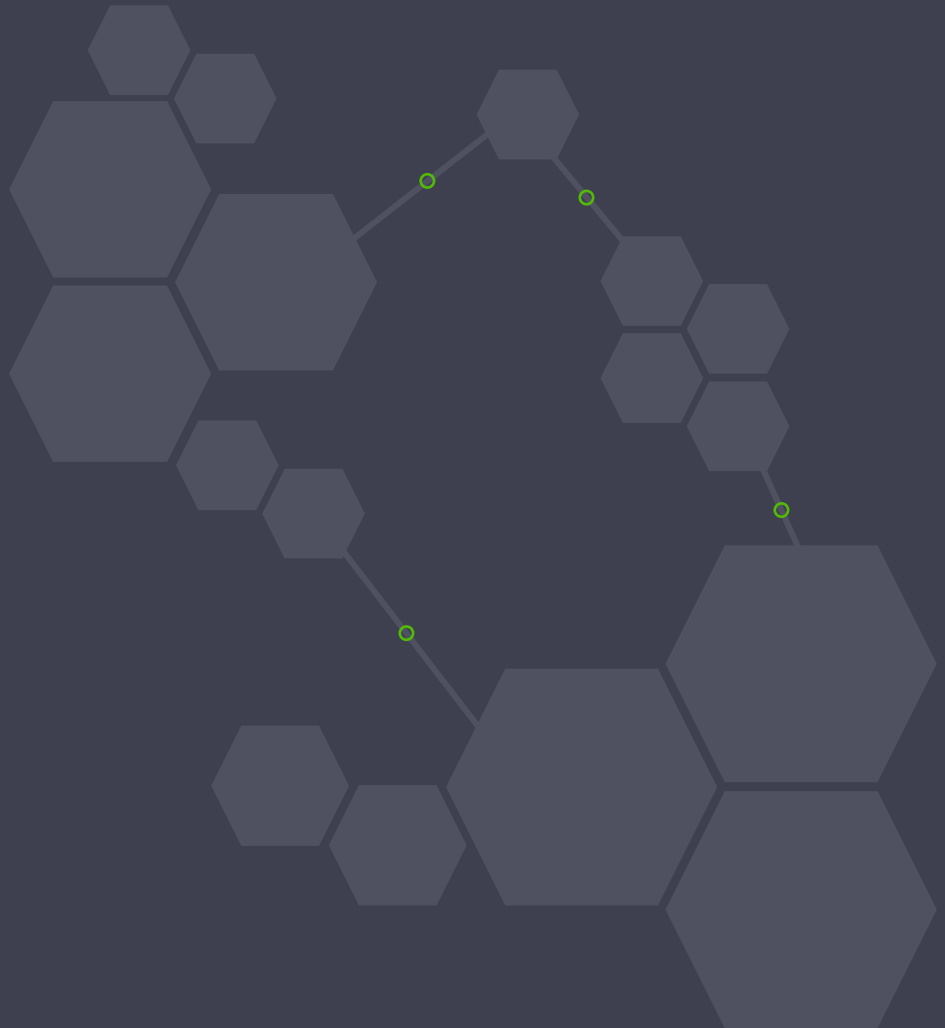
Why is state so tricky?



Why do I need storage?

Why do I need storage?

First challenge: No storage pets

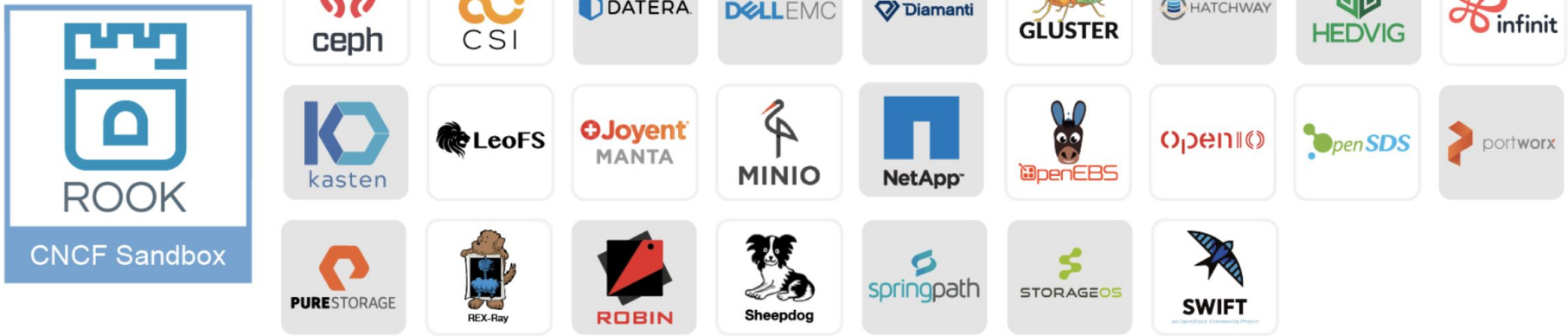
Second challenge: Data needs to follow

Third challenge: Humans are fallible

How do I compare storage?

From the CNCF Landscape

Cloud-Native Storage



Cloud Storage

	Azure	Google	AWS
Object Storage	Azure Blob Storage	Google Cloud Storage	Amazon Simple Storage Service (S3)
Virtual Machine / Block Storage	Azure Page Blobs / Premium Storage	Persistent Disk	Amazon Elastic Block Storage (EBS)
File Storage	Azure File Storage	⊘	Amazon Elastic File System (EFS)
Long Term Cold Storage	Azure Cool Storage	Google Coldline Storage	Amazon Glacier
Hybrid / Gateway Storage	Azure Storsimple	⊘	AWS Storage Gateway

Eight Principles of Cloud Native Storage

What is Cloud Native?

Horizontally scalable

No single point of failure

Resilient and self healing

Minimal operator overhead

Decoupled from the underlying platform

1 Application centric

Storage should be presented to and consumed by applications, not by operating systems or hypervisors

Eight principles of Cloud Native Storage

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The storage platform should be able to run anywhere. Upgrades and scaling is non-disruptive.

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Storage resources should be declared and composed just like all other resources required by applications and services.

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4 API driven

Storage resources and services should be easy to be provisioned, consumed, moved and managed via an API.

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5 Natively secure

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The storage platform should offer deterministic performance in complex distributed environments.

7 Performant

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6 Agile

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7 Performant

The storage platform should ensure high availability, durability, consistency with a predictable, proven data model.

8 Consistently available

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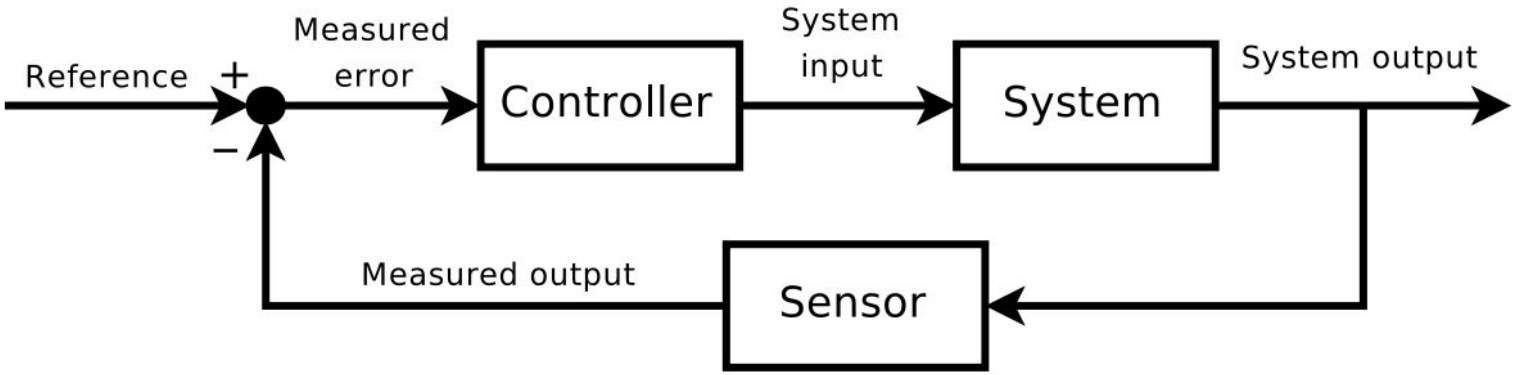
What storage should I use with Kubernetes?

Extremely quick intro to Kubernetes

- An open source container orchestrator platform, originally developed by Google
- One of the fastest moving projects in open source
- Abstraction layer for infrastructure in a cluster
- “The Linux of the cloud”

“Always run my application (packaged as a container/pod) with four replicas”



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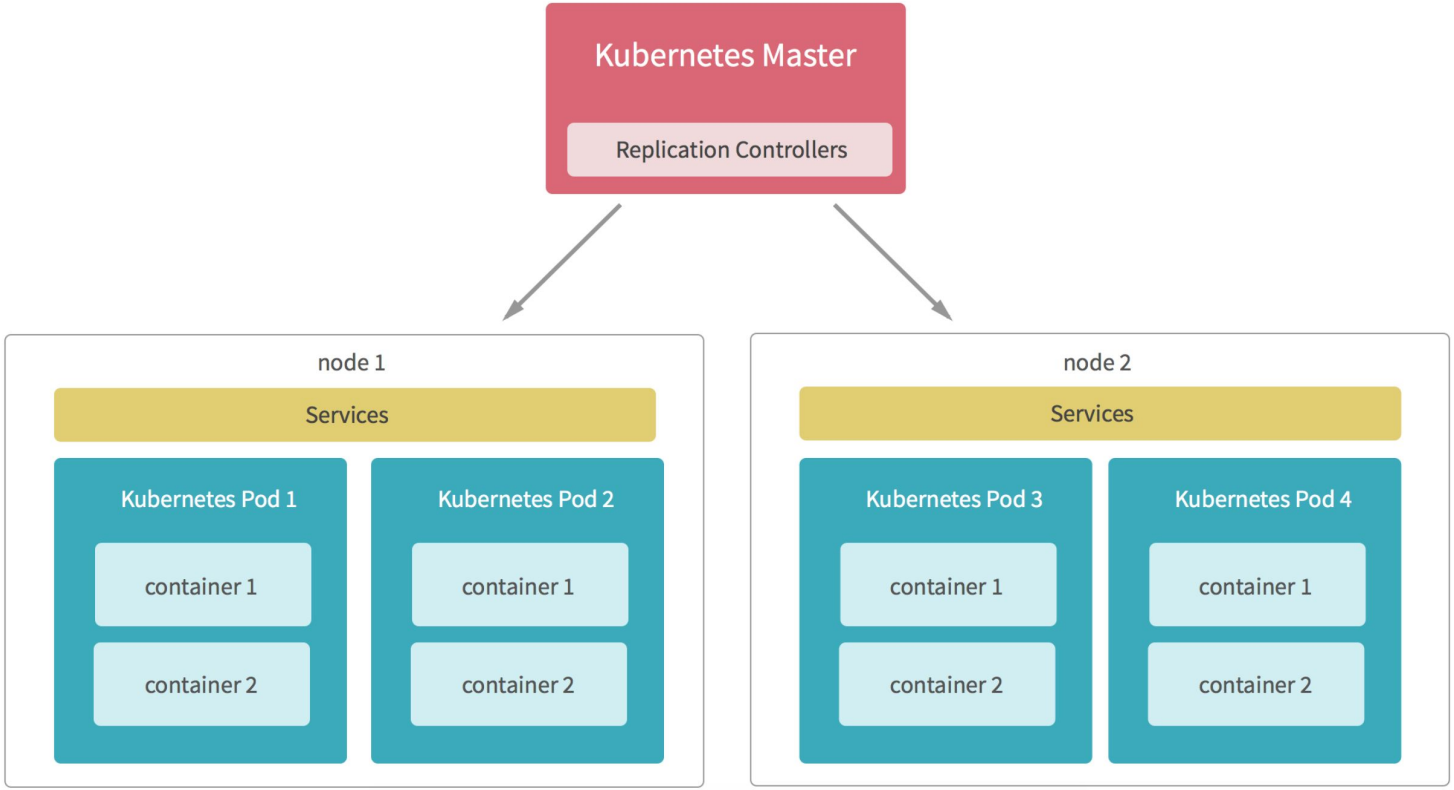
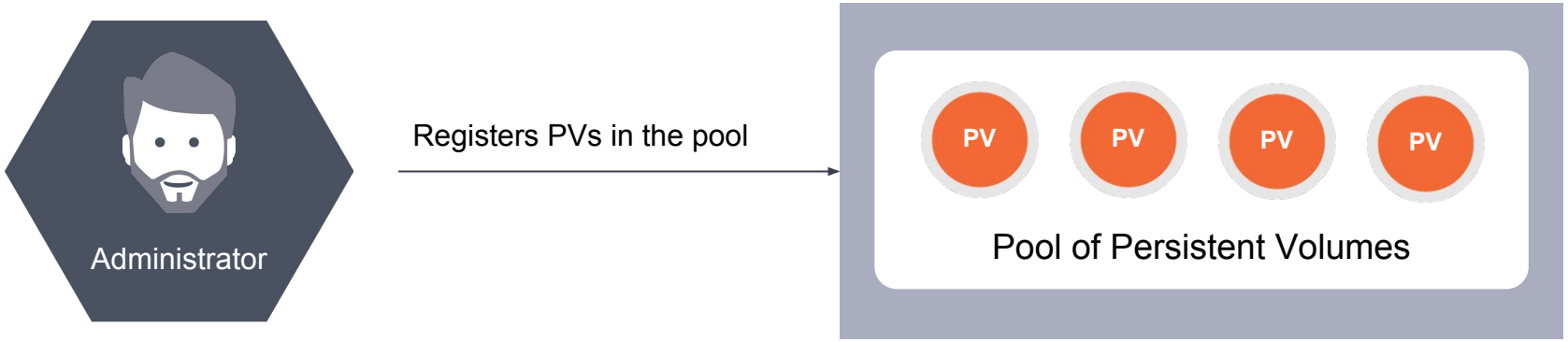


Kubernetes Storage Model: Persistent Volumes and Claims



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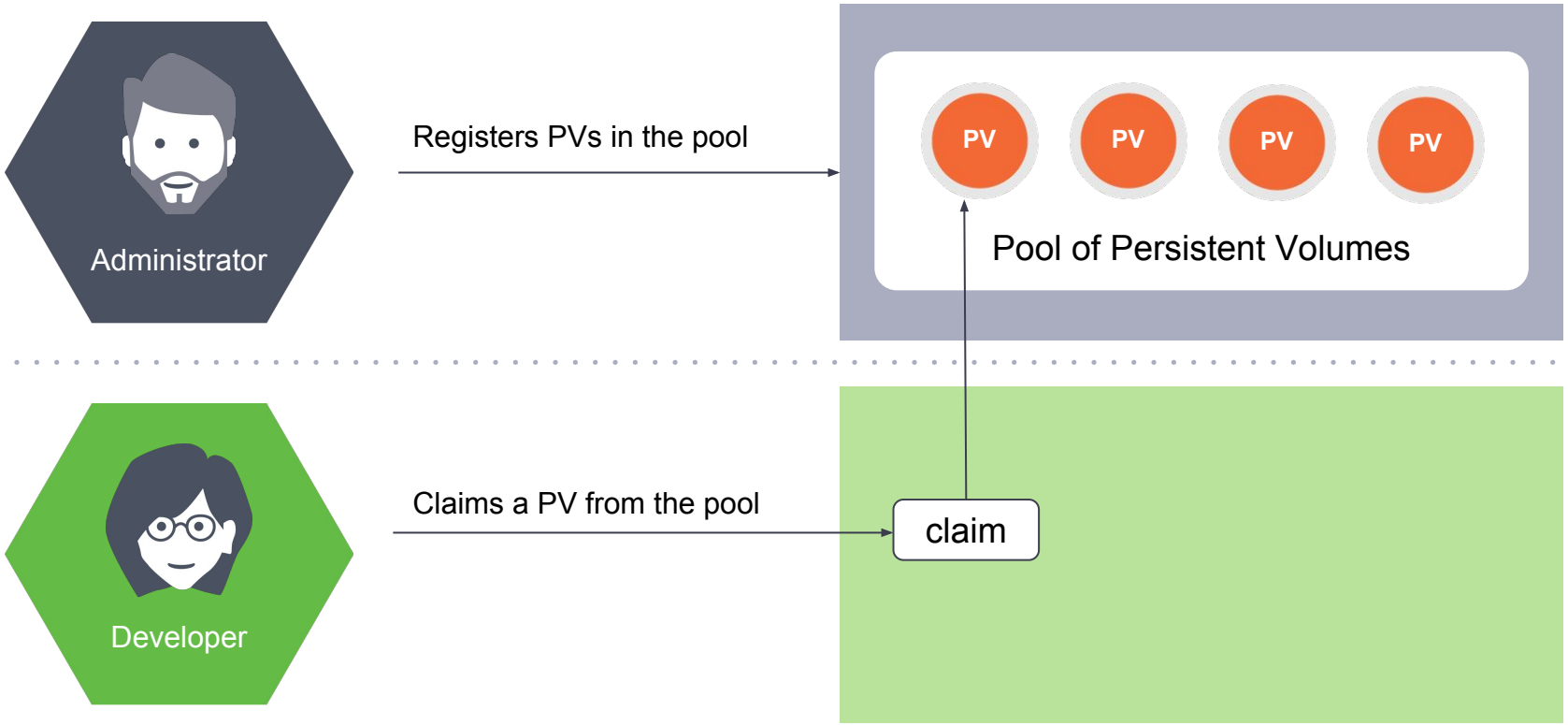

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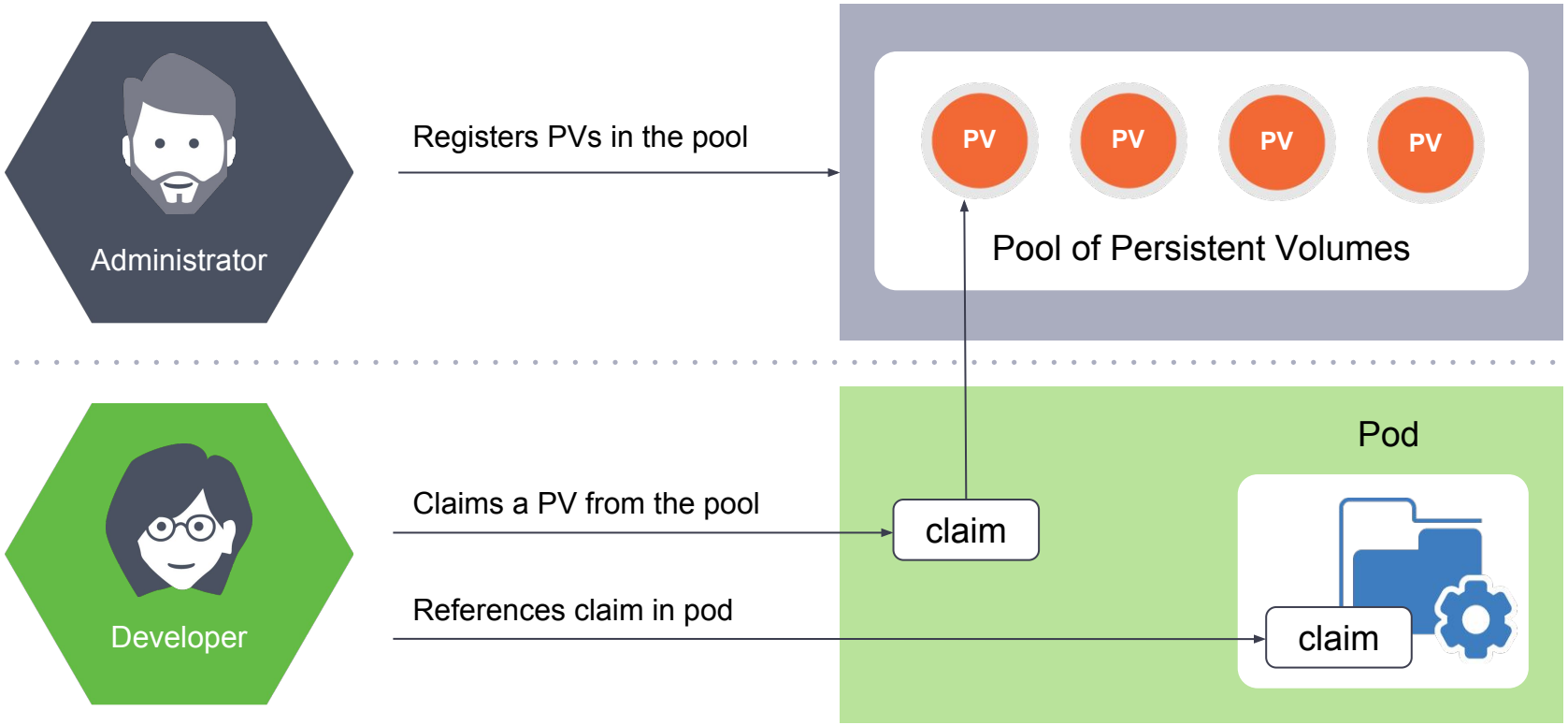
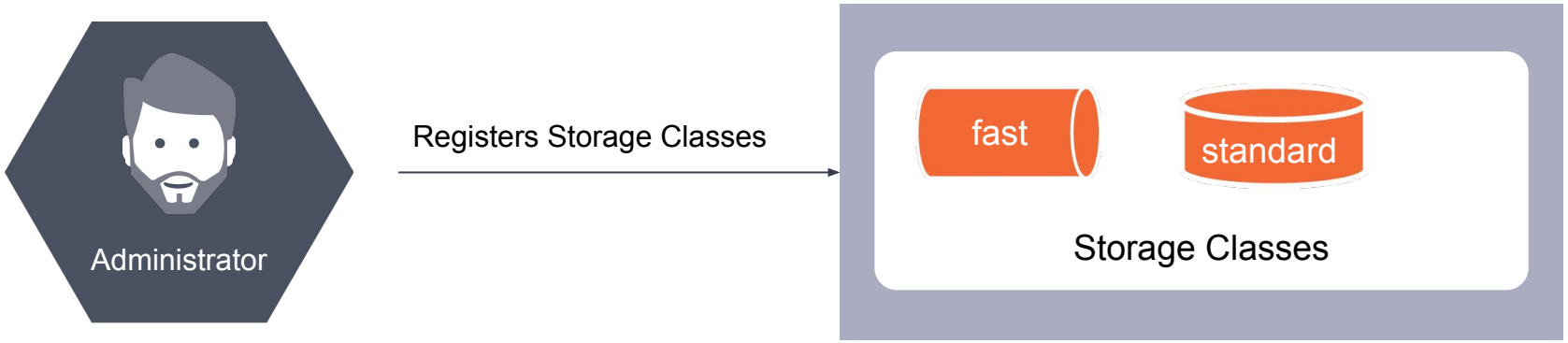


Dynamic provisioning with Storage Classes



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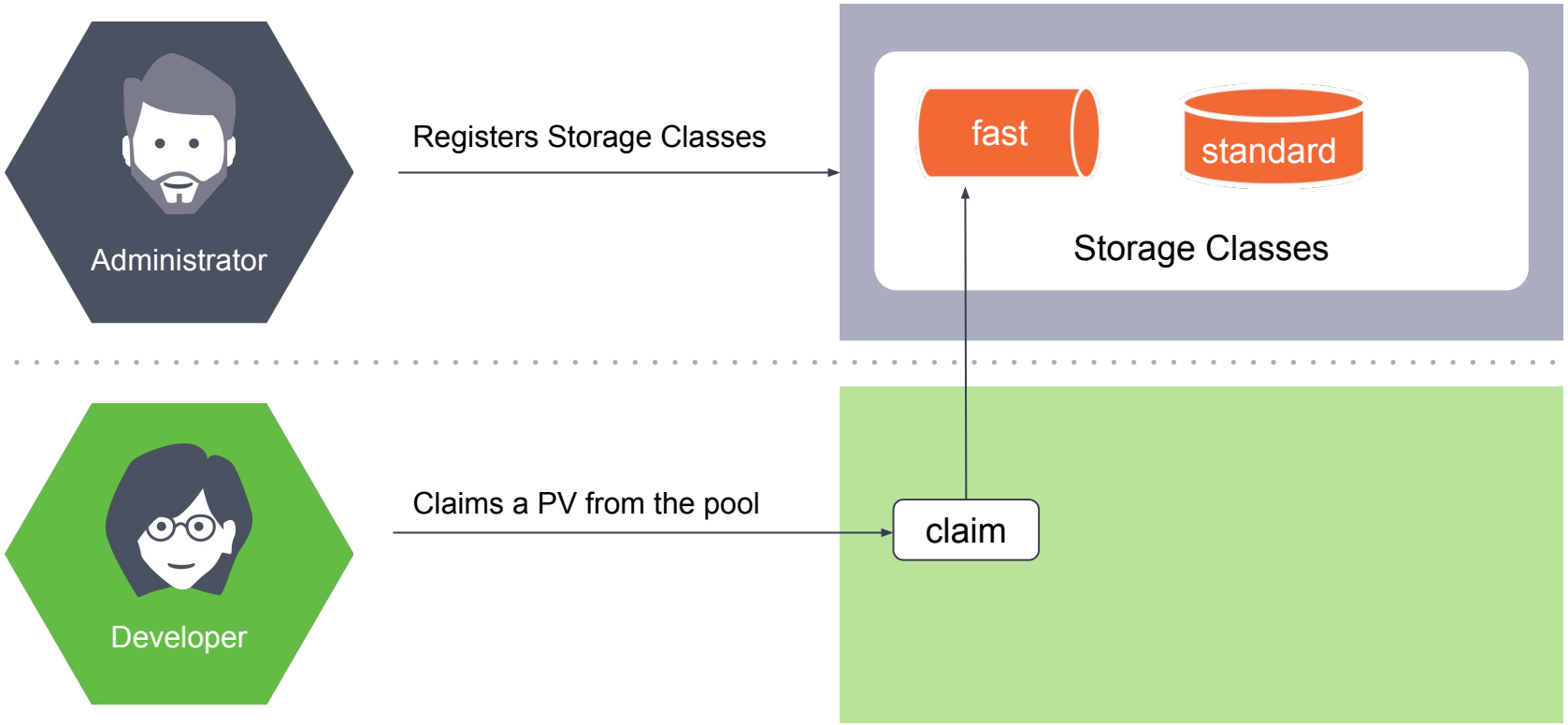

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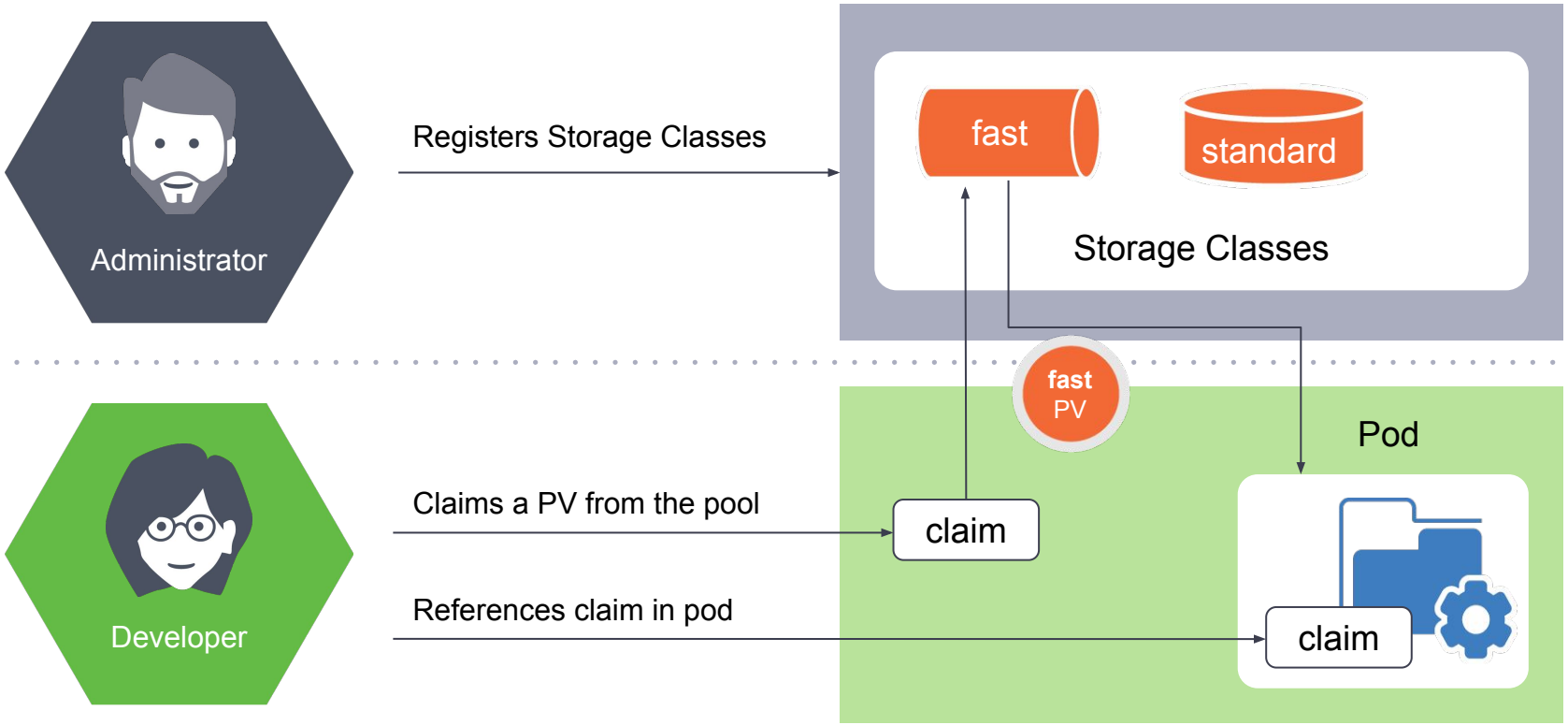
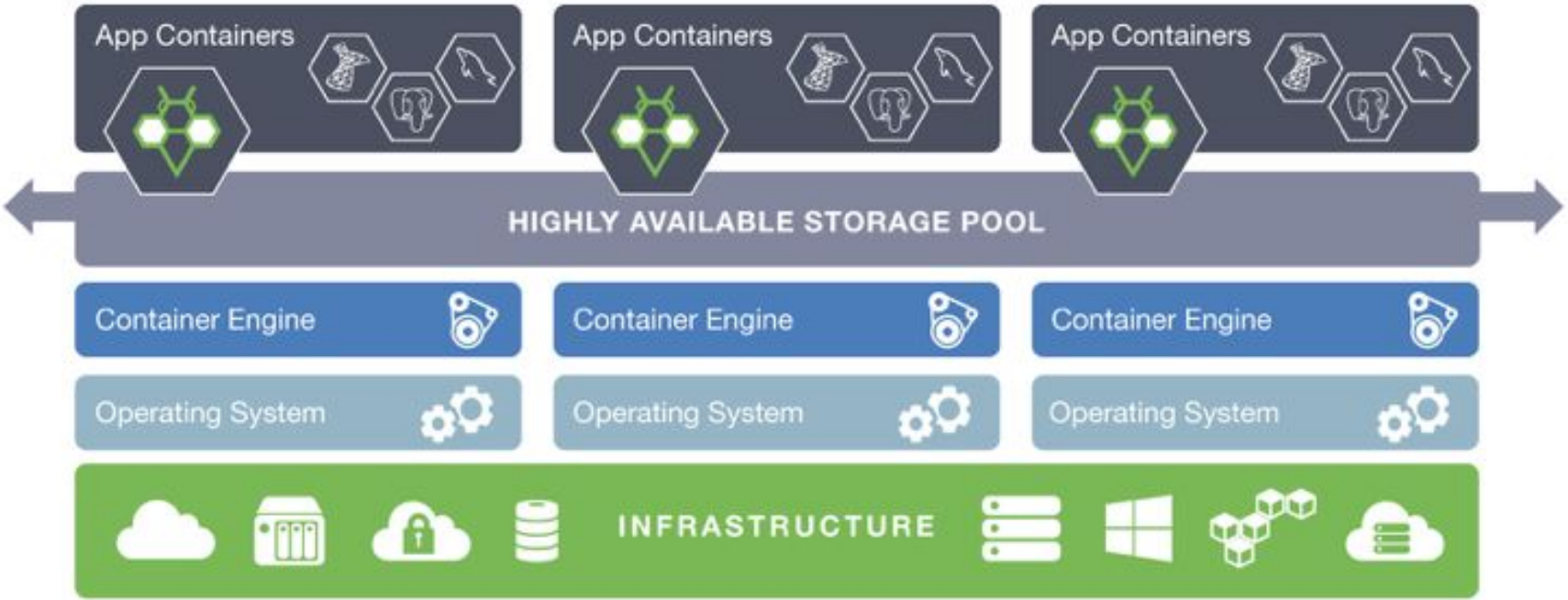
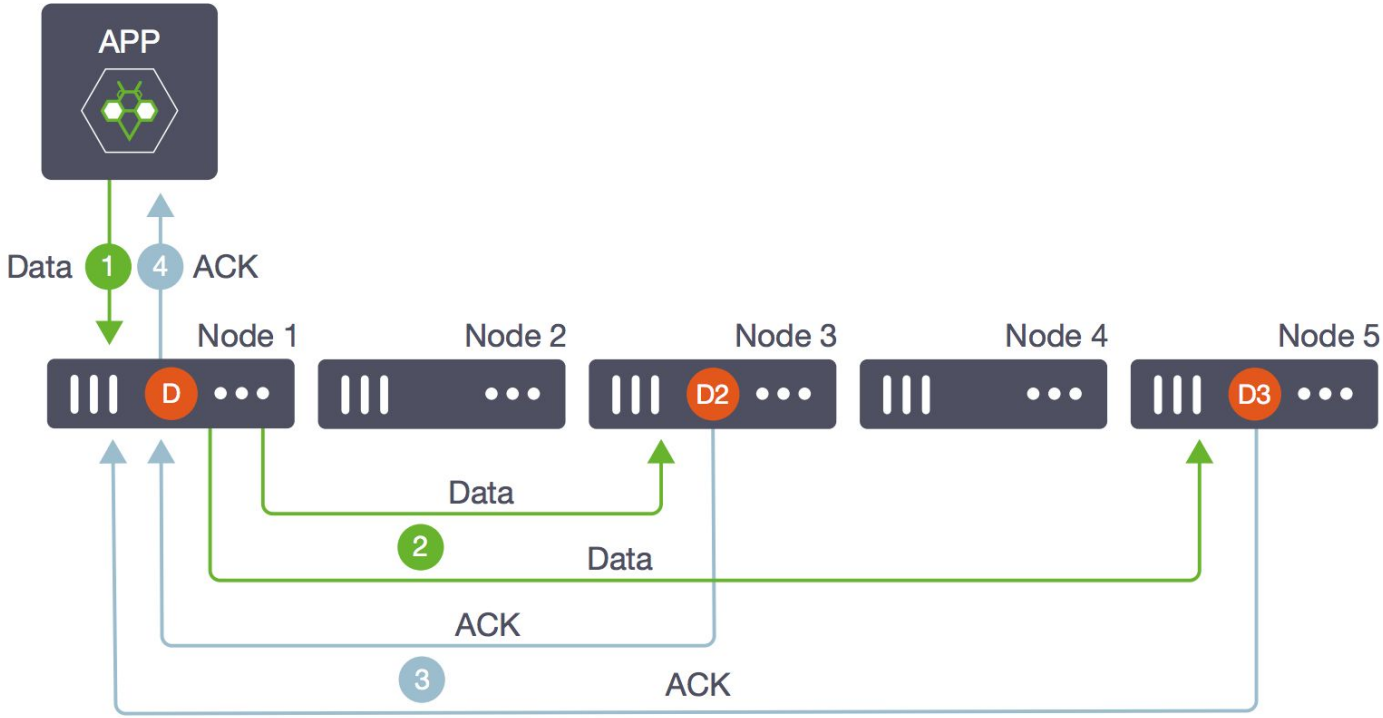


KEEP
CALM
IT IS
DEMO
TIME

StorageOS architecture



High availability with StorageOS



Meet Jane

- A DevOps engineer at a media company
- Migrating client Wordpress websites into Kubernetes
- Wants to follow the cloud native principles

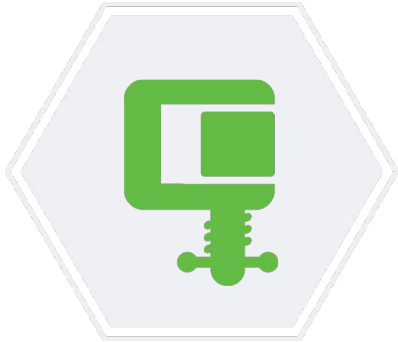
Key questions

1. What is my **use case**?
2. What are my **performance requirements**?
3. How should developers **access** storage?
4. Where is the storage **deployed and managed**?

1. What is my use case?

App binaries

App data



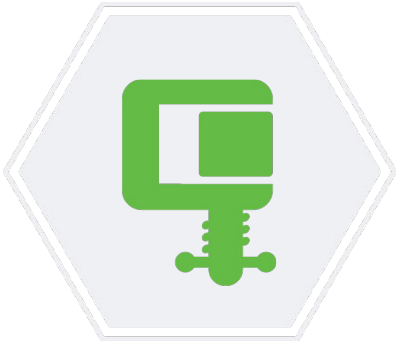
Config

Backup

2. What are my performance requirements?

App binaries
Ephemeral

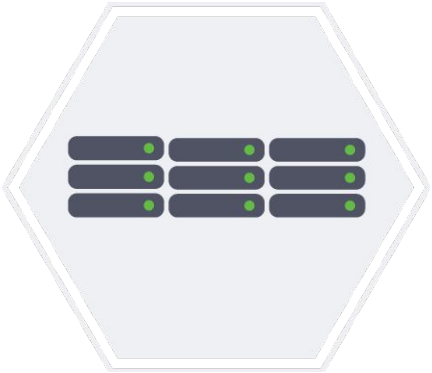
App data
Latency, availability, performant



Config
Shared

Backup
Cost efficient, cloud

3. How should developers access storage?

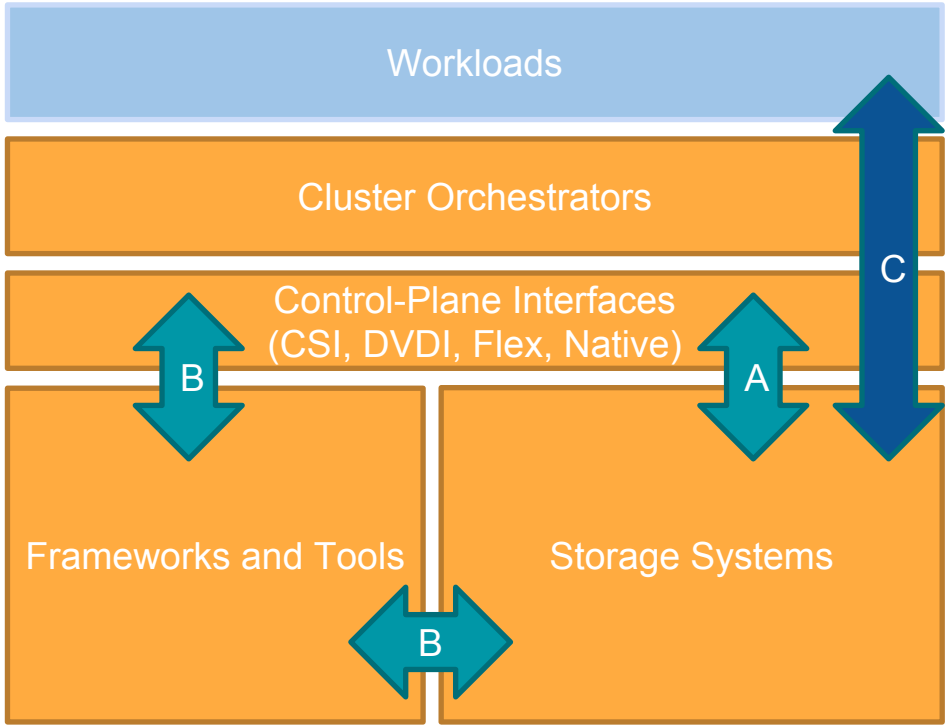


Block
Fixed-size ‘blocks’ in a rigid arrangement – ideal for enterprise databases

File
‘Files’ in hierarchically nested ‘folders’ – ideal for active documents

Object
‘Objects’ in scalable ‘buckets’ – ideal for unstructured big data and archiving

4. Where is the storage deployed and managed?



- CO supports one or more **Interfaces** to interact with the Storage System
- Storage System can **(A)** support control-plane interface API directly and interact directly with the CO or can **(B)** interact with the CO via an **API framework layer** or other **Tools**.
- Storage system must support the ability to provision and consume (C) volumes through a standard interface to be considered **Interoperable**
- Workloads interact (C) with storage systems over various data-plane methods

Jane’s storage requirements

- Postgres database for application data
- Database location, credentials
- Database and website backups
- User uploaded media

Database location and credentials

1. **Use case?** Configuration
2. **Performance requirements?** Shared across instances
3. **Access?** Kubernetes provides Secrets for sensitive data such as passwords, and ConfigMap for arbitrary config. Both can be accessed by the application through environment variables
4. **Deployed and managed?** Tight integration with Kubernetes

User uploaded media

1. **Use case?** Shared media
2. **Performance requirements?** Large blobs of data, shared across pods
3. **Access?** Shared filesystem
4. **Deployed and managed**?

Cloud: Managed NFS, or object store if the app can support it

On prem: Distributed FS (not NFS)

Database and website backup

1. **Use case?** Backup and archival
2. **Performance requirements?** Durability, cost, snapshots
3. **Access?** Object store
4. **Deployed and managed?**

Cloud: Managed object store, long term cold storage

On prem: Object store (not NAS)

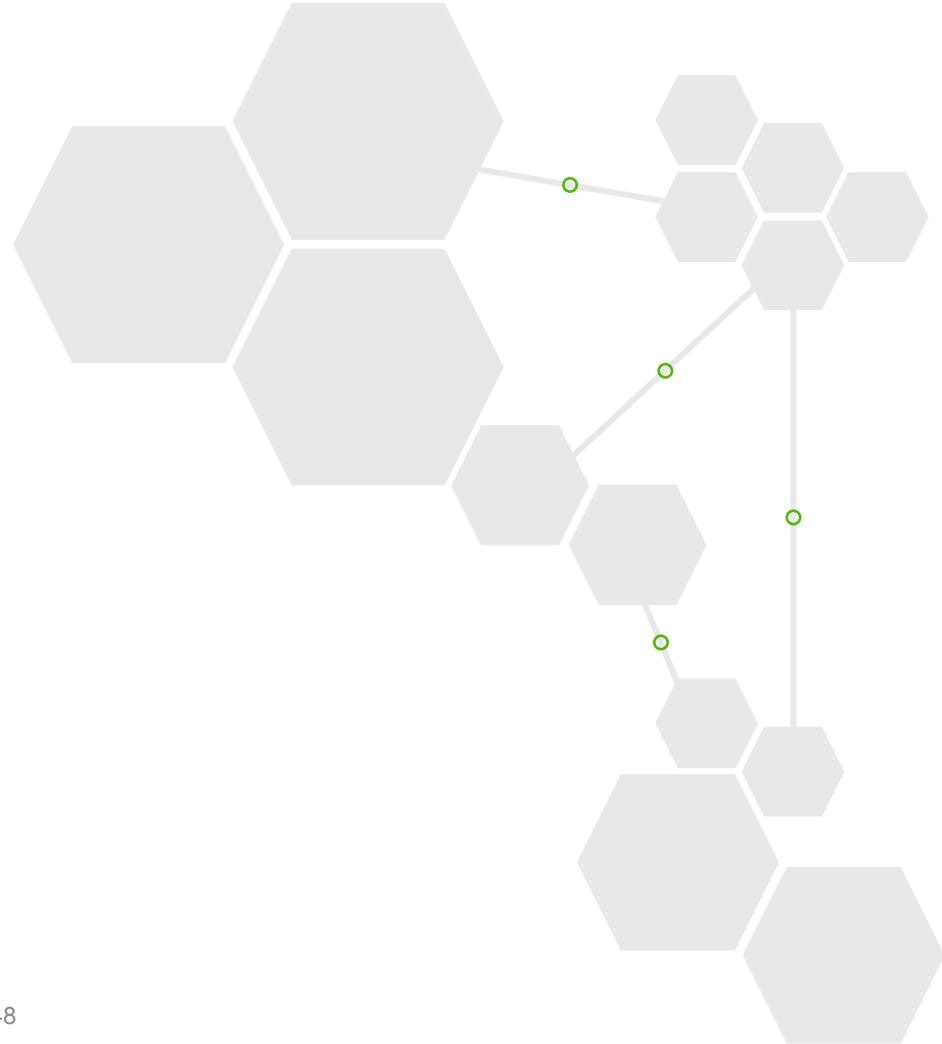
Postgres for application data

1. **Use case?** Transactional database
2. **Performance requirements?** High availability, low latency, deterministic performance
3. **Access?** Database connector
4. **Deployed and managed?**

Cloud: Cloud volumes (watch out for attach/detach times, compliance) or managed db (limited offerings)

On prem: Software defined storage

To Recap…



Storage principles

1 Application centric

2 Platform agnostic

3 Declarative/ composable

4 API driven

5 Natively secure

6 Agile

7 Performant

8 Consistently available

1. Use case?
2. Performance requirements?
3. Access?
4. Deployed and managed?

CSI in beta as of Kubernetes 1.10

Objective is to define an industry standard “Container Storage Interface” (CSI) that will enable storage vendors to develop a plugin once and have it work across a number of container orchestration systems.

StorageOS resources

Browser-based tutorials

- demo.storageos.cloud

Quickstart

- storageos.com/kubernetes

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Thanks

Slides at oicheryl.com

What is StorageOS?

A software-defined, scale-out storage platform for running enterprise containerized applications in production

What is StorageOS?

Platform agnostic

Horizontally scalable

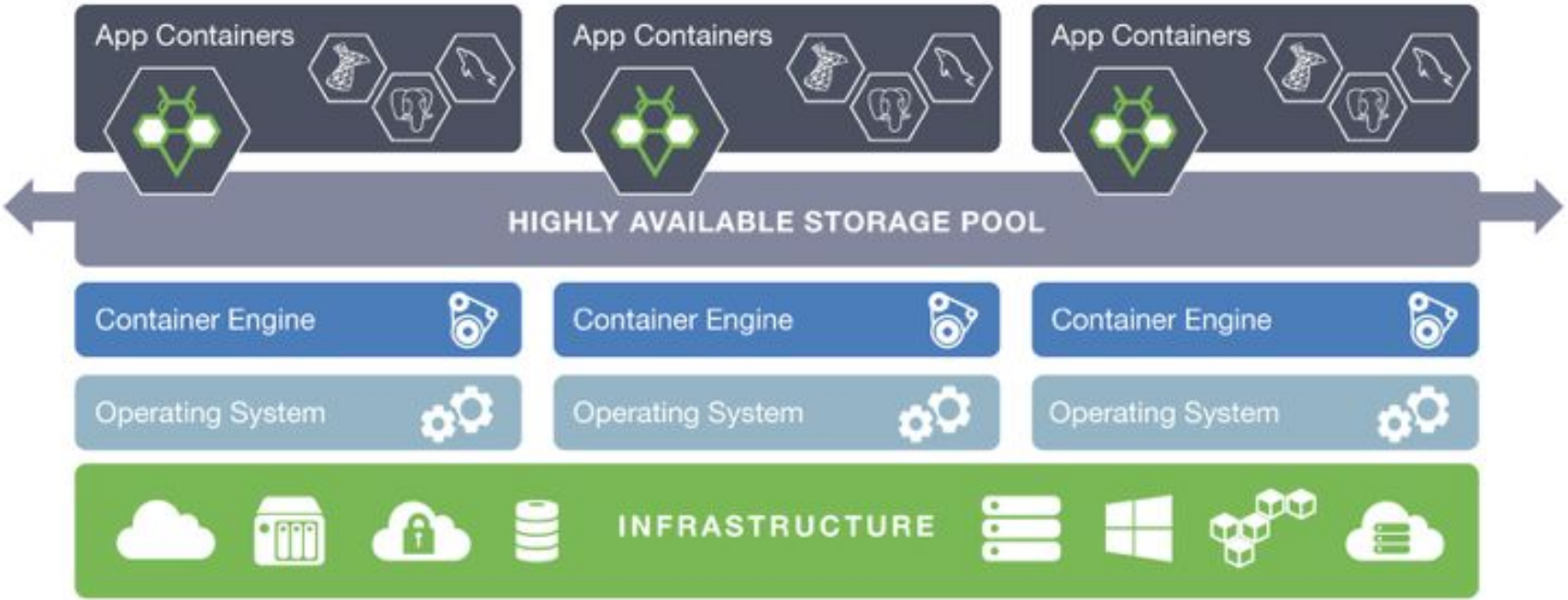
Stateful workloads eg. database

A software-defined, scale-out storage platform for running enterprise containerized applications in production

Docker/K8s integration

High availability

StorageOS architecture



StorageOS architecture

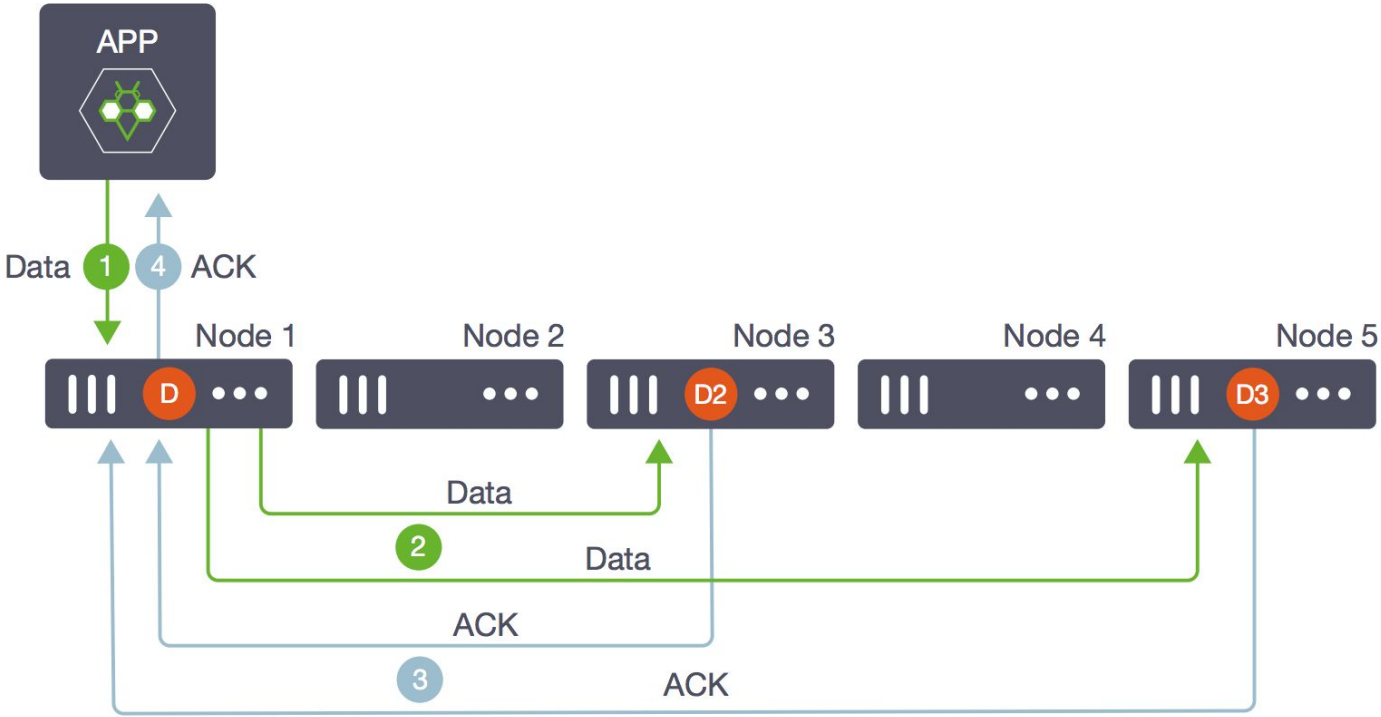
StorageOS is conceptually pretty simple; it's a virtualization layer on top of any commodity or cloud storage. It's deployed as one container per node, as a DaemonSet.

1. Nodes contribute local block storage to the storage pool.
2. Virtual volumes (block storage formatted with a standard filesystem) are created through the StorageOS volume plugin.
3. Any pods can mount the virtual volumes from any node. If a pod is rescheduled to a different node, StorageOS simply redirects reads and writes so the pod can continue to access the storage.

StorageOS architecture

It’s designed to scale horizontally by adding more nodes. New nodes contribute their storage into the storage pool, or, if they don’t have storage themselves, can access storage on other nodes.

High availability with StorageOS



High availability with StorageOS

StorageOS uses a hybrid master/replica architecture, where replicas are distributed across nodes.

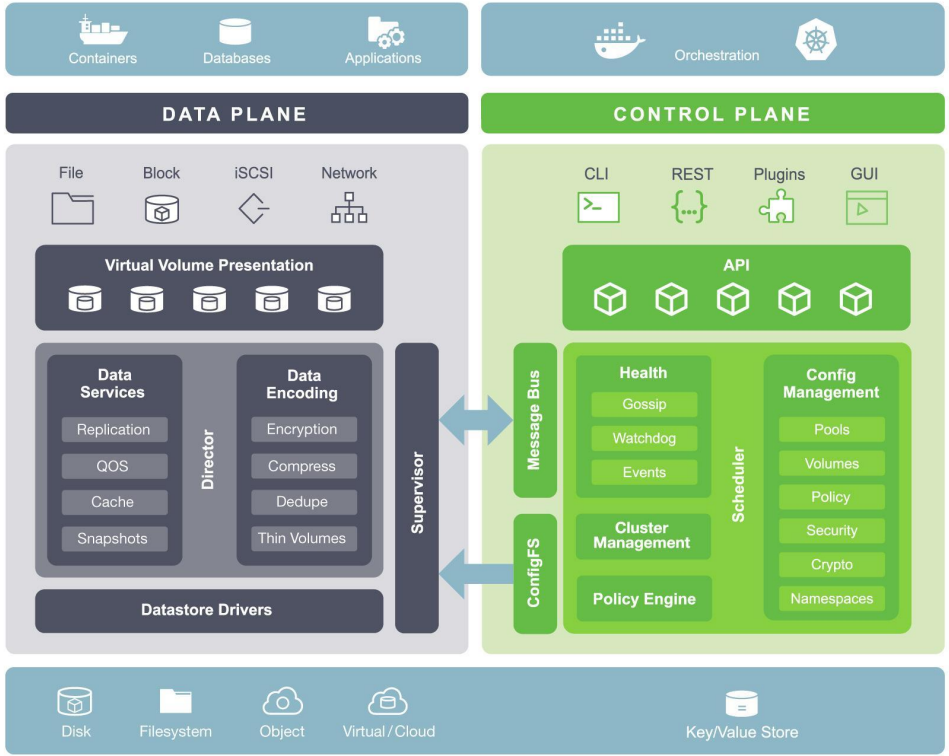
Replication is very simple in StorageOS. Volume D is created with two replicas. StorageOS creates the replicas (D2, D3) and schedules them to two different nodes (N3, N5). Incoming writes to D are synchronously replicated to D2 and D3, ie. writes are not persisted until acknowledged by both replicas.

If N1 fails, one of D2 or D3 gets promoted to master, providing instant failover and no interruption of service. StorageOS creates and resyncs a new replica on N2 or N4 in the background.

StorageOS: A modular enterprise storage solution in a container

DATA PLANE

- Manages data access requests
- Pools aggregate storage for presentation
- Runs as a container



CONTROL PLANE

- Manages config, health, scheduling, policy, provisioning and recovery
- API is accessed by plugins, CLI, GUI
- Runs as a container

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More reading

Download the technical architecture overview at storageos.com/storageos-platform-architecture-overview.

Try out in your browser, with zero downloads or configuration: demo.storageos.cloud

Full documentation at docs.storageos.com.