



# Persistent Storage with Kubernetes in Production

## *Which solution and why?*

ContainerDays 2018, Hamburg, 19 June 2018

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StorageOS

Ex-Google software eng, CNCF  
Ambassador



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



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

Anti-objective:

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





# Why is state so tricky?



# Why do I need storage?

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## First challenge: No storage pets

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## Second challenge: Data needs to follow

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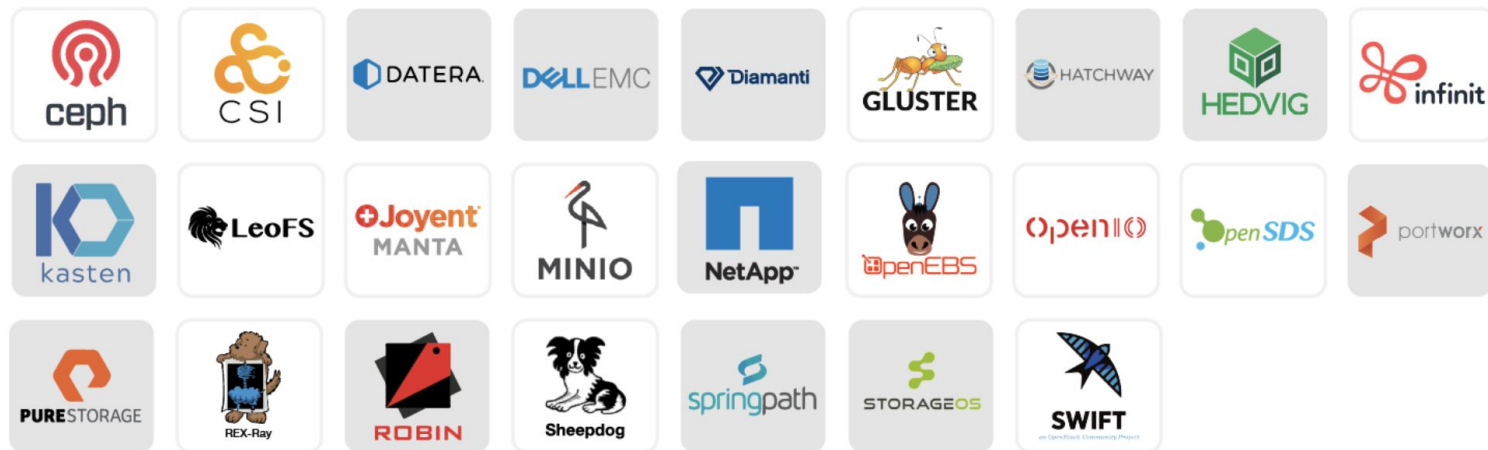
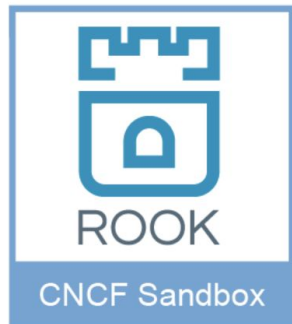
## Third challenge: Humans are fallible






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# How do I compare storage?

## Cloud-Native Storage



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

# Eight Principles of Cloud Native Storage



Horizontally scalable

No single point of failure

Resilient and self healing

Minimal operator overhead

Decoupled from the underlying platform



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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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**7 Performant**

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The platform should be able to move application data between locations, dynamically resize and snapshot volumes.

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

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

**5 Natively  
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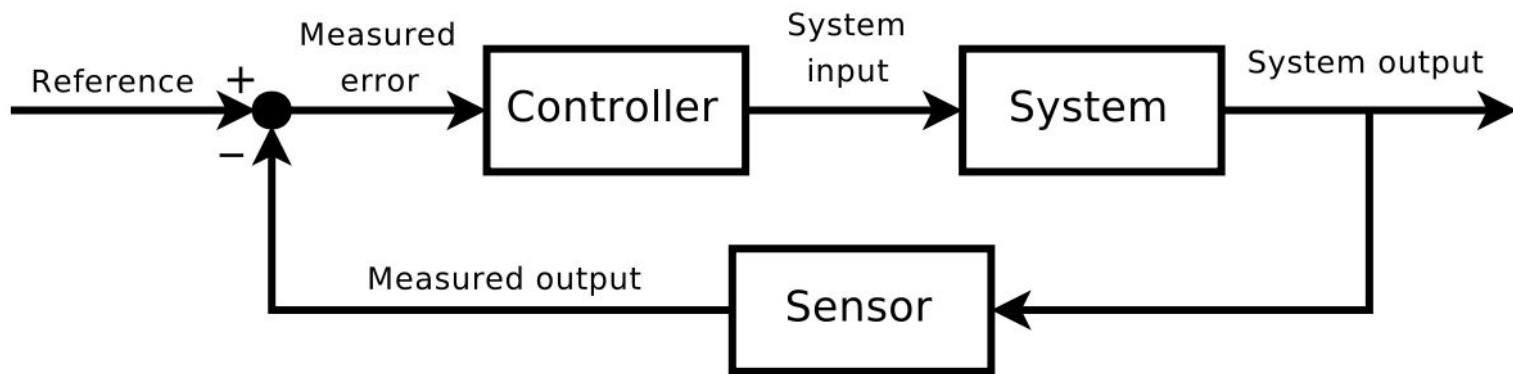
**8 Consistently  
available**

# What storage should I use with Kubernetes?



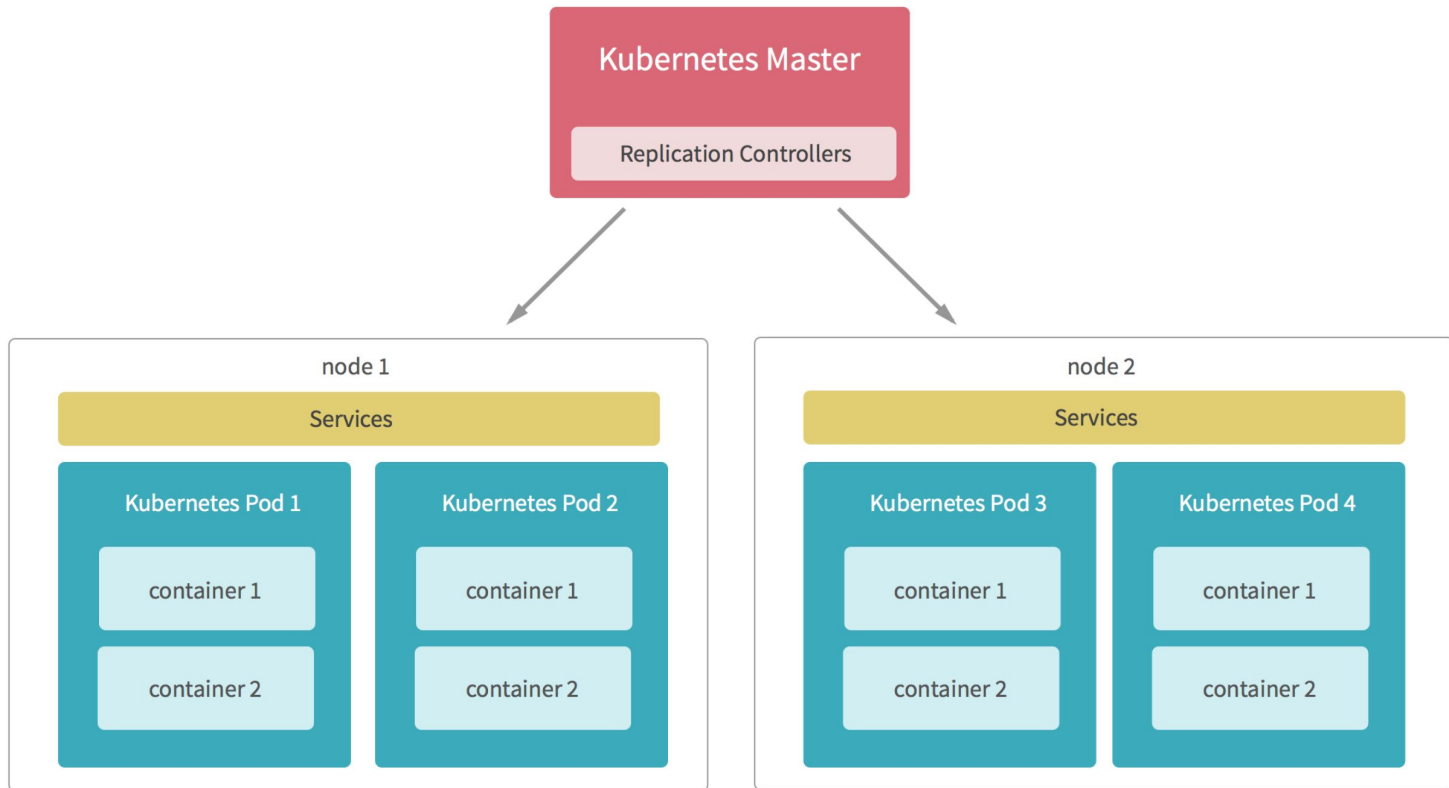
- An open source container orchestrator platform, originally developed by Google
- One of the fastest moving projects in open source
- Abstraction layer for infrastructure in a cluster
- “The Linux of the cloud”

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



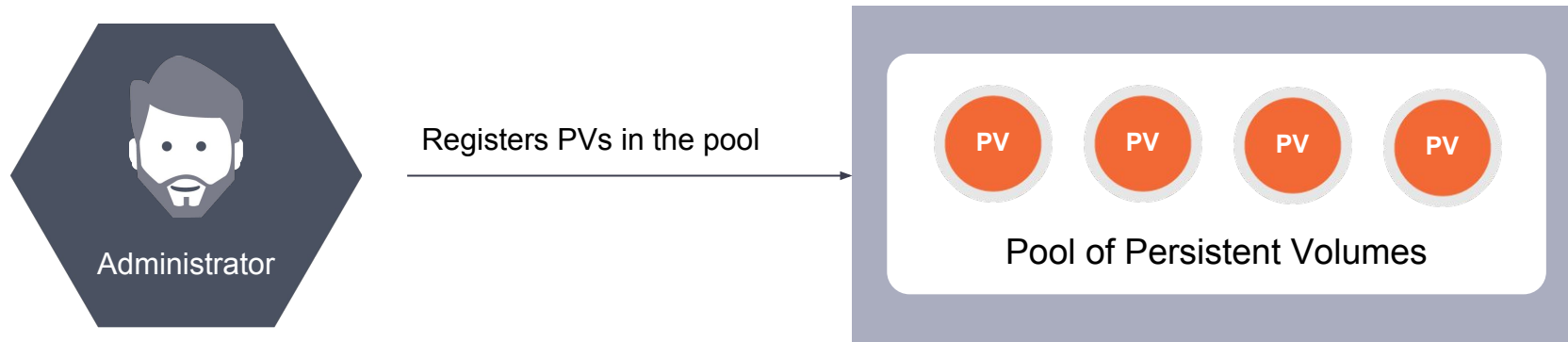
# Extremely quick intro to Kubernetes

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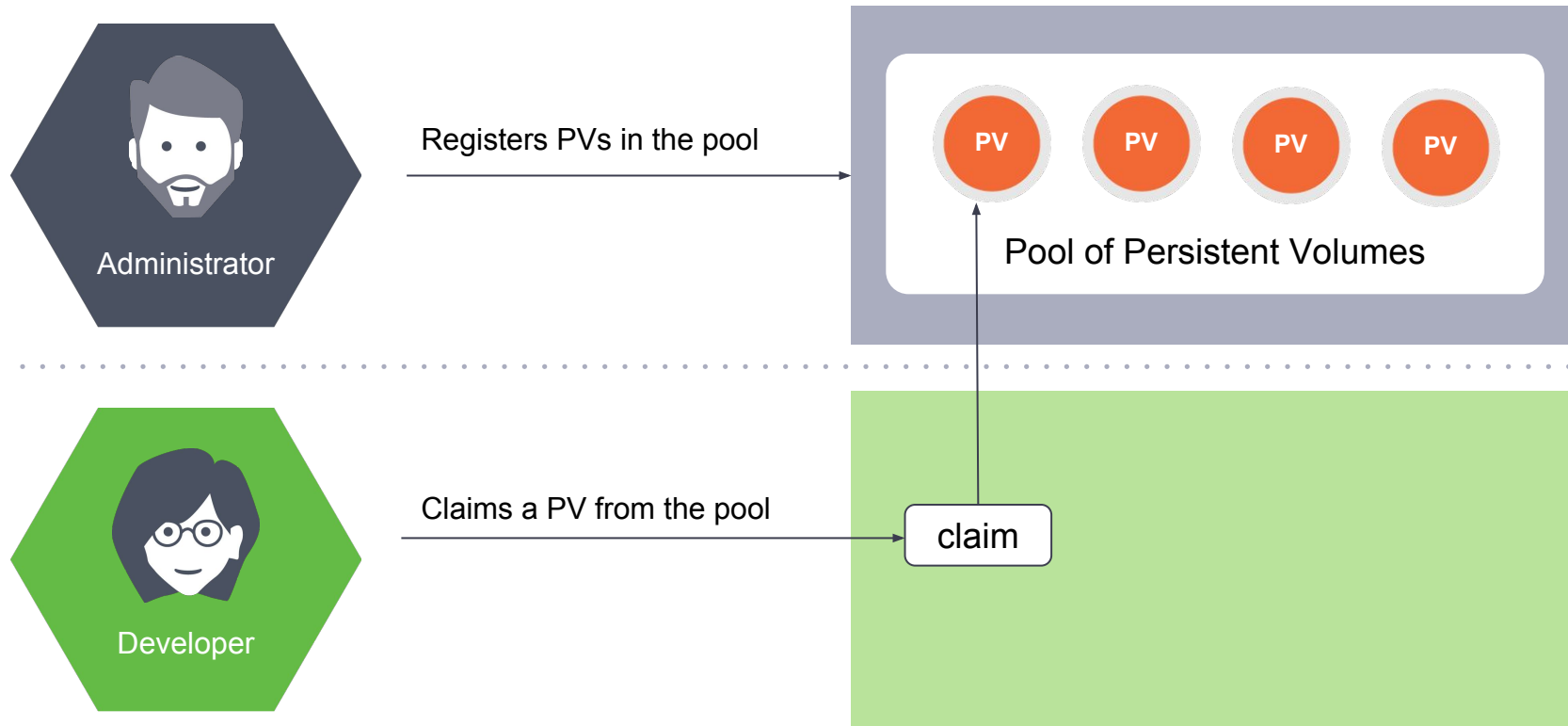
# Kubernetes Storage Model: Persistent Volumes and Claims

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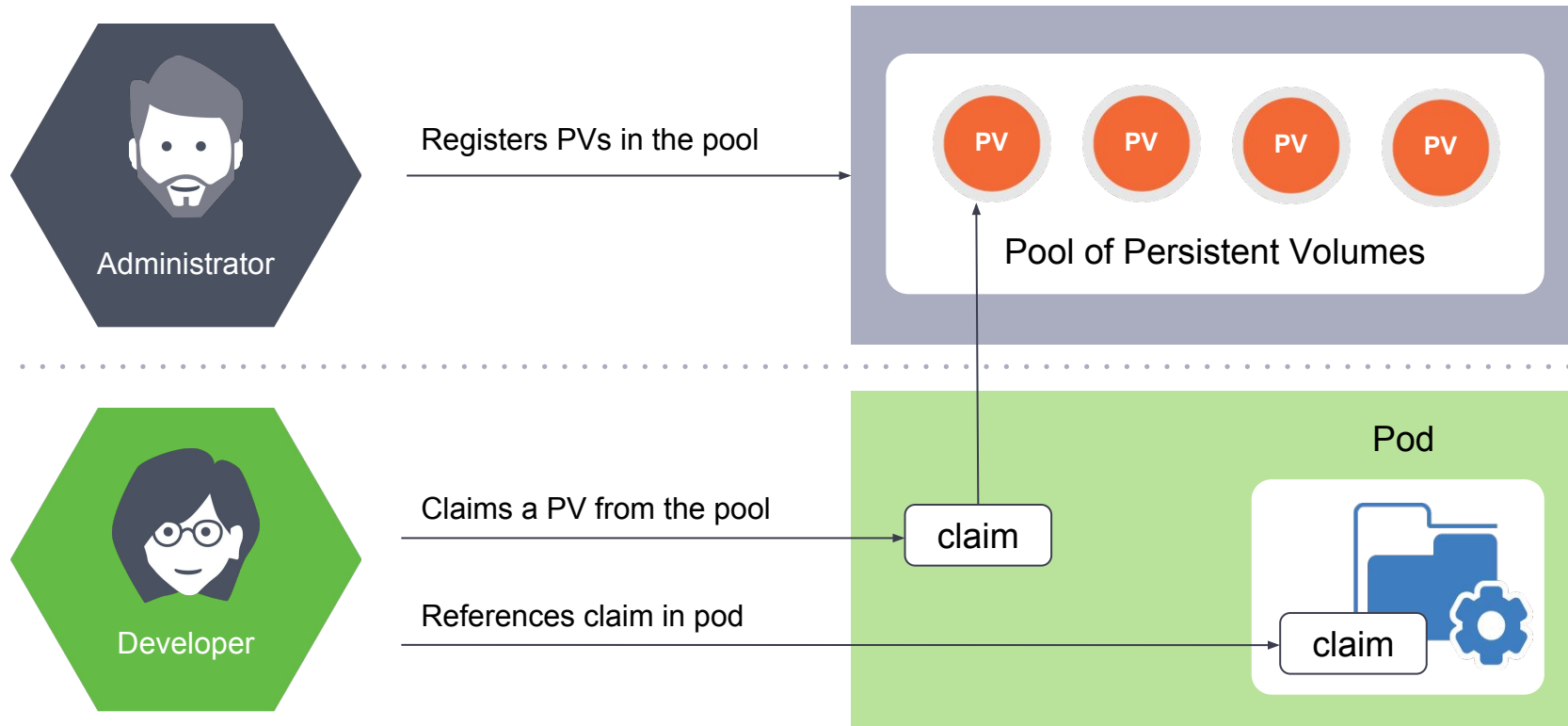
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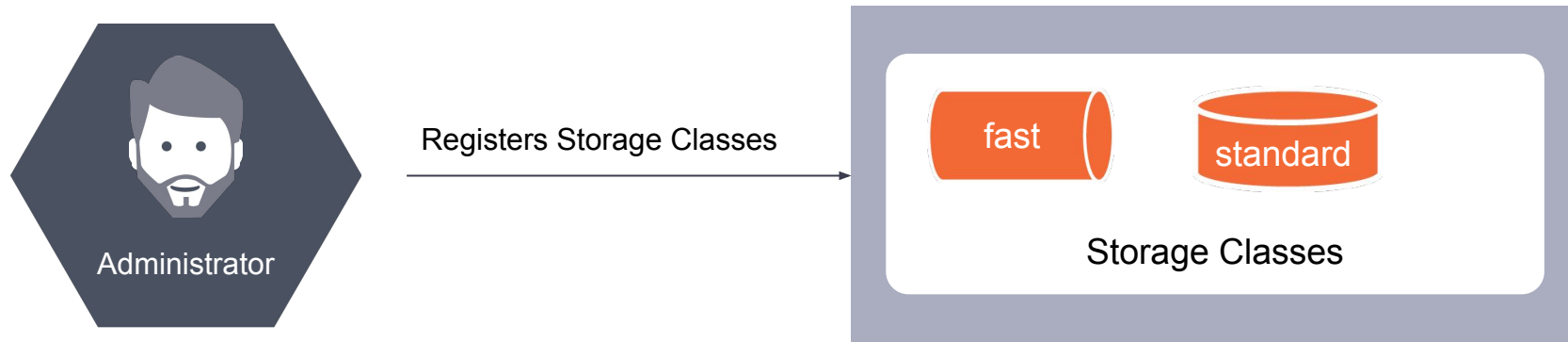
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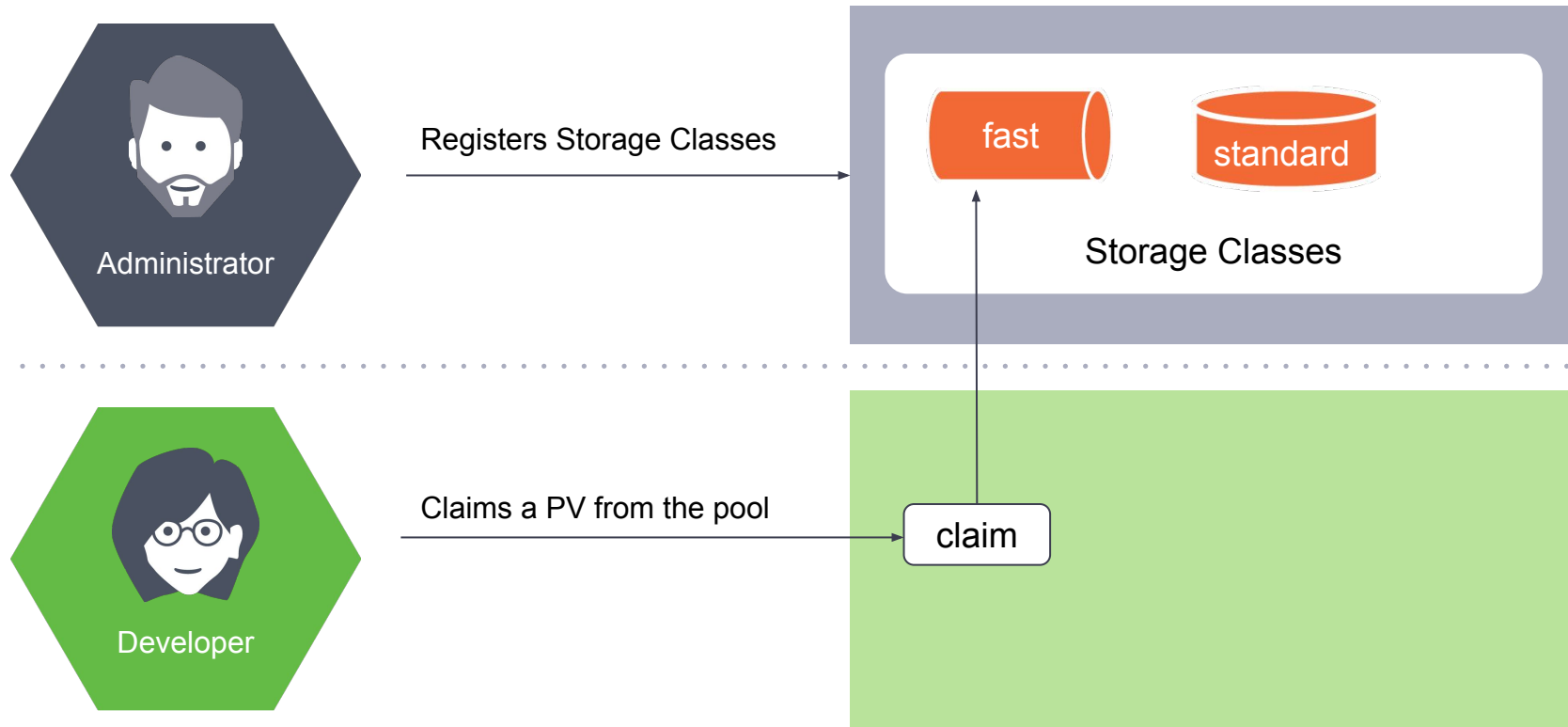
# Dynamic provisioning with Storage Classes

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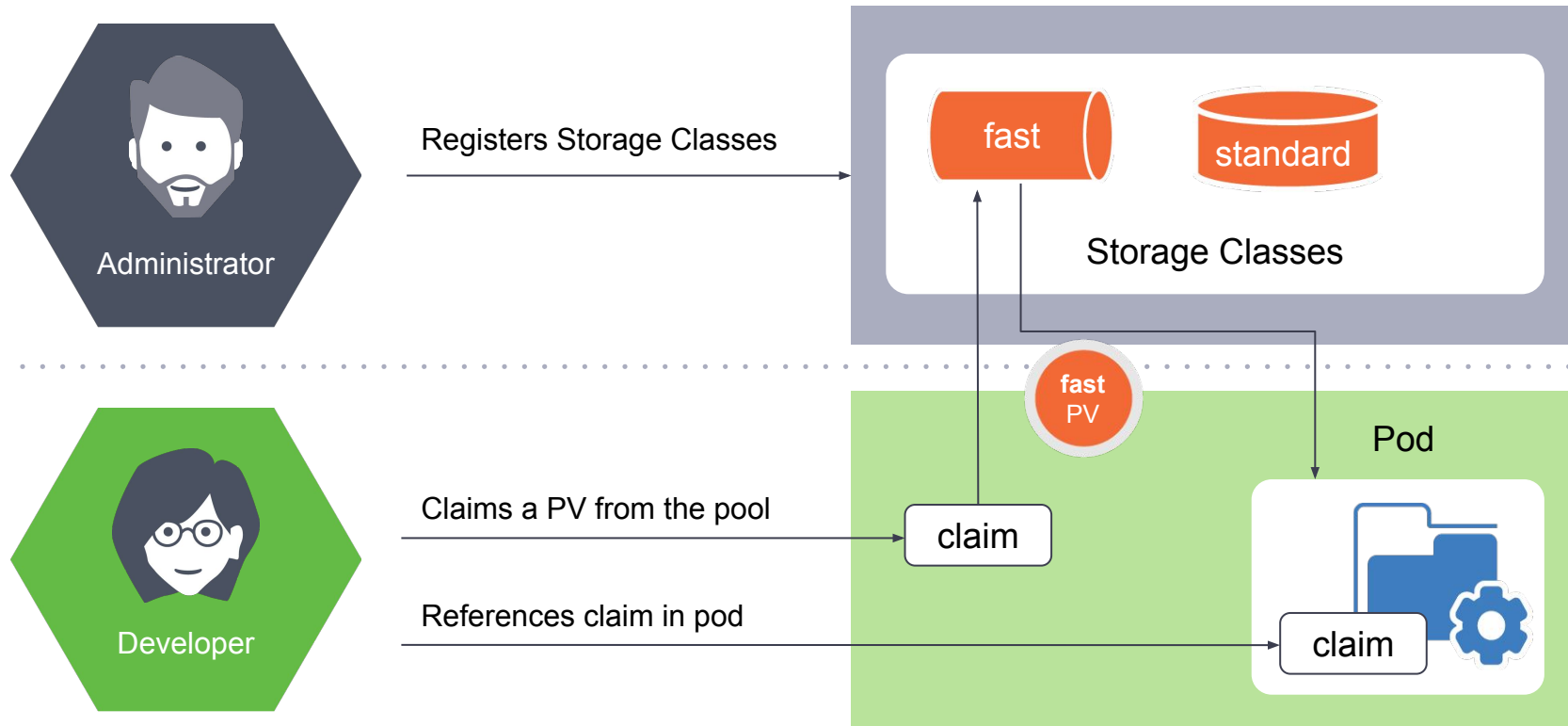
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# Dynamic provisioning with Storage Classes

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A DevOps engineer at a media company

Needs to migrate client Wordpress websites into Kubernetes

What storage does she need?

# 1. What is my use case?

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**App binaries**



**App data**



**Config**



**Backup**

## 2. What are my performance requirements?

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**App binaries**  
Ephemeral



**App data**  
Latency,  
availability,  
performant



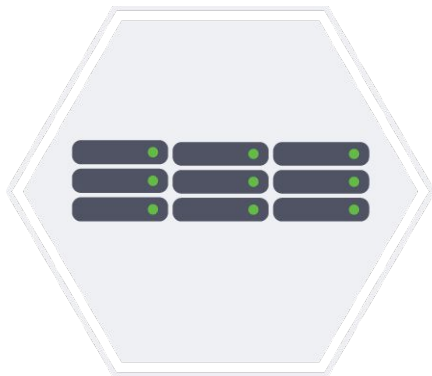
**Config**  
Shared



**Backup**  
Cost efficient,  
cloud

### 3. How should developers access storage?

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#### **Block**

Fixed-size 'blocks' in a rigid arrangement – ideal for enterprise databases



#### **File**

'Files' in hierarchically nested 'folders' – ideal for active documents

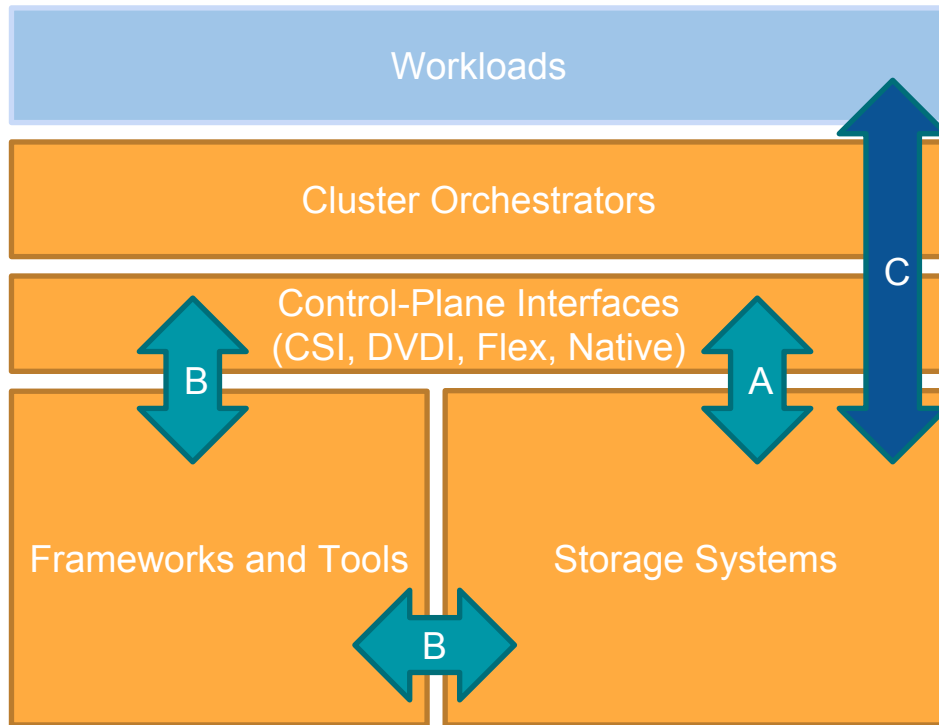


#### **Object**

'Objects' in scalable 'buckets' – ideal for unstructured big data and archiving

## 4. Where is the storage deployed and managed?

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- 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



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

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



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)

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

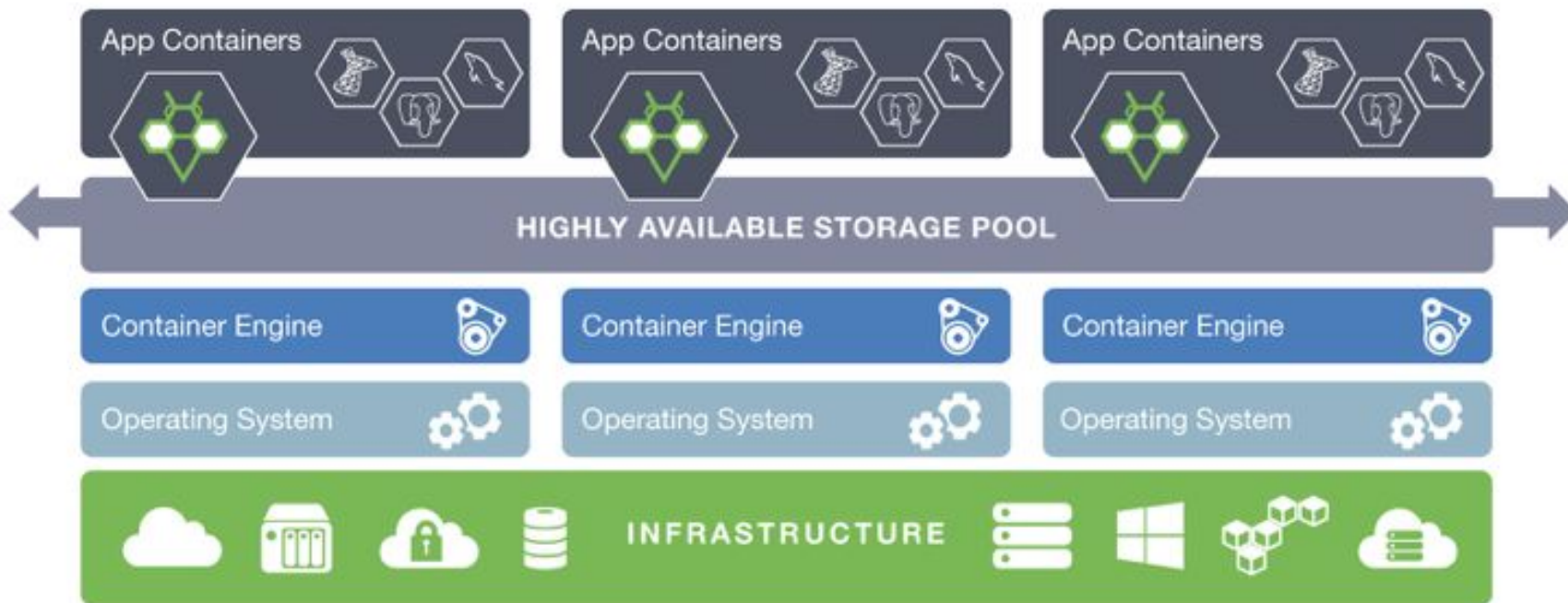
**Cloud:** Managed object store, long term cold storage

**On prem:** Object store (not NAS)

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

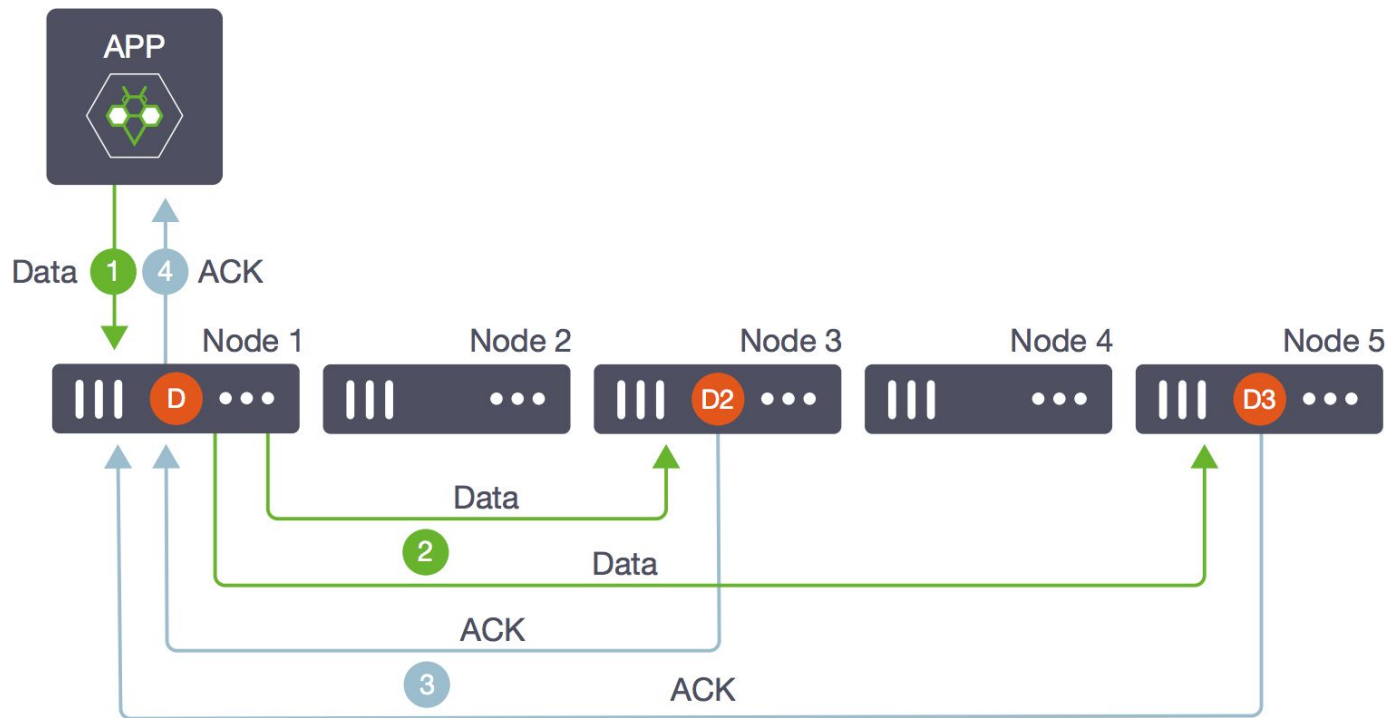




**KEEP  
CALM  
IT IS  
DEMO  
TIME**

# High availability with StorageOS

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# To Recap...



**1 Application  
centric**

**5 Natively  
secure**

**2 Platform  
agnostic**

**6 Agile**

**3 Declarative/  
composable**

**7 Performant**

**4 API driven**

**8 Consistently  
available**

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







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.

## Browser-based tutorials

- [demo.storageos.cloud](https://demo.storageos.cloud)

## Quickstart

- [storageos.com/kubernetes](https://storageos.com/kubernetes)





# Thanks

Slides at [oicheryl.com](https://oicheryl.com)

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



# What is StorageOS?

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Platform  
agnostic

Horizontally  
scalable

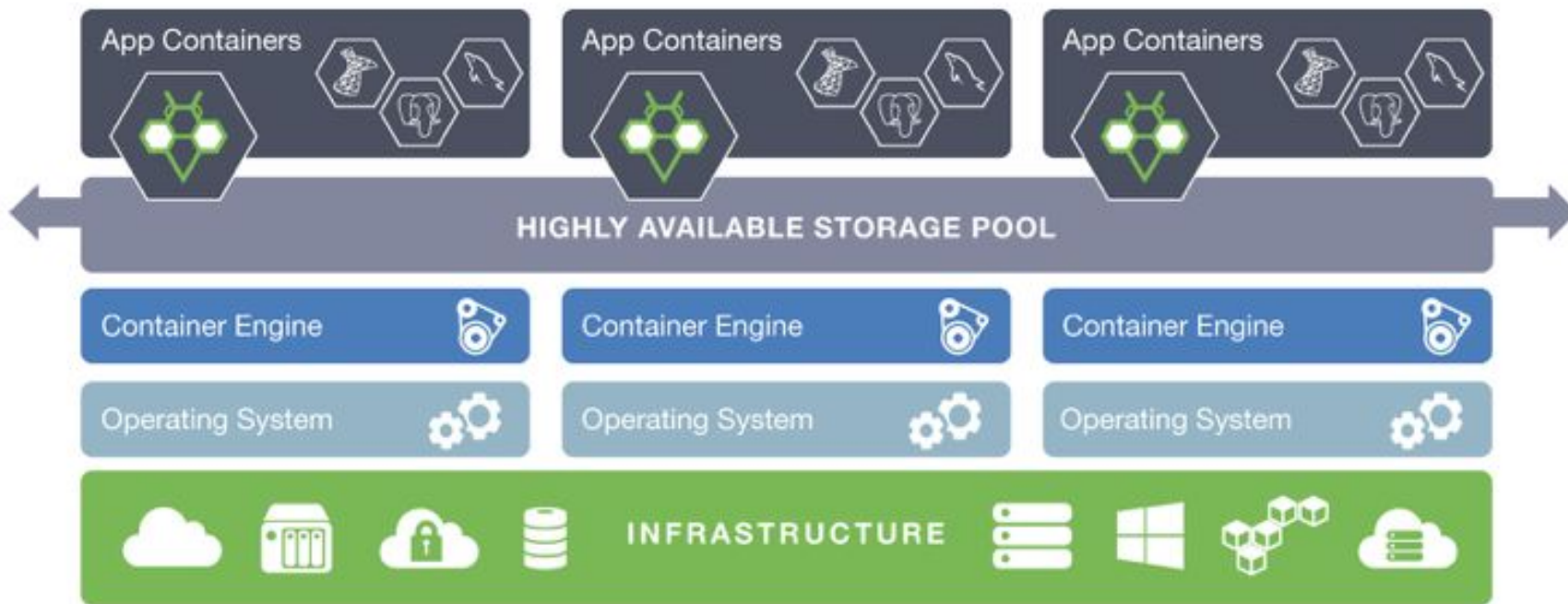
Stateful workloads  
eg. database

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

Docker/K8s  
integration

High  
availability





StorageOS 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.

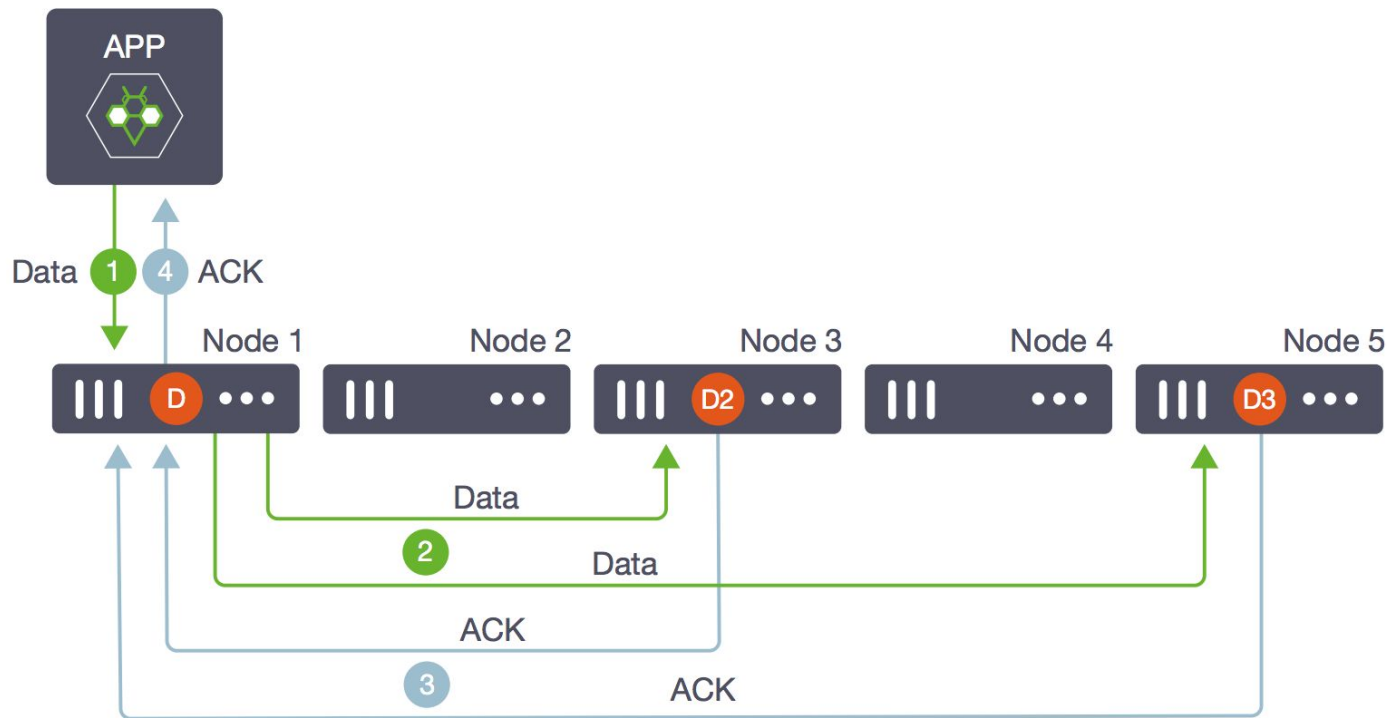
1. Nodes contribute local block storage to the storage pool.
2. Virtual volumes (block storage formatted with a standard filesystem) are created through the [StorageOS volume plugin](#).
3. Any pods can mount the virtual volumes from any node. If a pod is rescheduled to a different node, StorageOS simply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

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

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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

## More reading

Download the technical architecture overview at [storageos.com/storageos-platform-architecture-overview](https://storageos.com/storageos-platform-architecture-overview).

Try out in your browser, with zero downloads or configuration: [demo.storageos.cloud](https://demo.storageos.cloud)

Full documentation at [docs.storageos.com](https://docs.storageos.com).