Let’s decompose storage (again)

Why? How? Huh?

MSST May 17 2017

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blog.openebs.io

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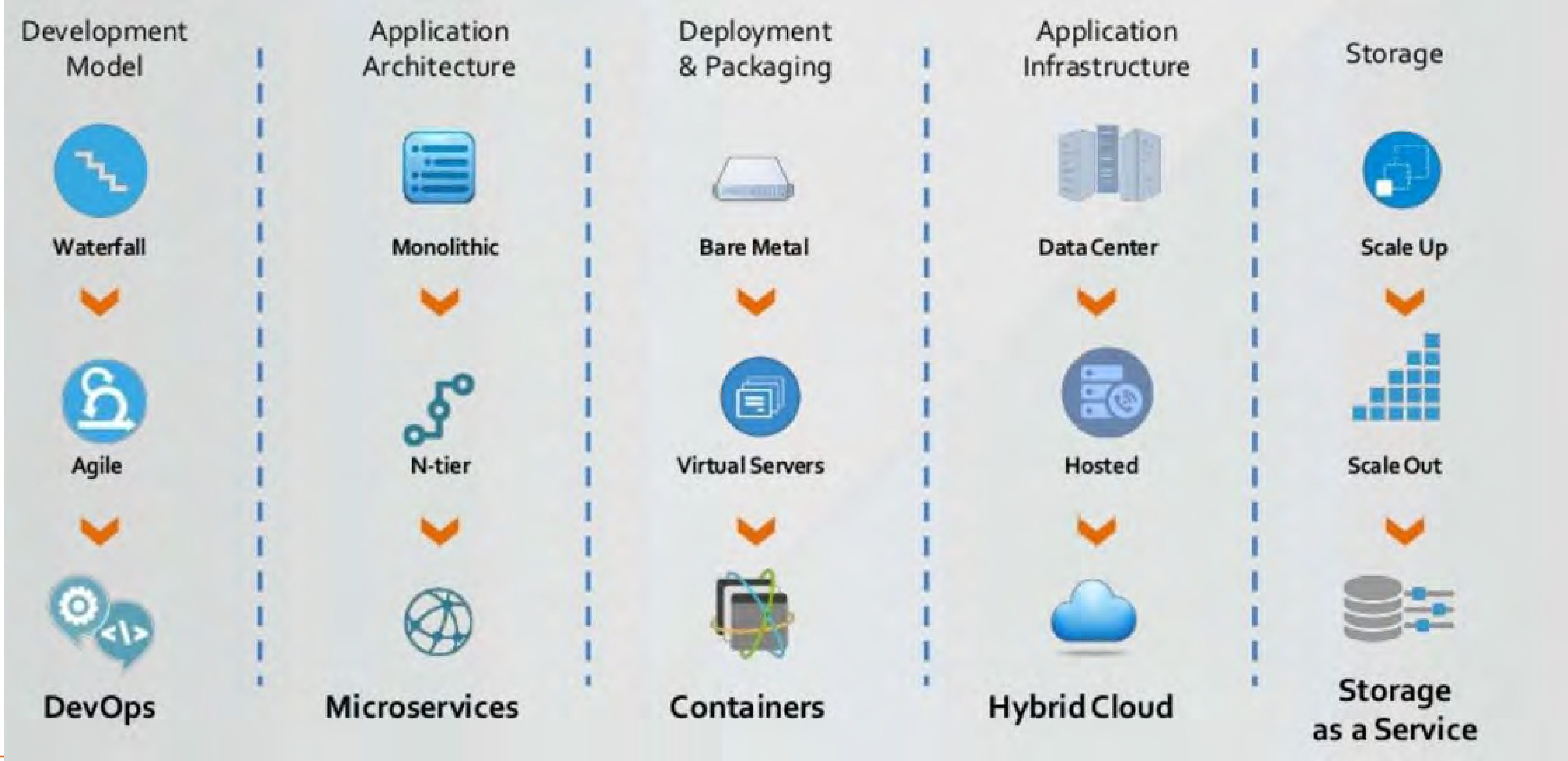
What’s new?



Development Model	Application Architecture	Deployment & Packaging	Application Infrastructure	Storage
Waterfall	Monolithic	Bare Metal	Data Center	Scale Up
Agile	N-tier	Virtual Servers	Hosted	Scale Out
DevOps	Microservices	Containers	Hybrid Cloud	Storage as a Service

http://www.slideshare.net/ColleenCorrice/persistent-storage-for-containerized-applications

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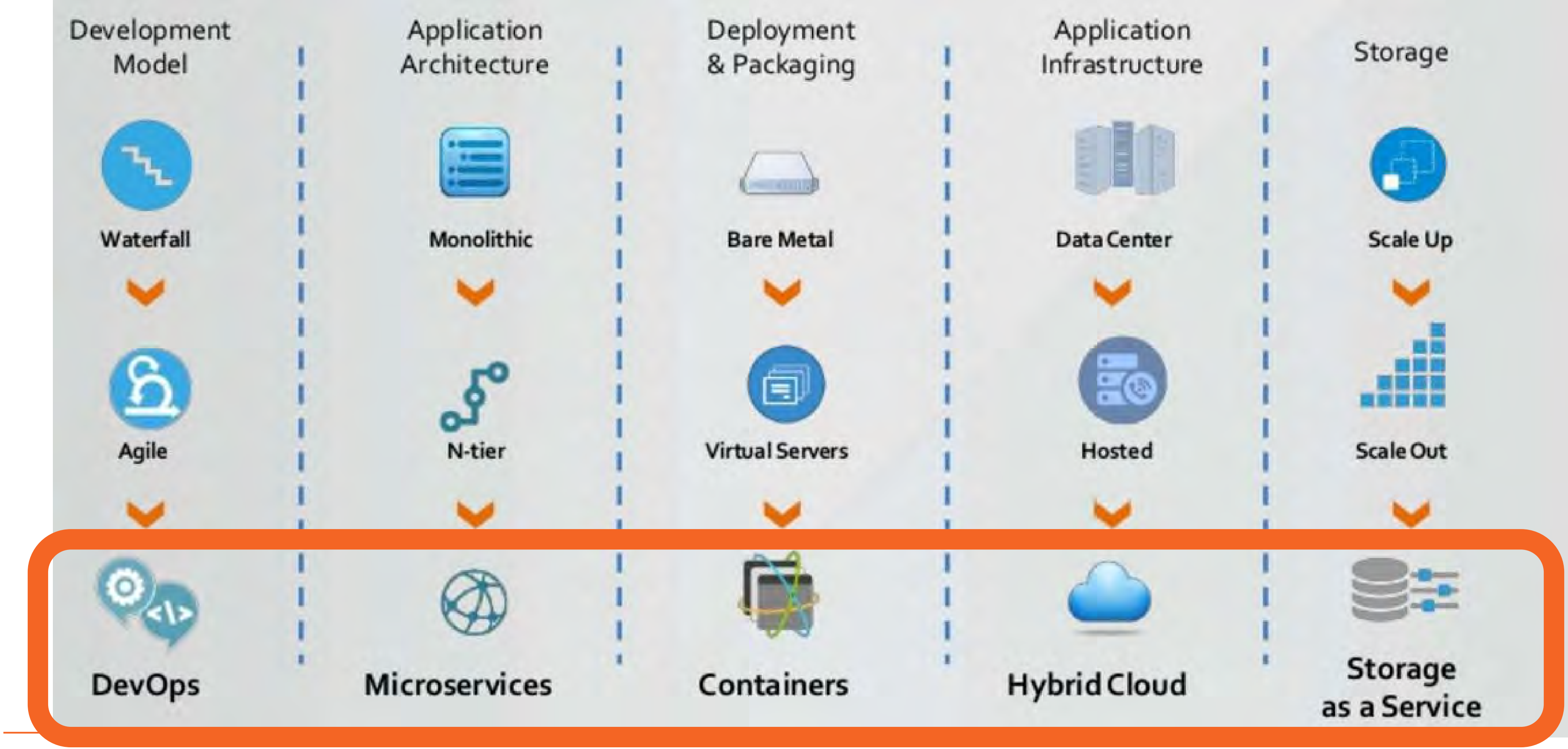

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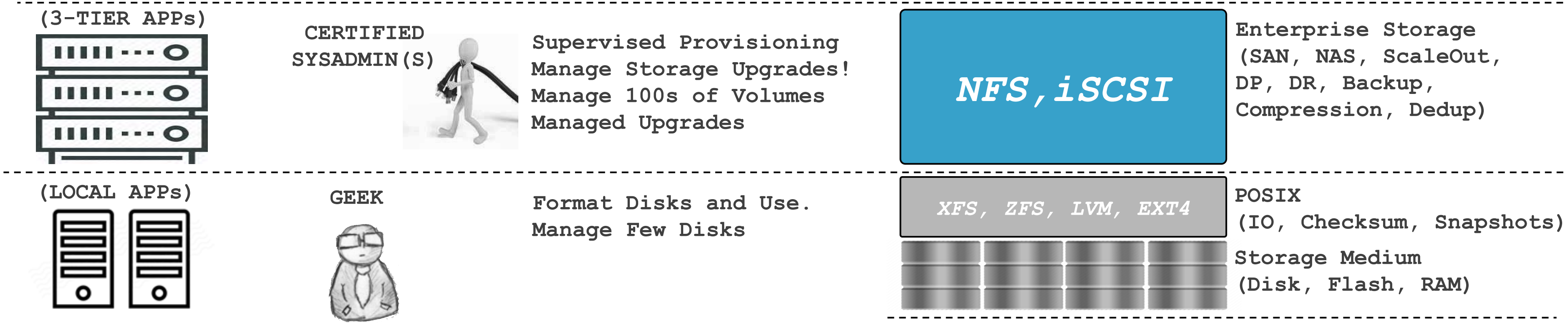
Layering



(3-TIER APPs)	CERTIFIED SYSADMIN(S)	Supervised Provisioning Manage Storage Upgrades! Manage 100s of Volumes Managed Upgrades	*NFS,iSCSI*	Enterprise Storage (SAN, NAS, ScaleOut, DP, DR, Backup, Compression, Dedup)
(LOCAL APPs)	GEEK	Format Disks and Use. Manage Few Disks	*XFS, ZFS, LVM, EXT4*	POSIX (IO, Checksum, Snapshots)
				Storage Medium (Disk, Flash, RAM)

Layering

(MICRO APPS)	DEVOPS AT SPEED	Auto-magically Provisioned Auto-managed Storage(ML) Data Mobility Manage Millions of Volumes Seamless Upgrades	*OpenEBS*	Containerized Storage (Hyper-Converged, Auto-Scaling, Auto-Upgradable, Yaml Driven)
(CLOUD SERVICE)	PAAS ADMINs	Auto-Provisioned Delegated Administration Manage Shared Infra Manage 1000s of Volumes Scheduled Upgrades	*OpenStack Cinder, VASA*	Cloud Storage - SDS (Public, Private, Hybrid)
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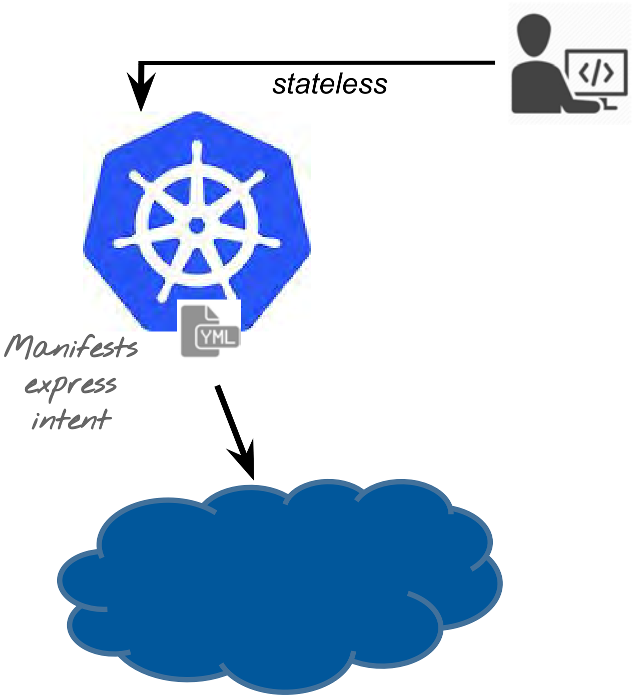
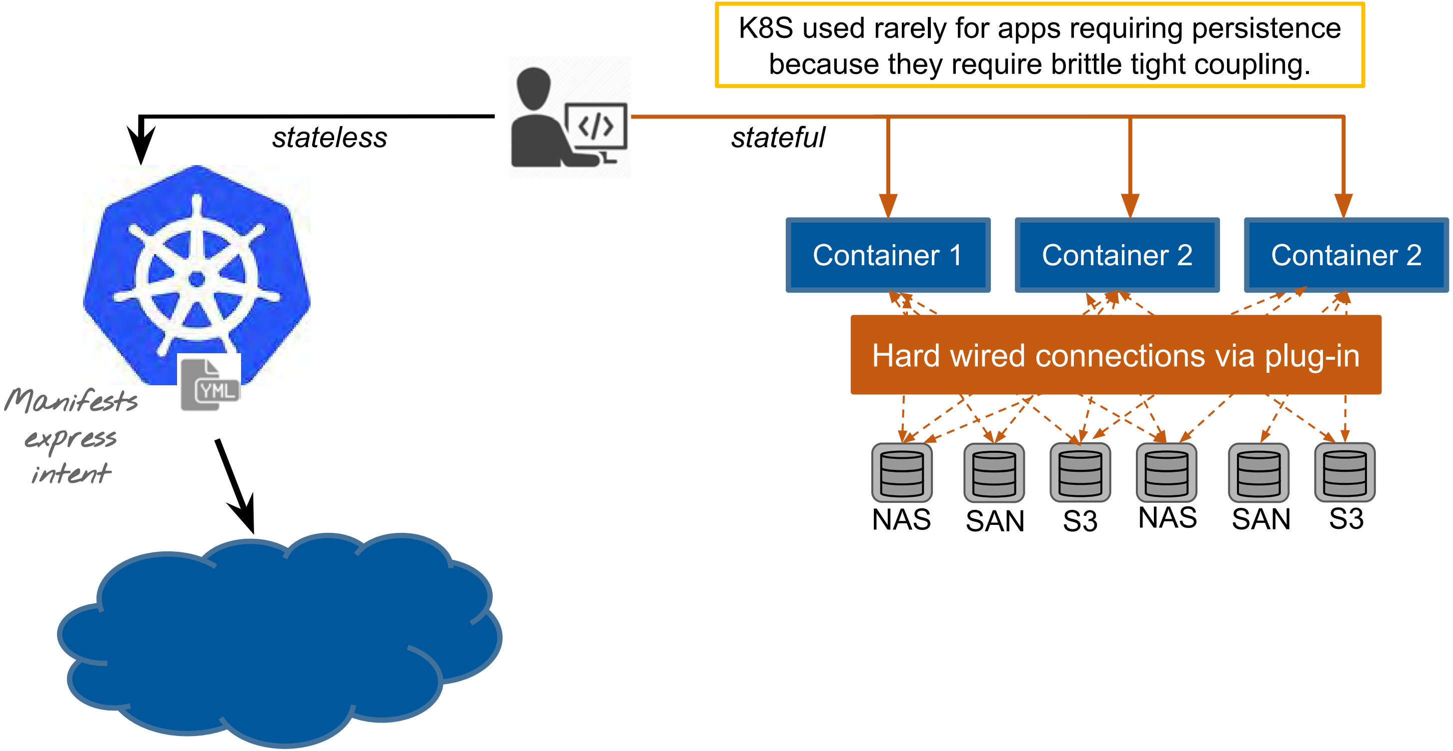
OpenSource Technology Stack

Happy days!



Painful persistence



K8S used rarely for apps requiring persistence because they require brittle tight coupling.

stateless

stateful

Manifests express intent

YML

Container 1

Container 2

Container 2

Hard wired connections via plug-in

NAS

SAN

S3

NAS

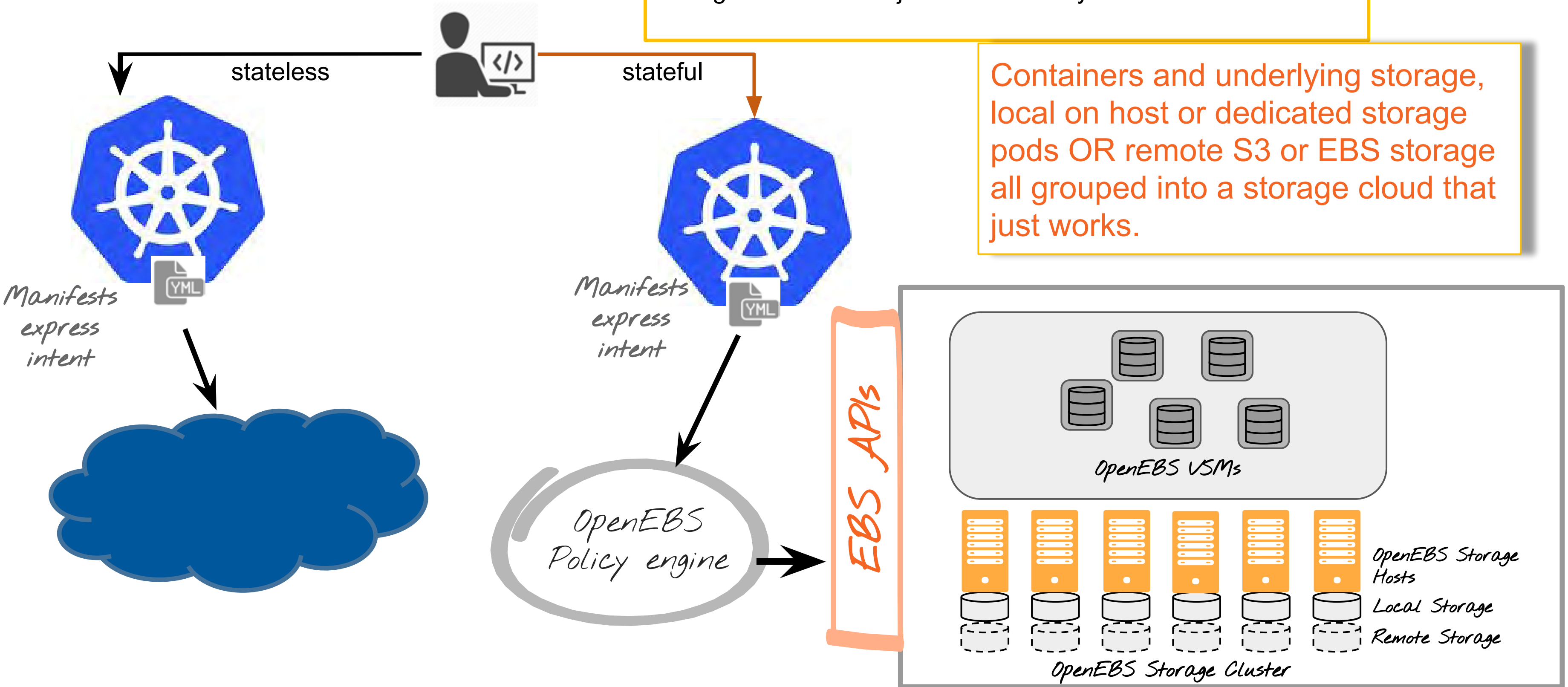
SAN

S3

Desired state of state

No changes to DevOps workflow even for containers requiring persistence. Users manifest their intent and the storage and storage controllers adjust automatically as needed.

Containers and underlying storage, local on host or dedicated storage pods OR remote S3 or EBS storage all grouped into a storage cloud that just works.



stateless

stateful

Architecture and Design

- Powered by Linux, Go and OpenSource
- Built and Delivered as Containers / Micro-services
- Longhorn, Gotgt, Kubernetes, Consul

Design Goals and Constraints

Fault tolerant and secure by default

Low entry barrier, easy to setup

Storage optimized for Containerized Applications

Horizontally scalable to millions of Containers

Seamless integration into existing private and public cloud environments

Non-disruptive upgrades

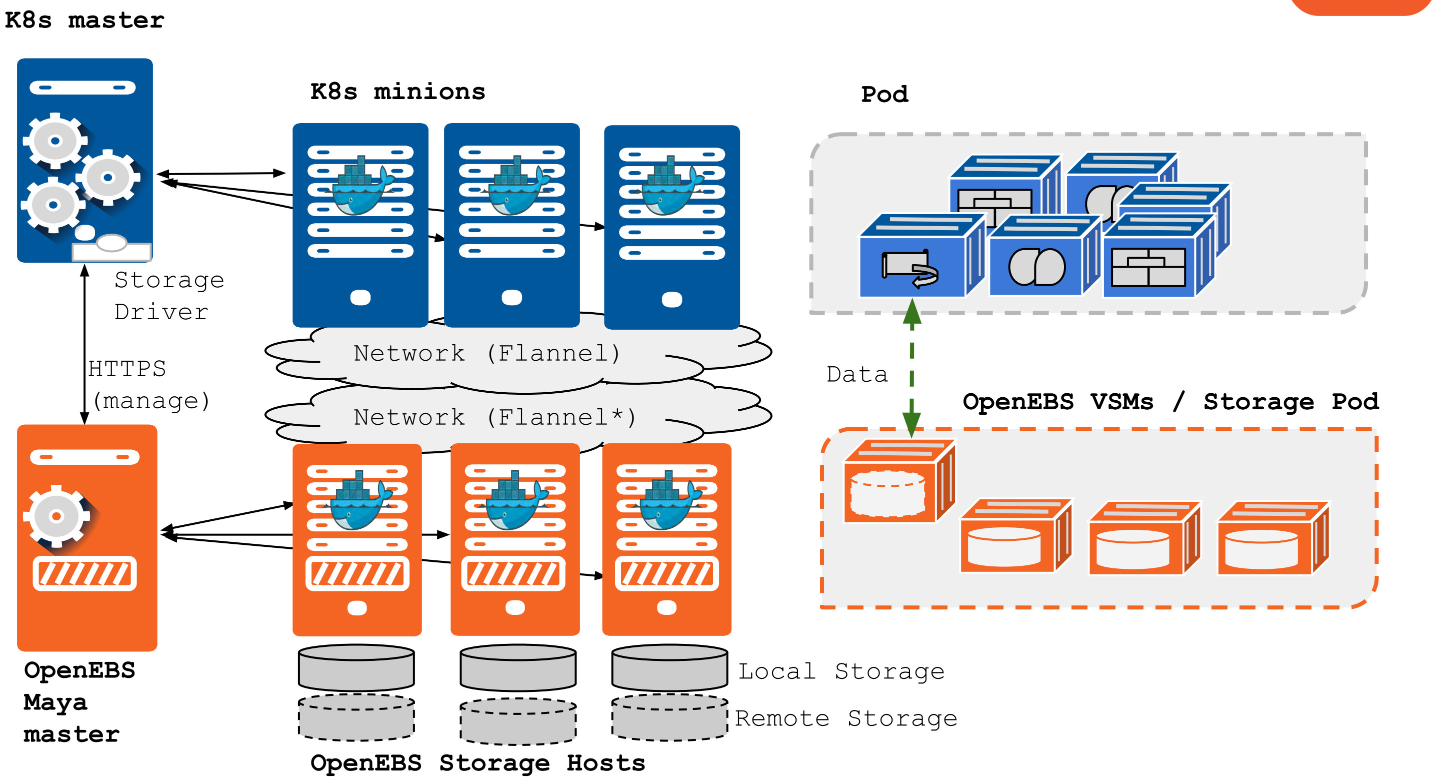
Developer and Operators Friendly

Completely OpenSource (Apache license)

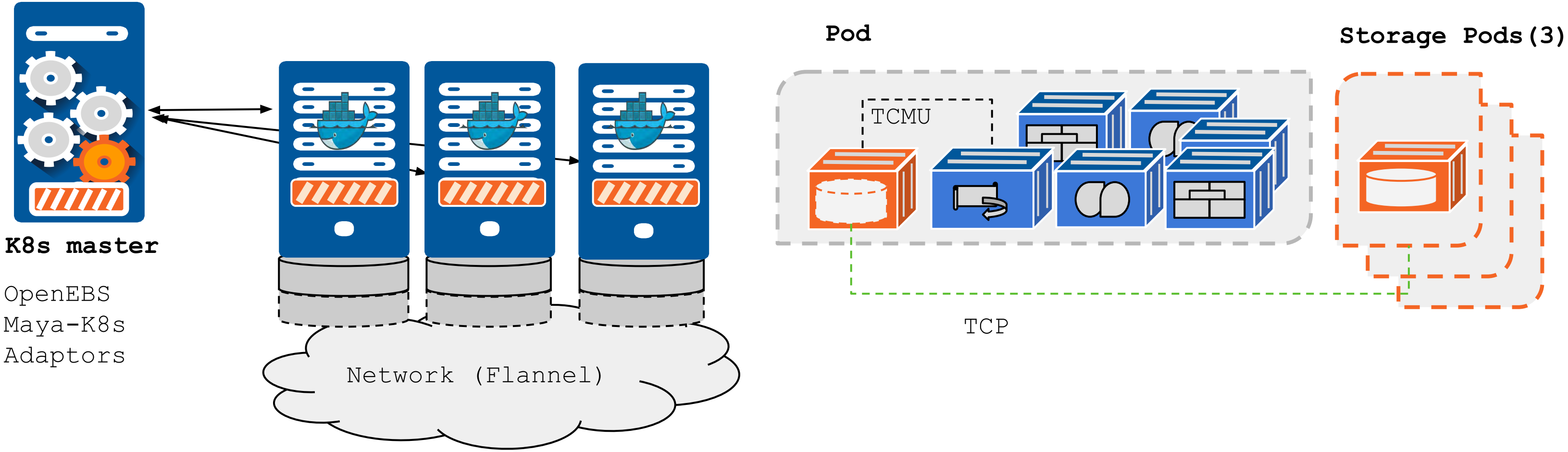
Microservices based

DevOps architecture

Overview & Terminology



Deployment - Hyper-Converged



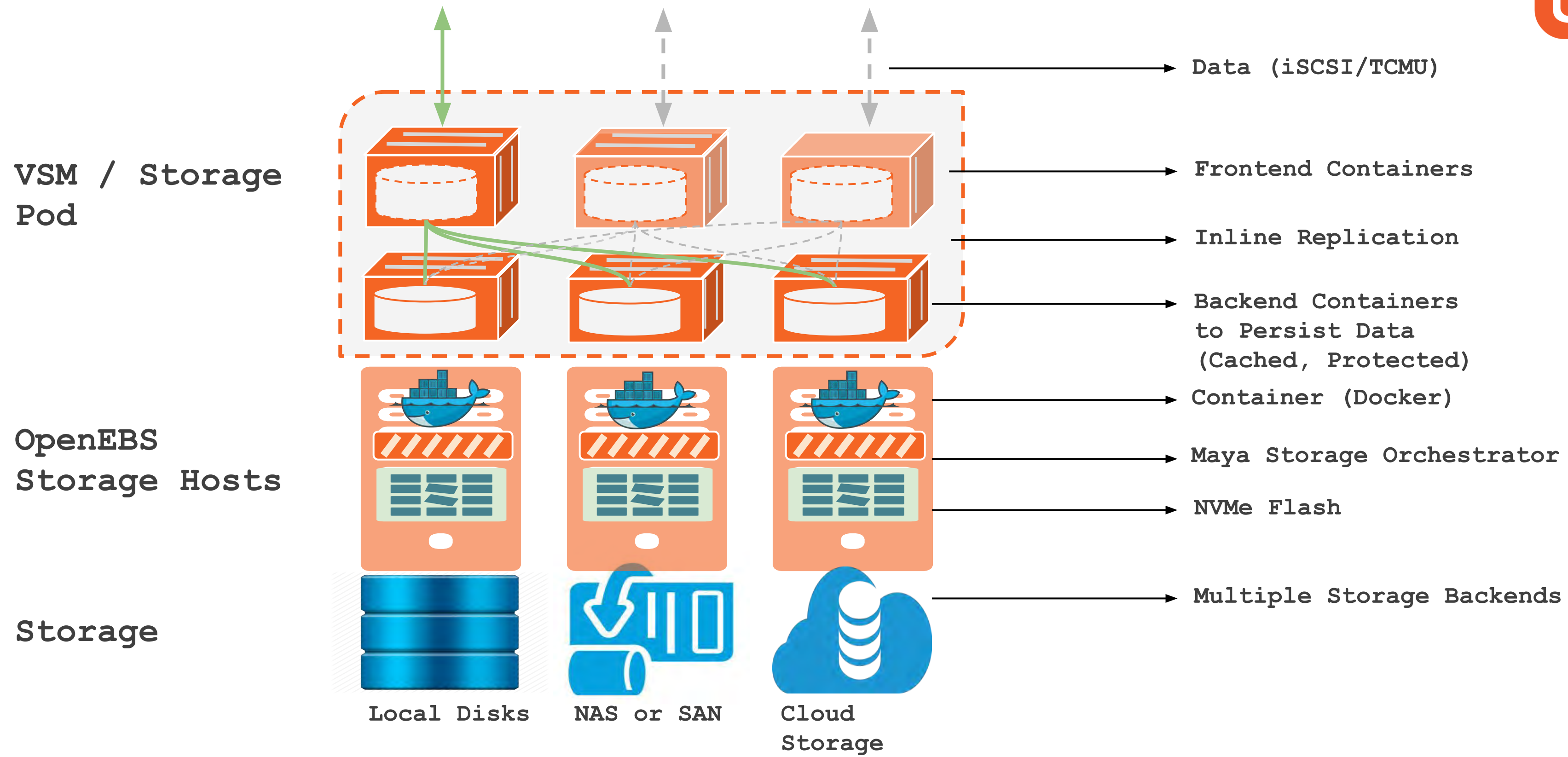
K8s master

OpenEBS
Maya-K8s
Adaptors

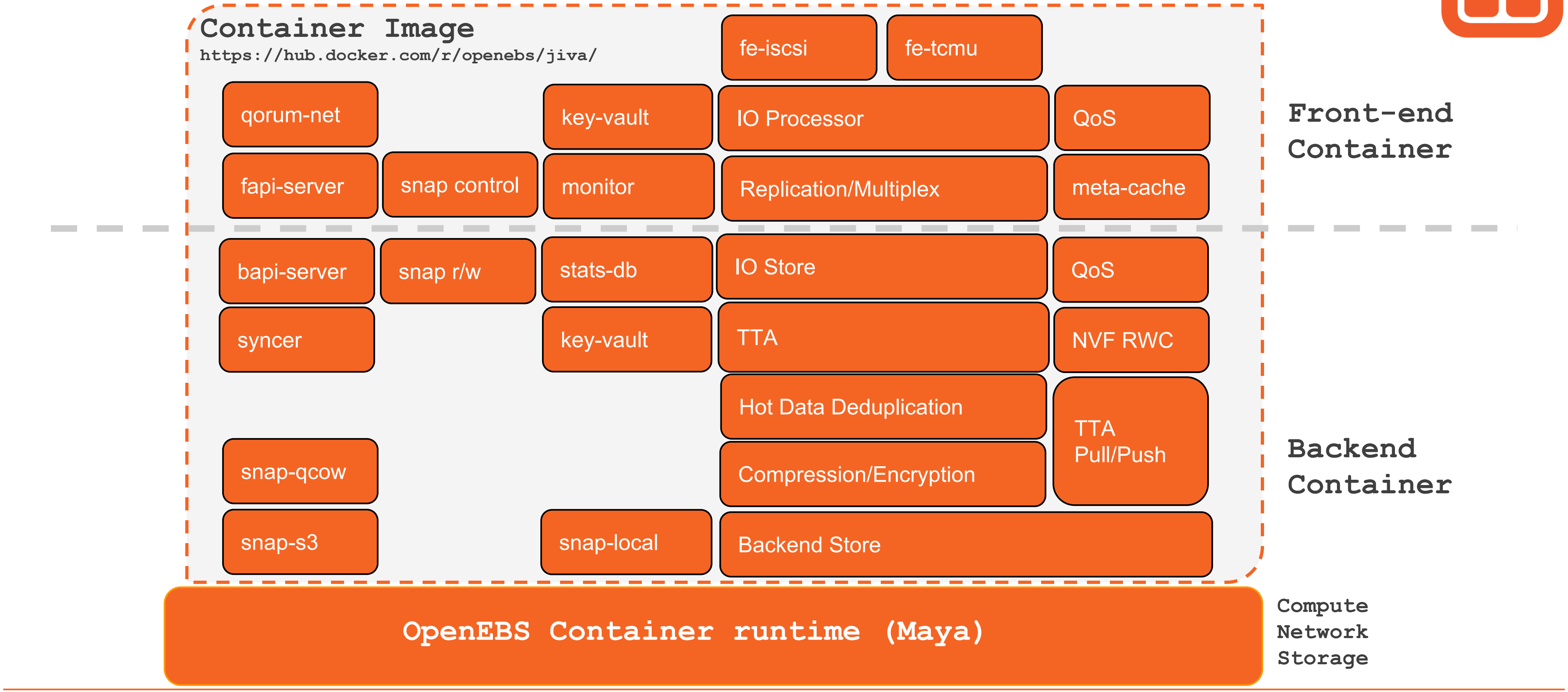
K8s minions

OpenEBS Maya Storage
Orchestrator

VSM - Storage in Containers



Jiva - Containerized Storage Image



Container Image

https://hub.docker.com/r/openebs/jiva/

fe-iscsi

fe-tcmu

qorum-net

key-vault

IO Processor

QoS

fapi-server

snap control

monitor

Replication/Multiplex

meta-cache

Front-end Container

bapi-server

snap r/w

stats-db

IO Store

QoS

syncer

key-vault

TTA

NVF RWC

Hot Data Deduplication

TTA Pull/Push

Compression/Encryption

snap-qcow

snap-s3

snap-local

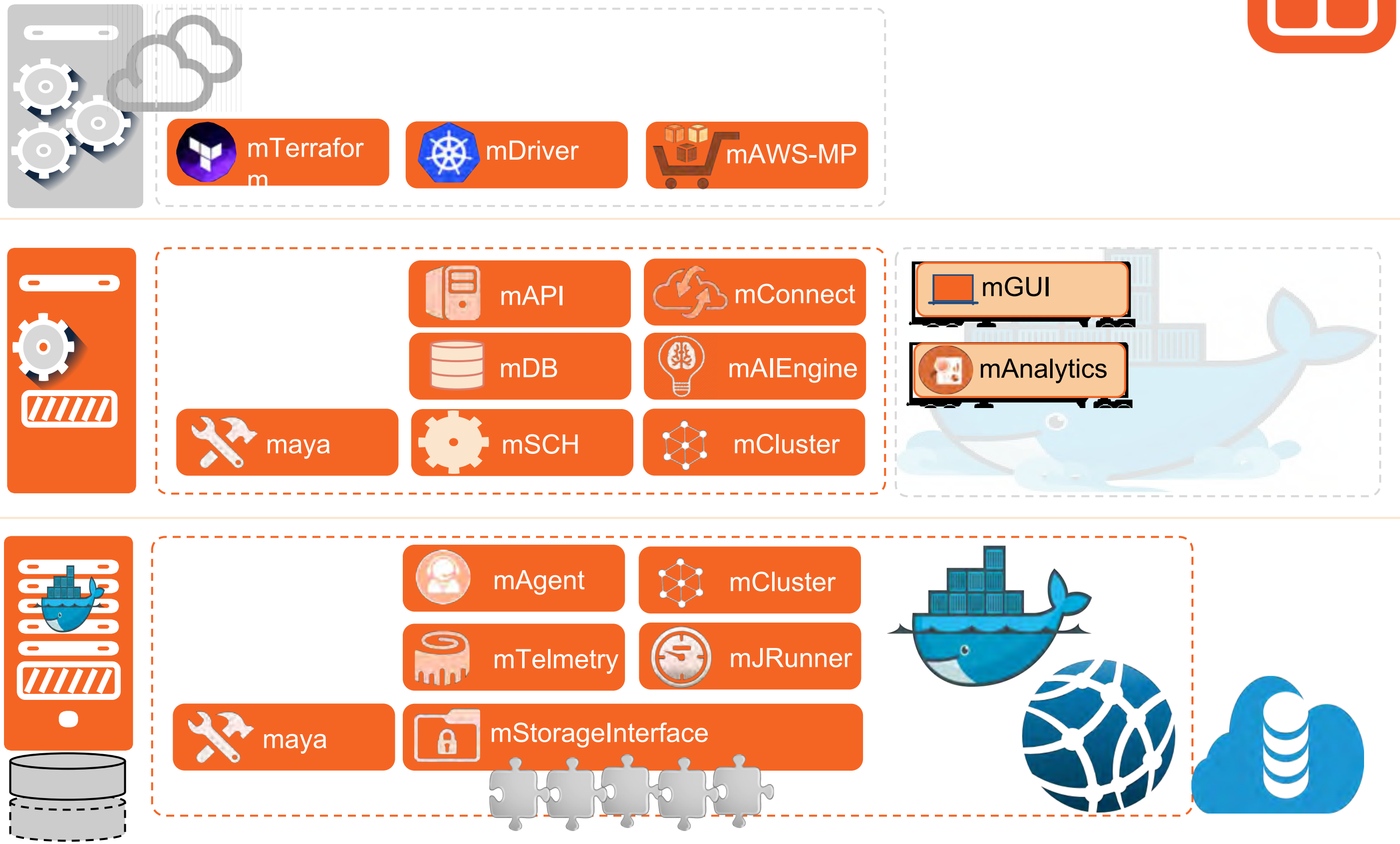
Backend Store

Backend Container

OpenEBS Container runtime (Maya)

Compute
Network
Storage

Maya - Container Storage Orchestration



Integrations

mTerraform

mDriver

mAWS-MP

OpenEBS Maya Master

mAPI

mConnect

mDB

mAIEngine

maya

mSCH

mCluster

mGUI

mAnalytics

OpenEBS Storage Host

mAgent

mCluster

mTelmetry

mJRunner

maya

mStorageInterface

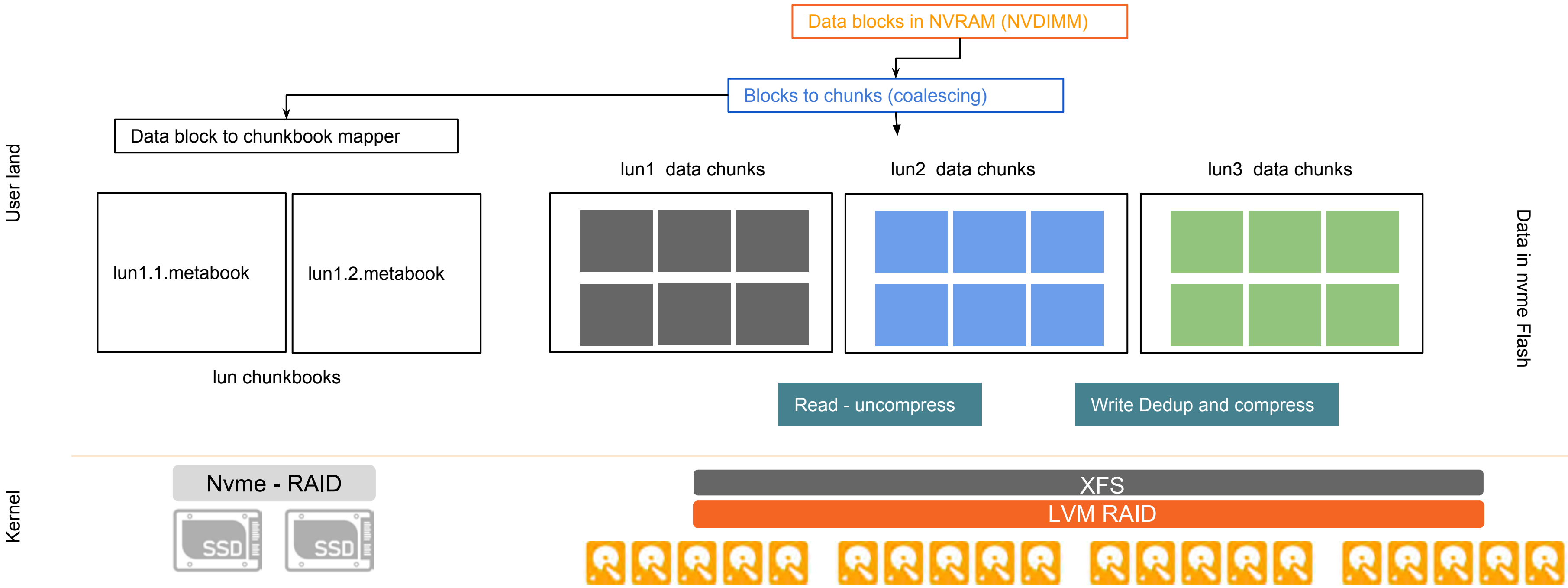
Storage Internals

- Capacity Management
- QoS
- Access - iSCSI, TCMU
- Snapshot / Restore (S3)
- Backup / Migration
- Caching/Tiering
- Replication / Rebuild

OpenEBS - Core differentiations

- The block storage software is made into a micro service
- The ‘micro service’ has its own block protocol stack, tiering engine, QoS engine and ML prediction capability
- The block storage knowledge is maintained on a per-volume basis. The data of each volume is divided into cold-data and hot-data. Cold-data resides on NVMe-Flash or on 3DX-Memory. Hot-data resides in slower disks / SAN/ Cloud-Storage/S3
- The metadata knowledge also is maintained at a volume level (not the entire storage). This saves us from the issue of huge-metadata-sifting at scale. The traversal through meta-data depends on the “size of the volume” and not on the “number of volumes”.
- Within the volume the meta data is not managed at “block-level” but at “chunk-level”. Typical block-size is 4KB and Typical chunk-size is 4 MB. This results in the huge reduction of metadata size of the block-volume that needs to be maintained.
- Checksum - One of the important metadata is checksum. OpenEBS guarantees bit-rot protection through the use of checksums. The checksums are managed at a chunk level only on Cold-Data. The checksums are not managed on hot-data, the blocks go in and out of chunks on the hot-data without the need of checksum calculation on the fly.
- Deduplication-while-tiering: Deduplication has capacity benefits but kills performance (either inline or offline). But in OpenEBS, we do this while moving the data from hot-to-cold tiers. In effect, the benefits of deduplication without the performance penalty.

Cchchchcunking


Data blocks in NVRAM (NVDIMM)

Blocks to chunks (coalescing)

Data block to chunkbook mapper

User land

lun1.1.metabook

lun1.2.metabook

lun chunkbooks

lun1 data chunks

lun2 data chunks

lun3 data chunks

Data in nvme Flash

Read - uncompress

Write Dedup and compress

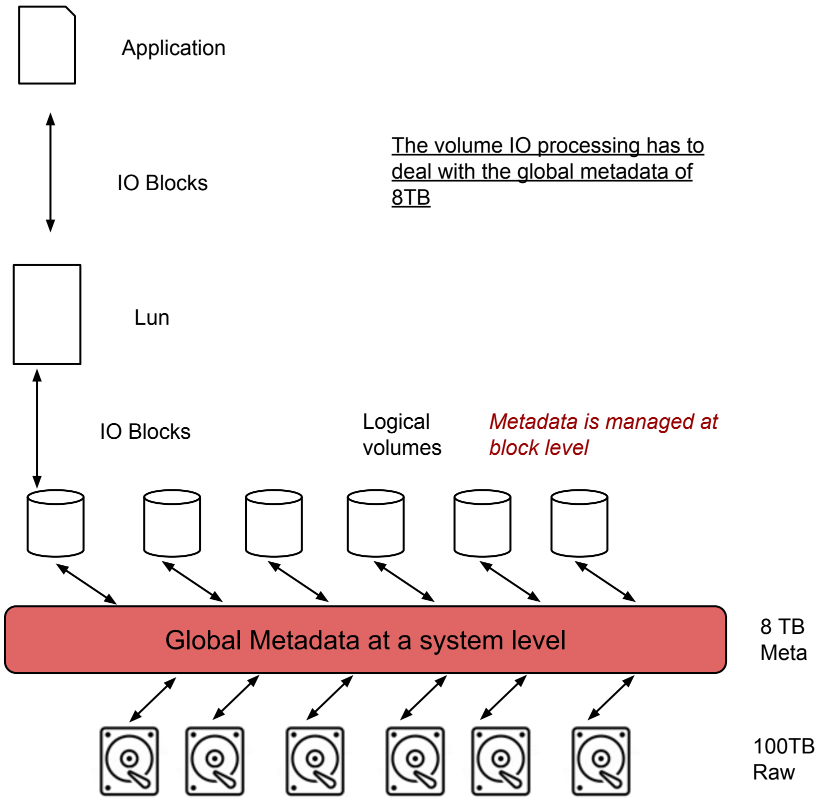
Kernel

Nvme - RAID

XFS

LVM RAID

OpenEBS - Metadata at scale is not an issue



Application

IO Blocks

Lun

IO Blocks

Logical volumes

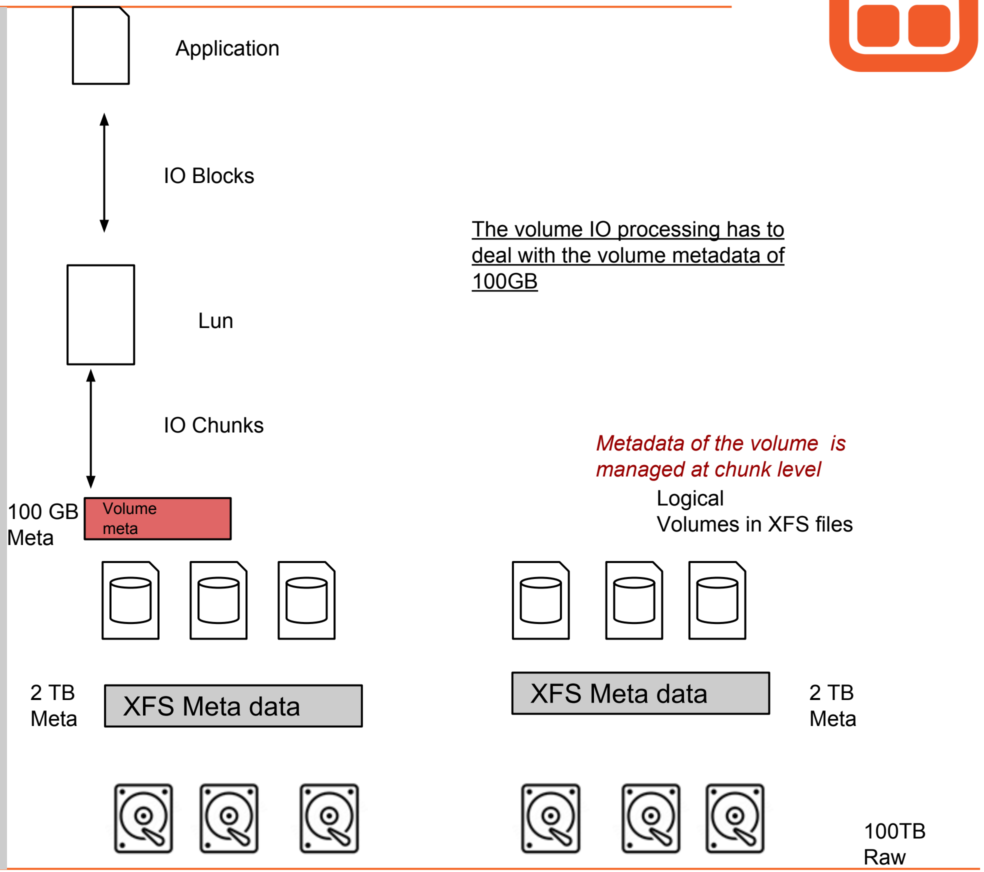
Global Metadata at a system level

8 TB Meta

100TB Raw

The volume IO processing has to deal with the global metadata of 8TB

Metadata is managed at block level



Application

IO Blocks

Lun

IO Chunks

100 GB Meta

Volume meta

Logical Volumes in XFS files

2 TB Meta

XFS Meta data

XFS Meta data

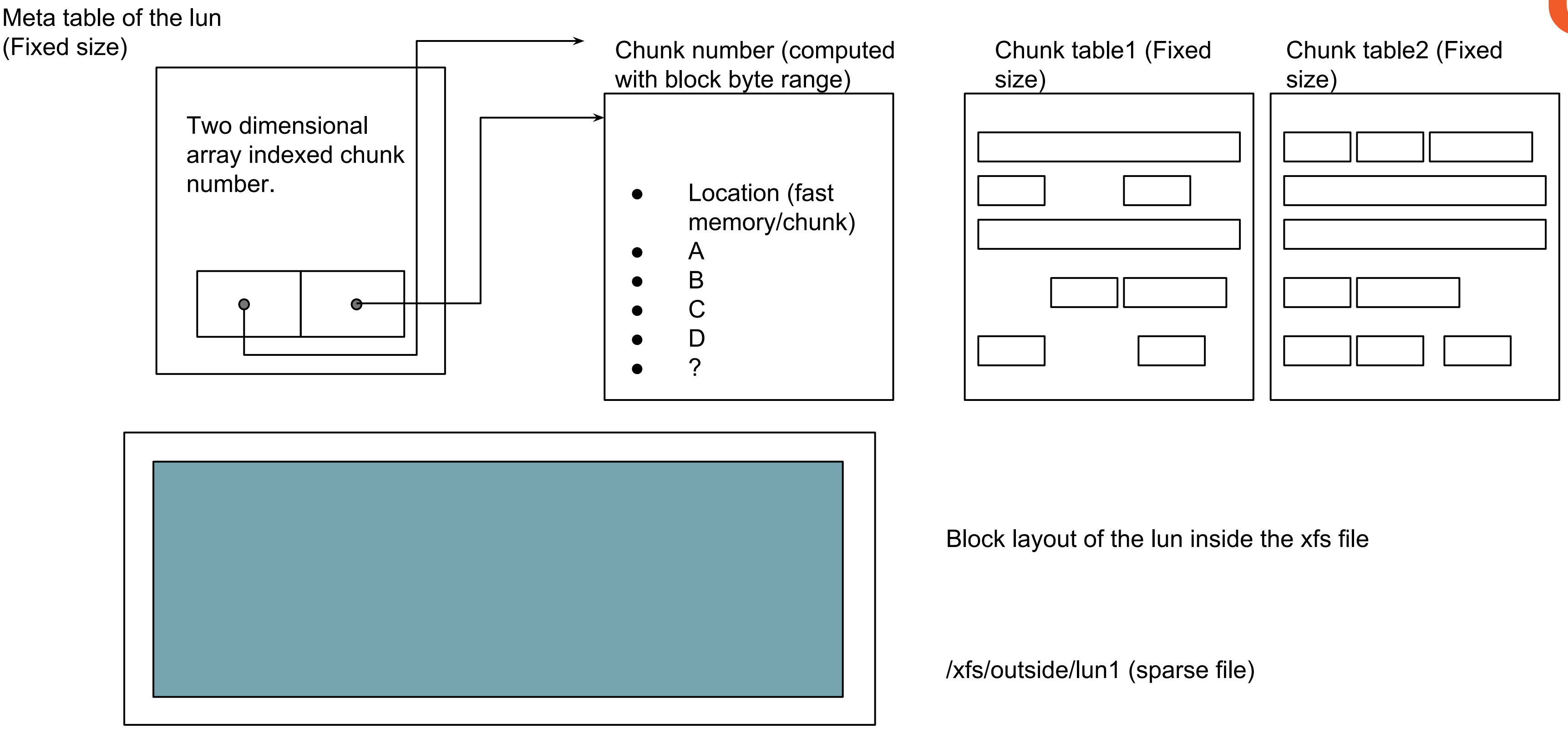
2 TB Meta

100TB Raw

The volume IO processing has to deal with the volume metadata of 100GB

Metadata of the volume is managed at chunk level

Storage Data format



Meta table of the lun (Fixed size)

Two dimensional array indexed chunk number.

Chunk number (computed with block byte range)

- Location (fast memory/chunk)
- A
- B
- C
- D
- ?

Chunk table1 (Fixed size)

Chunk table2 (Fixed size)

Block layout of the lun inside the xfs file

/xfs/outside/lun1 (sparse file)

Storage Interface

- HardDisks
- SAS/SATA Flash
- NVMe Flash
- PCIe Flash
- S3
- Cloud Block Storage

VSM Network Interface

- Host Networking
- VLANs / IPSpaces

Ease of Configuration

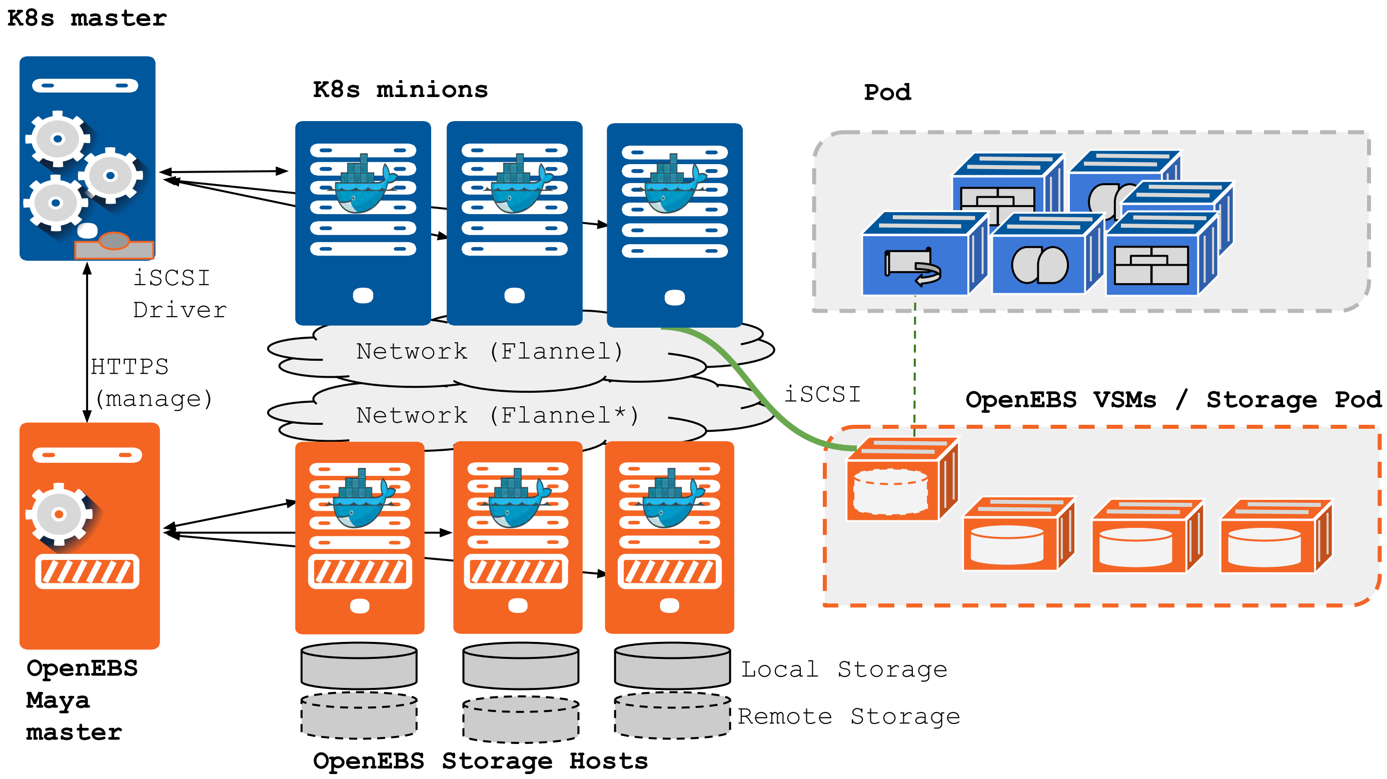
- VSM Configuration Spec
- Infra Spec
- Integrate into K8s / EBS Compatible

Integration to Orchestration

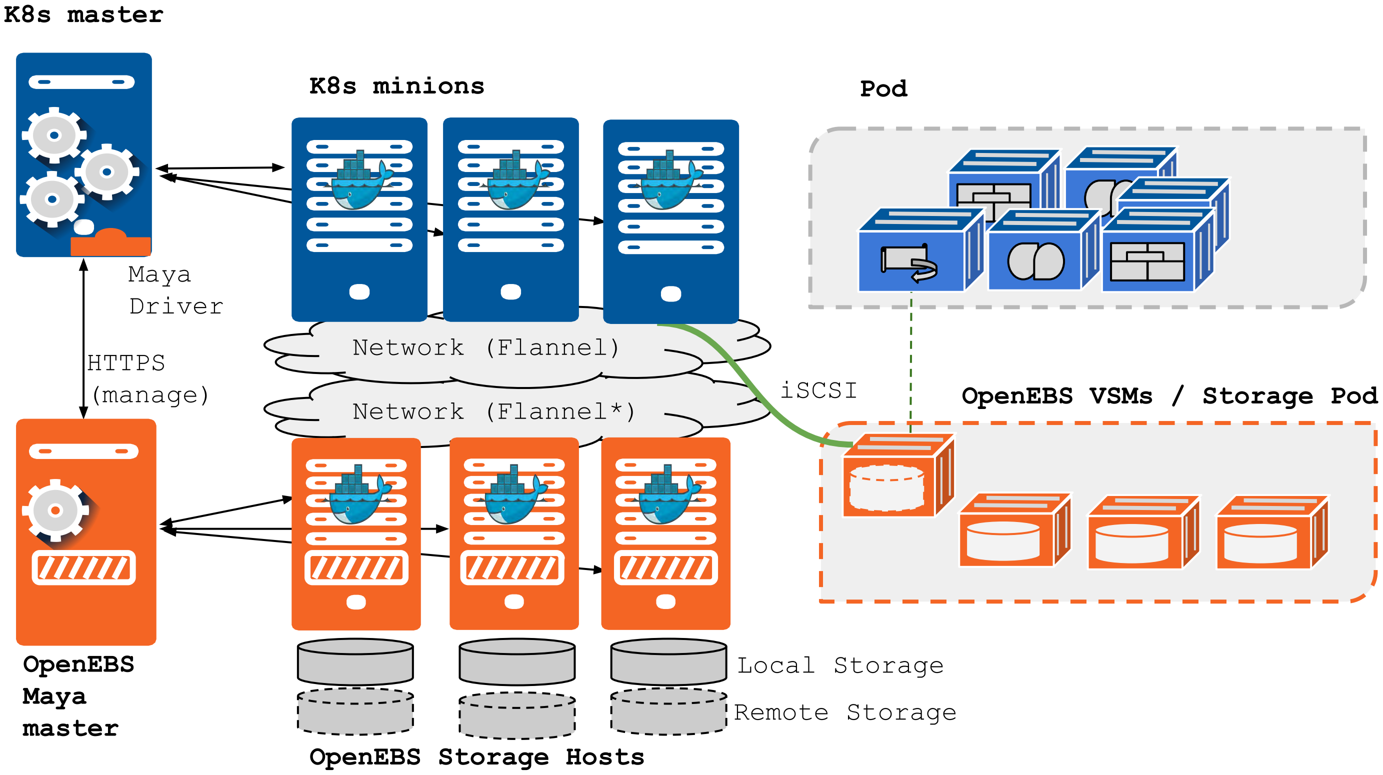
Options to consume the storage by containers:

- iSCSI Driver (Pre-provisioned)
- Maya Volume Driver
- Integrated Orchestration

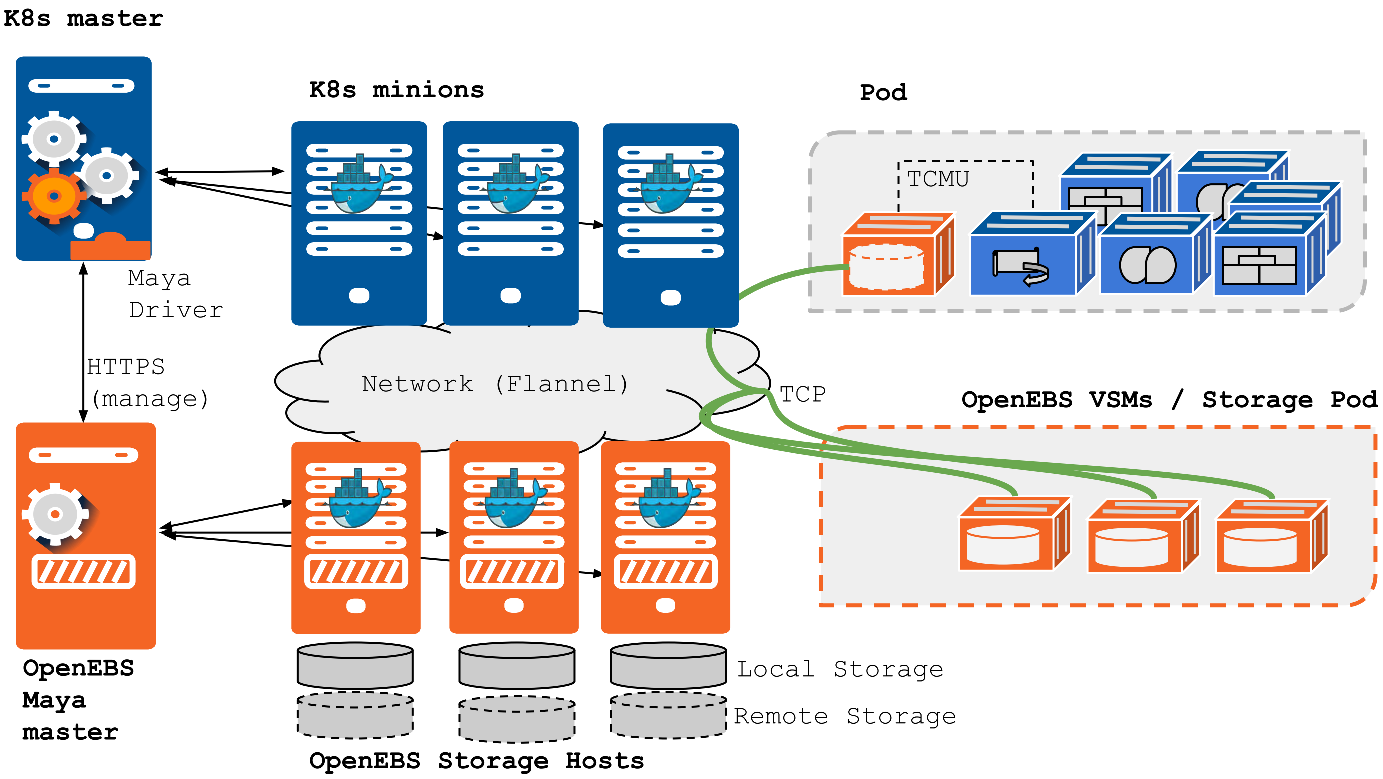
Storage Connectivity - iSCSI Claims



Storage Connectivity - Maya Driver



Storage Connectivity - Shared Orchestration



Resiliency and Fault Tolerance

- Scaleout
- Blue-Green Upgrades - Infra
- Rolling Upgrades - VSMs
- High-Availability

Security

- Data Security
- Encryption
- Secure Delete

Telemetry

- Monitoring and Troubleshooting
- Analytics

Performance

- IO Latency
- Provisioning
- Analytics

Scale

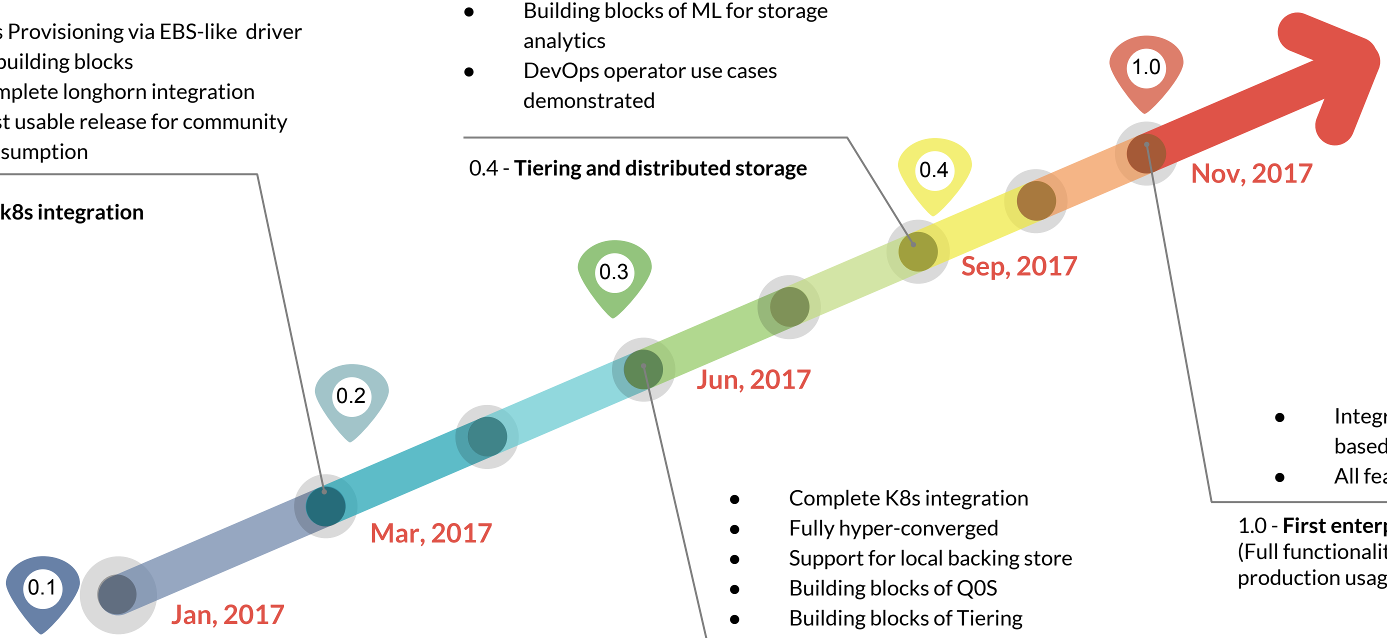
- Capacity
- Number of Volumes

Deployment Flexibility

OpenEBS Deployment Options for:

- Dedicated Storage (External)
- Hyper-converged
- Hybrid-Cloud (AWS)

OpenEBS Roadmap



- **Soft launch / Basic version**
- Containerized controller
- Longhorn integration basics

0.2 - **Basic k8s integration**

- K8s Provisioning via EBS-like driver
- S3 building blocks
- Complete longhorn integration
- First usable release for community consumption

0.3 - **Full k8s integration**
(Hyper-Converged)

- Complete K8s integration
- Fully hyper-converged
- Support for local backing store
- Building blocks of Q0S
- Building blocks of Tiering

0.4 - **Tiering and distributed storage**

- Tiering and QoS demonstrated
- Building blocks of ML for storage analytics
- DevOps operator use cases demonstrated

1.0 - **First enterprise edition**
(Full functionality for basic production usage)

- Integration into Enterprise LDAP w/ role based access control
- All features supportable at scale

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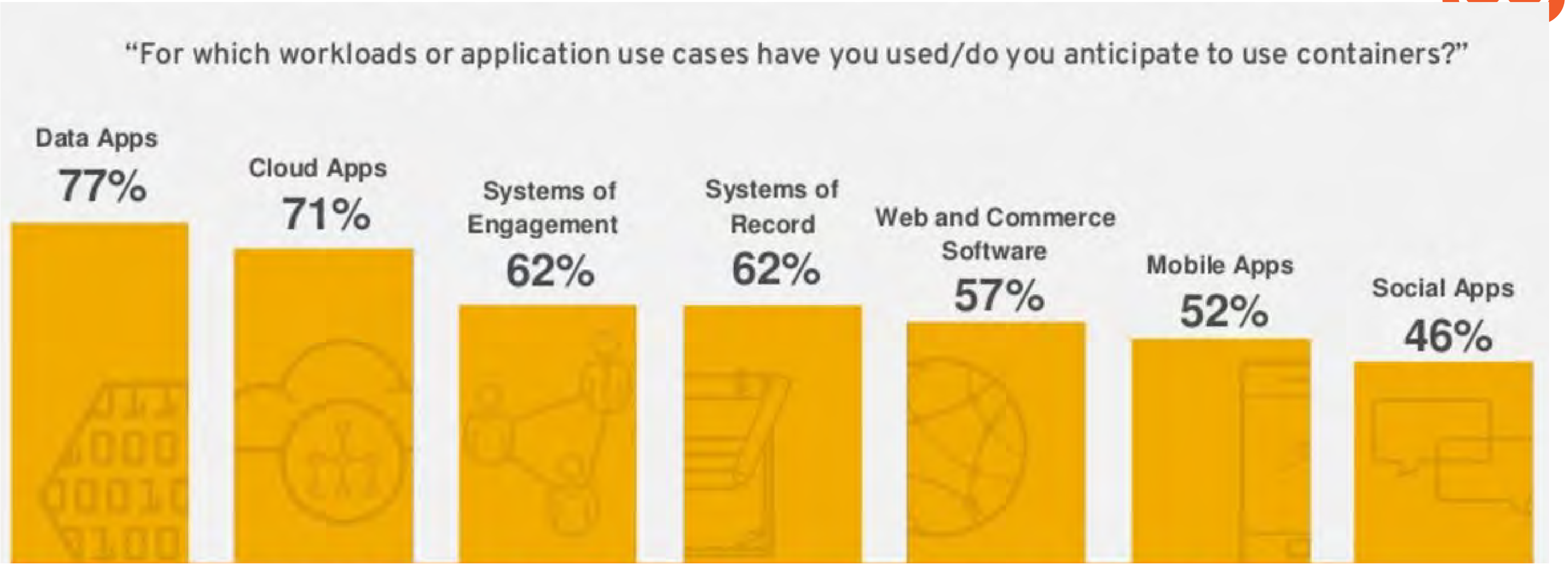
Stateful containers?!



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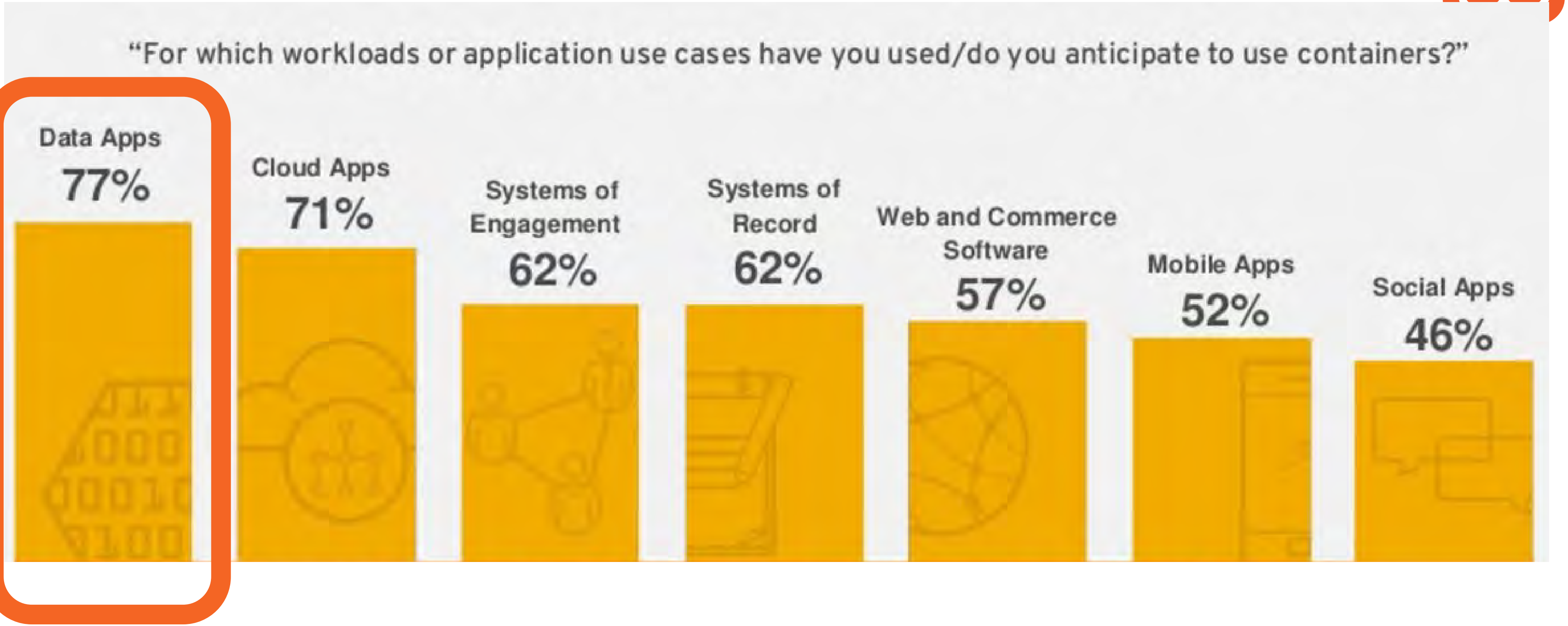

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