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Cloud Storage Futures (previously: Designing Private & Public Clouds)

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Part 1:

The Two Cloud Architectures

A Story of Two Clouds

... Driven by Two App Types

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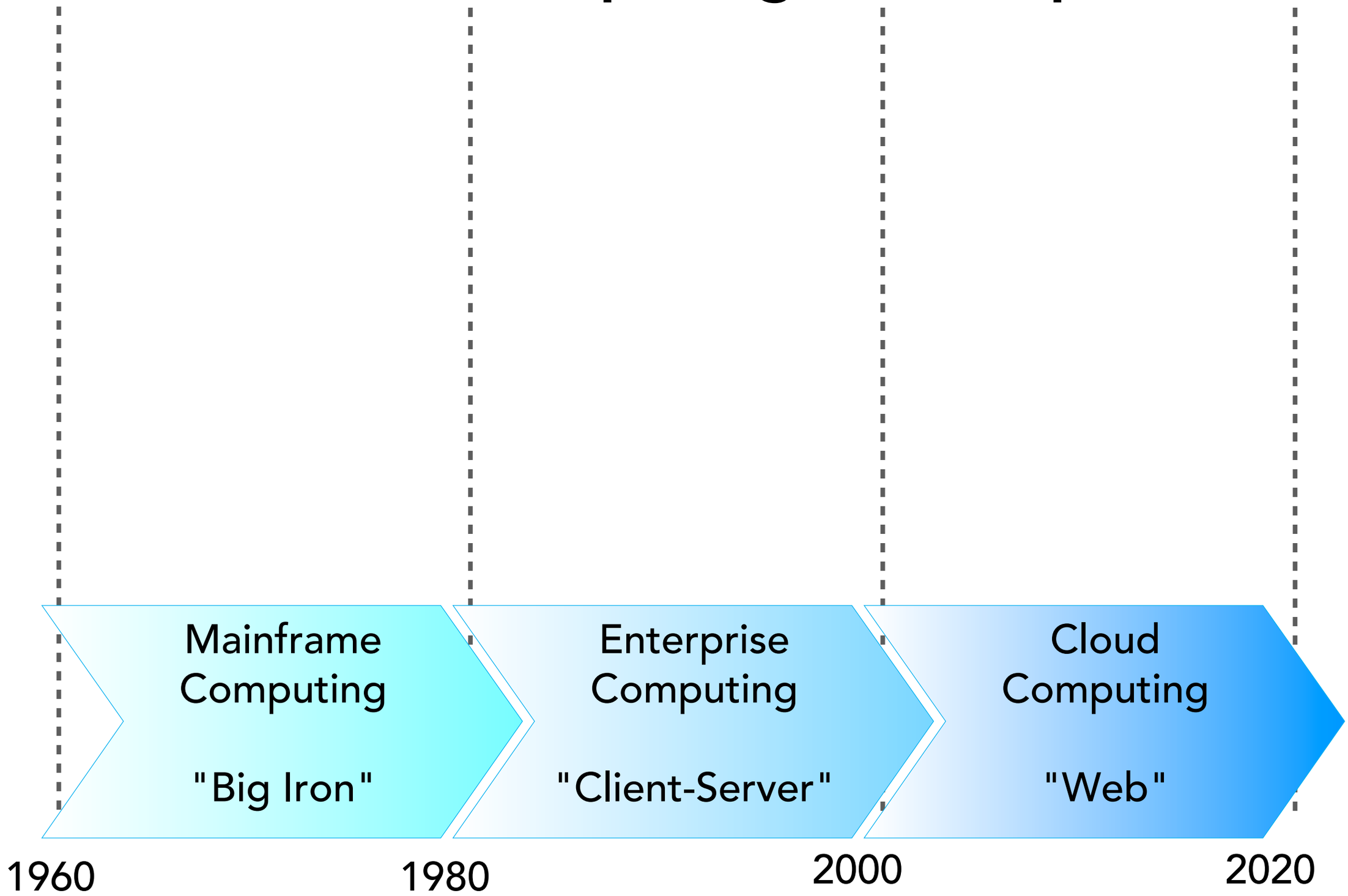
Cloud Computing ... Disrupts



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Cloud Computing ... Disrupts

IBM

TANDEM

CONTROL DATA

Mainframe Computing

"Big Iron"

Enterprise Computing

"Client-Server"

Cloud Computing

"Web"

1960 1980 2000 2020

Disruption

Cloud Computing ... Disrupts

IBM

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IBM

EMC²

CISCO

Microsoft

Mainframe Computing

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Cloud Computing

"Web"

1960

1980

2000

2020

Disruption

Disruption

Cloud Computing ... Disrupts

IBM

TANDEM

CONTROL DATA

IBM

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CISCO

Microsoft

Google Apps

amazon web services™

nexenta
Enterprise class storage for everyone

Cassandra

openstack

hadoop

Mainframe Computing

"Big Iron"

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Cloud Computing

"Web"

1960 — 1980 — 2000 — 2020

Disruption — Disruption — Disruption

IT – Evolution of Computing Models

SLA

Scaling

Hardware

HA Type

Software

Consumption

IT – Evolution of Computing Models

SLA	99.999
Scaling	Vertical
Hardware	Custom
HA Type	Hardware
Software	Centralized
Consumption	Centralized Service

IT – Evolution of Computing Models

SLA	99.999	99.9
Scaling	Vertical	Horizontal
Hardware	Custom	Enterprise
HA Type	Hardware	Software
Software	Centralized	Decentralized
Consumption	Centralized Service	Shared Service

Mainframe "big-iron" → Enterprise "client/server" → Cloud "scale-out"

IT – Evolution of Computing Models

SLA	99.999	99.9	Always On
Scaling	Vertical	Horizontal	
Hardware	Custom	Enterprise	Commodity
HA Type	Hardware	Software	
Software	Centralized	Decentralized	Distributed
Consumption	Centralized Service	Shared Service	Self-service

Mainframe "big-iron" → Enterprise "client/server" → Cloud "scale-out"

Enterprise Computing
(existing apps built in silos)

Cloud Computing
(new elastic apps)

Scale-out apps require elastic infrastructure

	Traditional apps	Elastic cloud-ready apps
APPS	SAP, ORACLE, Windows, VB.net, Microsoft .net	HTML5, JS, PHP, BIG DATA, iOS, Android, Chrome
INFRA	nexenta Enterprise class storage for everyone, vmware, SAVVIS, EMC², terremark	amazon web services™, rackspace, Google

Scale-out Cloud Technology

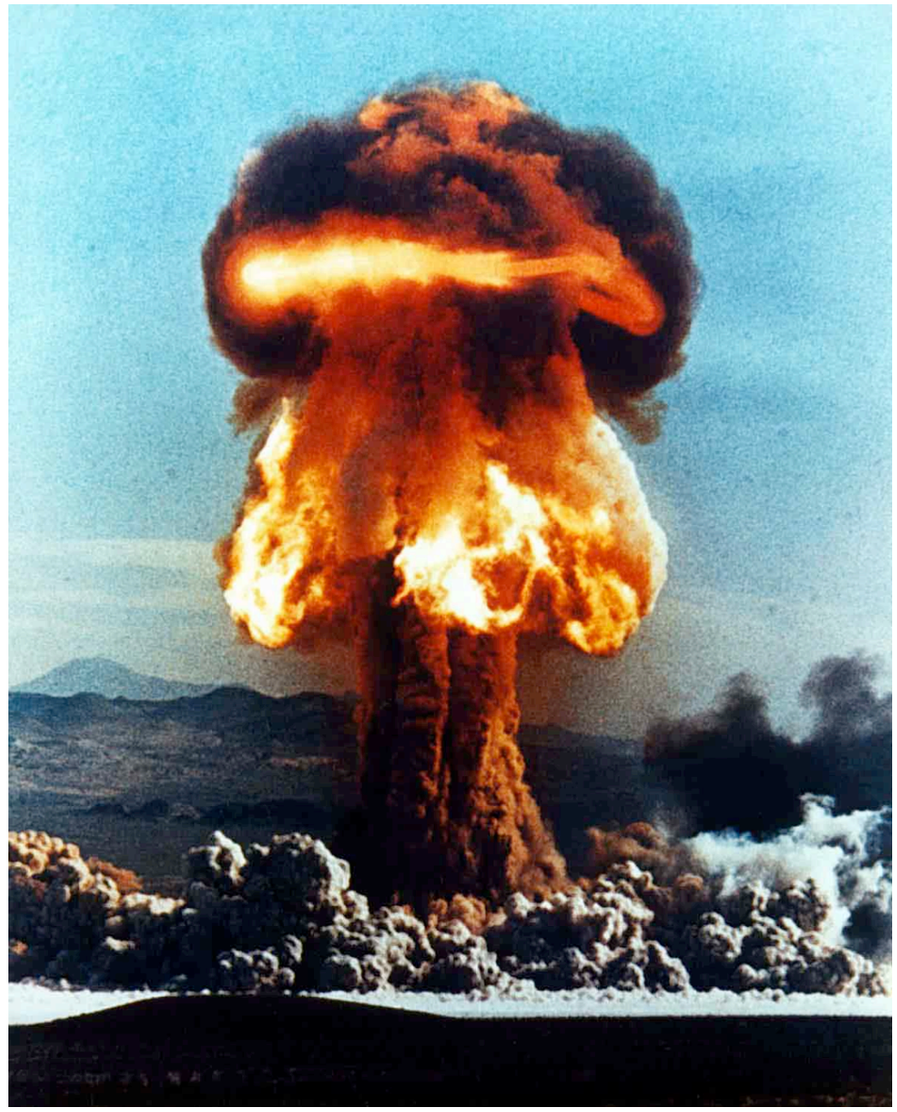
	Traditional apps	Elastic cloud-ready apps
APPS	SAP, ORACLE, Windows, VB.net, Microsoft .net	HTML, JS, PHP, BIG DATA, iOS
INFRA	nexenta Enterprise class storage for everyone, vmware, SAVVIS, EMC², terremark	openstack™, nexenta Enterprise class storage for everyone, ARISTA, EUCALYPTUS

Scale-out Principles

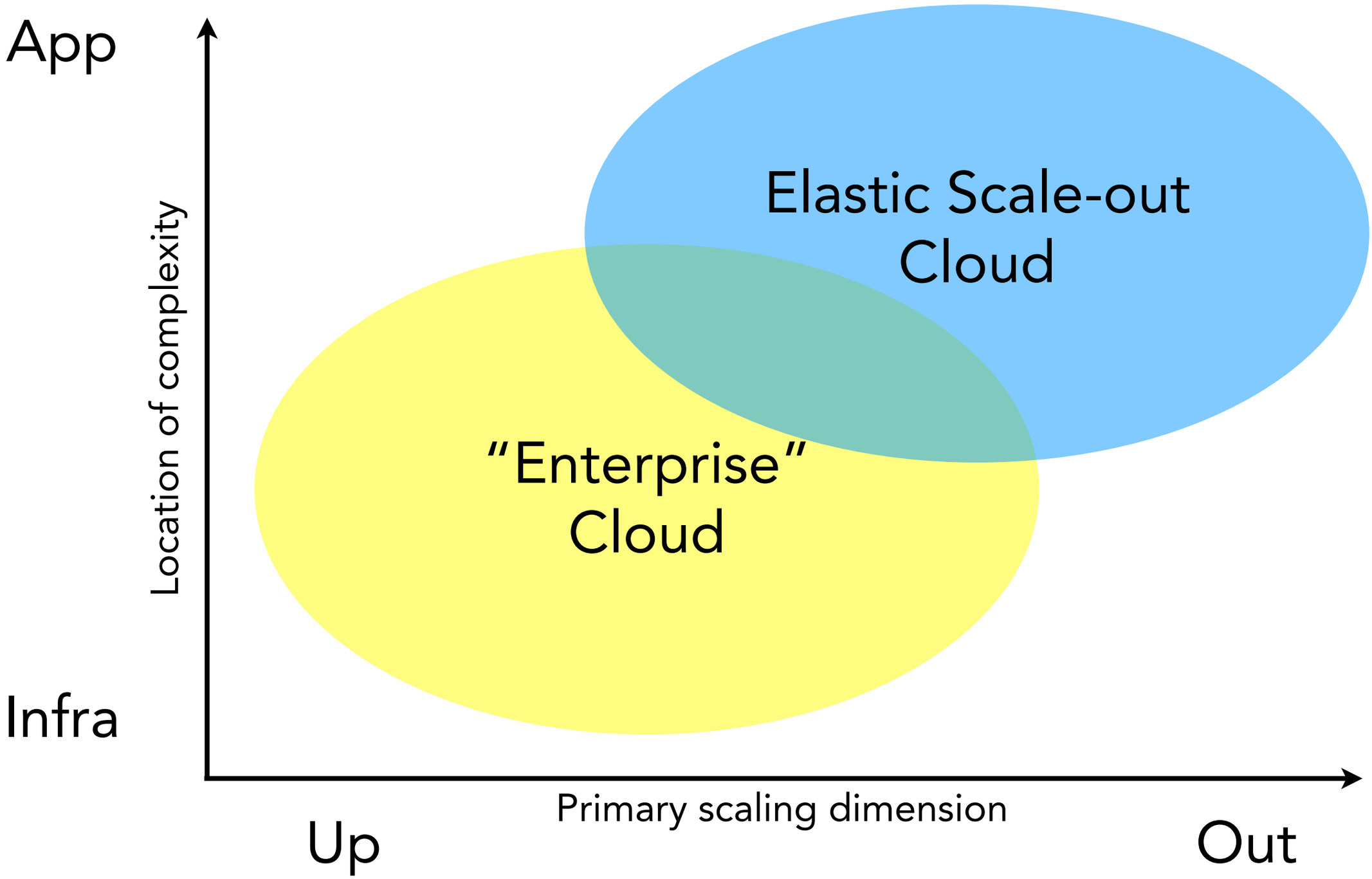
- Small failure domains
- Risk acceptance vs. risk mitigation
- More boxes for throughput & redundancy
- Assume app manages complexity:
  - Data replication
  - Assumes infrastructure is unreliable:
    - Server & data redundancy
  - Geo-distribution
  - Auto-scaling

What's a failure domain?

- "Blast radius" during a failure
- What is impacted?
- Public SAN failures:
  - FlexiScale SAN failure in 2007
  - UOL Brazil in 2011:
    - http://goo.gl/8ct9n
  - There are many more
- Enterprise HA 'pairs' typically support BIG failure domains



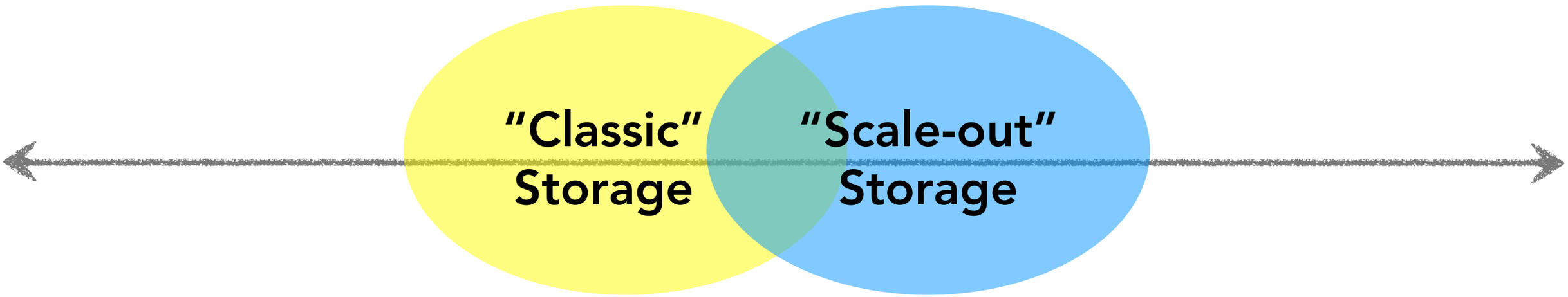
Two Diff Arches for Two Kinds of Apps



Part 2:

Storage Architectures Are Changing

Two Diff Storages for Two Kinds of Clouds



Uptime in Infra
Every part is redundant
Data mgmt in Infra
Bigger SAN/NAS/DFS

Uptime in apps
Minimal h/w redundancy
Data mgmt in apps
Smaller failure domains

Difference in Tiers

Tier	$	Purpose	Classic	Scale-out
1	$$$$	Mission Critical	•SAN, then NAS •10-15K RPM •SSD	•On-demand SAN (EBS) •DynamoDB (AWS) •Variable service levels
2	$$	Important	•NAS then SAN •7.2K RPM	•DAS •App / DFS to scale out
3	$	Archive & Backups	•Tape •Nearline 5.4K	•Object Storage

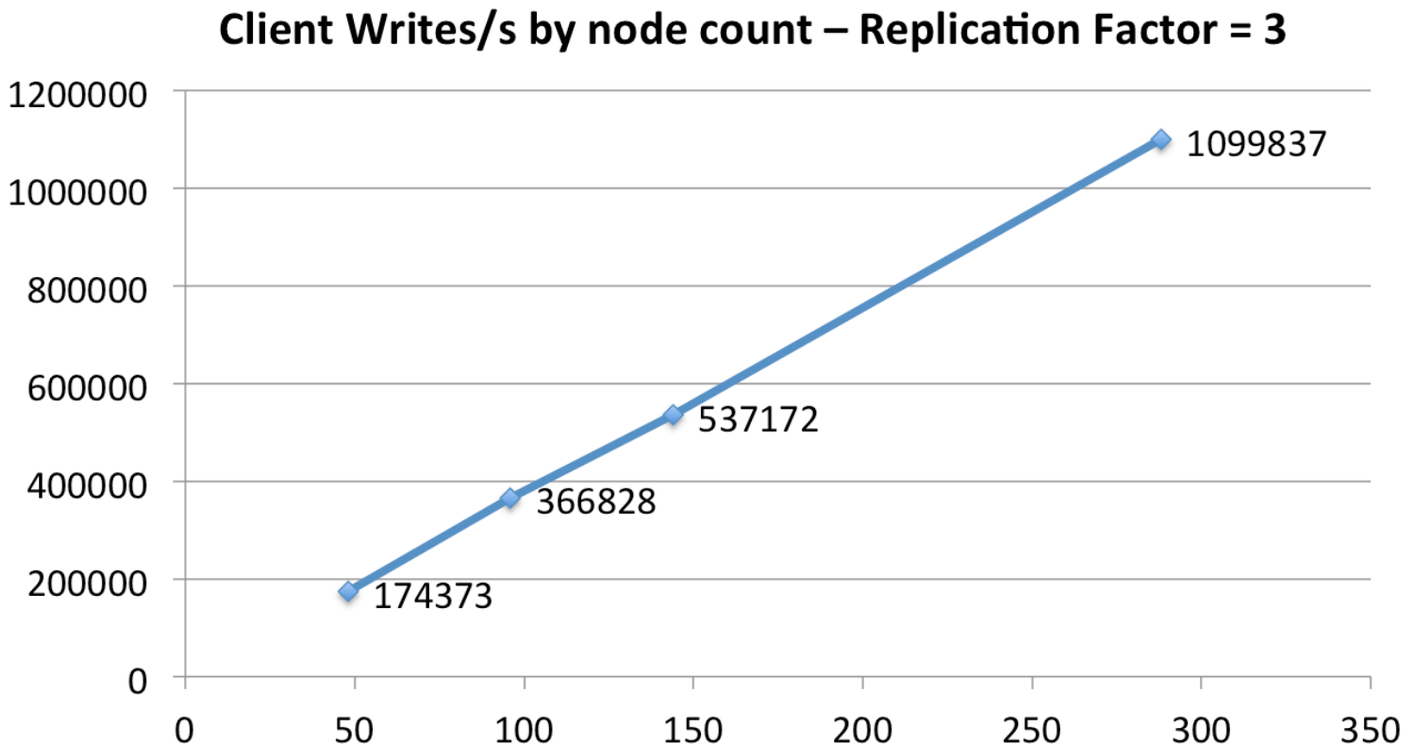
The Biggest Difference is in Where Data Management Resides

- In scale-out systems, apps are managing the data:
  - Riak / Scale-out distributed data store
  - Hadoop+HDFS / Scale-out distributed computation systems
  - Cassandra / Scale-out distributed columnar database

Cassandra / Netflix use case

- 3 x Replication
- Linearly scaling performance
  - 50 - 300 nodes
- > 1M writes/second

- When is this perfect?
  - data size unknown
  - growth unknown
  - lots of elastic dynamism



Cassandra / Netflix use case

- DAS ('ephemeral store')
- Per node perf is constant
  - disk
  - CPU
  - network
- Client write times constant
- Nothing special here

Per Node Activity

Per Node	48 Nodes	96 Nodes	144 Nodes	288 Nodes
Per Server Writes/s	10,900 w/s	11,460 w/s	11,900 w/s	11,456 w/s
Mean Server Latency	0.0117 ms	0.0134 ms	0.0148 ms	0.0139 ms
Mean CPU %Busy	74.4 %	75.4 %	72.5 %	81.5 %
Disk Read	5,600 KB/s	4,590 KB/s	4,060 KB/s	4,280 KB/s
Disk Write	12,800 KB/s	11,590 KB/s	10,380 KB/s	10,080 KB/s
Network Read	22,460 KB/s	23,610 KB/s	21,390 KB/s	23,640 KB/s
Network Write	18,600 KB/s	19,600 KB/s	17,810 KB/s	19,770 KB/s

Node specification – Xen Virtual Images, AWS US East, three zones

- Cassandra 0.8.6, CentOS, SunJDK6
- AWS EC2 m1 Extra Large – Standard price $ 0.68/Hour
- 15 GB RAM, 4 Cores, 1Gbit network
- 4 internal disks (total 1.6TB, striped together, md, XFS)

Cassandra / Netflix use case

- On-demand & app-managed
- Cost per GB/hr: $.006
- Cost per GB/mo: $4.14
- Includes: storage, DB, storage admin, network, network admin, etc. etc. etc.

Time is Money

	48 nodes	96 nodes	144 nodes	288 nodes
Writes Capacity	174373 w/s	366828 w/s	537172 w/s	1,099,837 w/s
Storage Capacity	12.8 TB	25.6 TB	38.4 TB	76.8 TB
Nodes Cost/hr	$32.64	$65.28	$97.92	$195.84
Test Driver Instances	10	20	30	60
Test Driver Cost/hr	$20.00	$40.00	$60.00	$120.00
Cross AZ Traffic	5 TB/hr	10 TB/hr	15 TB/hr	30[1] TB/hr
Traffic Cost/10min	$8.33	$16.66	$25.00	$50.00
Setup Duration	15 minutes	22 minutes	31 minutes	66[2] minutes
AWS Billed Duration	1hr	1hr	1 hr	2 hr
Total Test Cost	$60.97	$121.94	$182.92	$561.68

[1] Estimate two thirds of total network traffic
[2] Workaround for a tooling bug slowed setup

Part 3:

Scale-out Storage ... Now & Future

Only Change is Certain

There are a few basic approaches being taken ...

Scale-out SAN

DAS+DFS

Block-devices-as-a-Service (EBS)

DAS+BigData

DAS+Database

Scale-out SAN

- In-rack SAN == faster, bigger DAS w/ better stat-muxing
- Accept normal DAS failure rates
- Assume app handles data replication
- Like AWS ‘ephemeral storage’
- KT architecture
- *Customers didn’t “get it”*
  - “Ephemeral SAN” not well understood

Dedicated Storage SW

9K Jumbo Frames

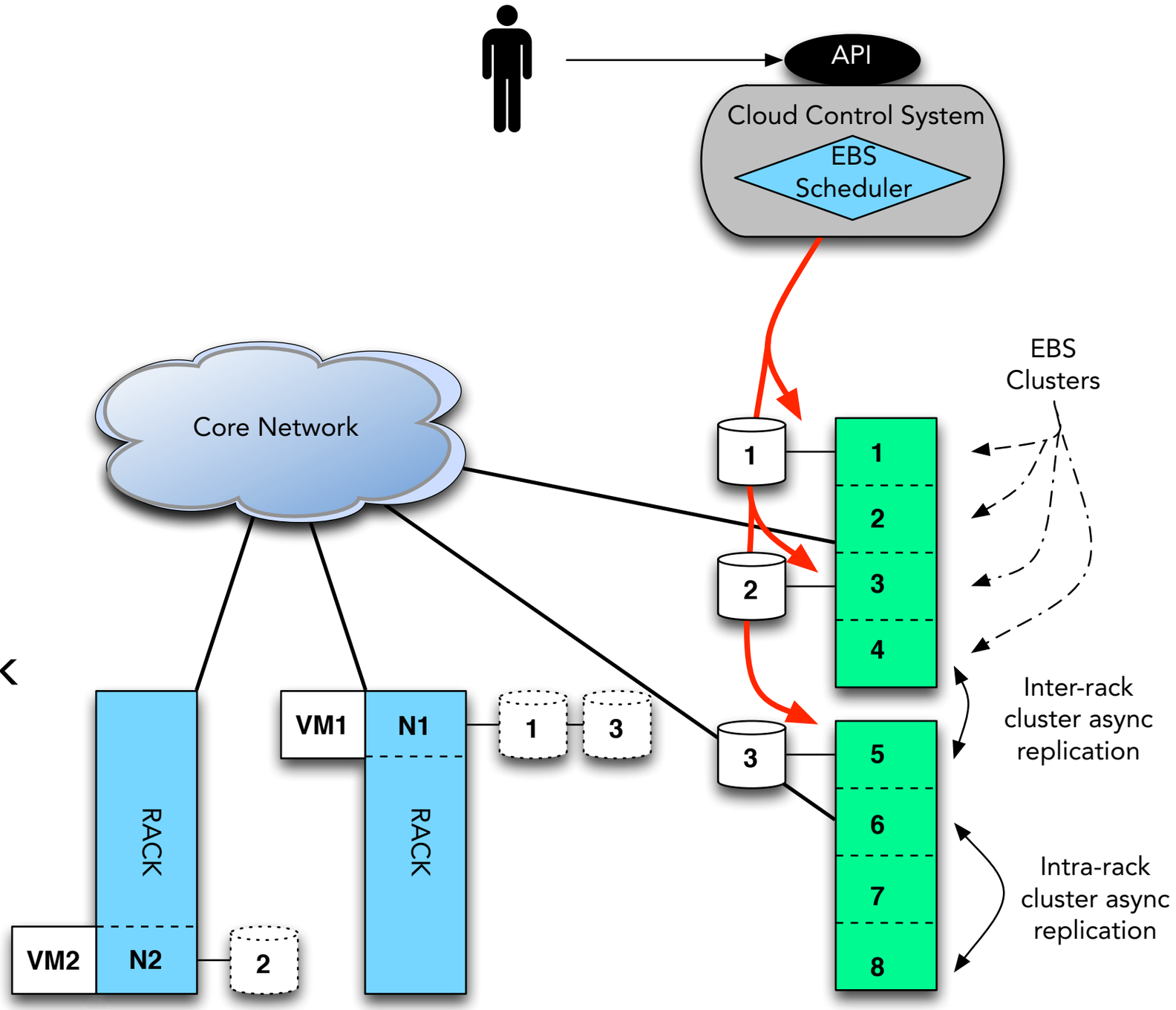
SSD caches (ZIL/L2ARC)

No replication

Max HW redundancy

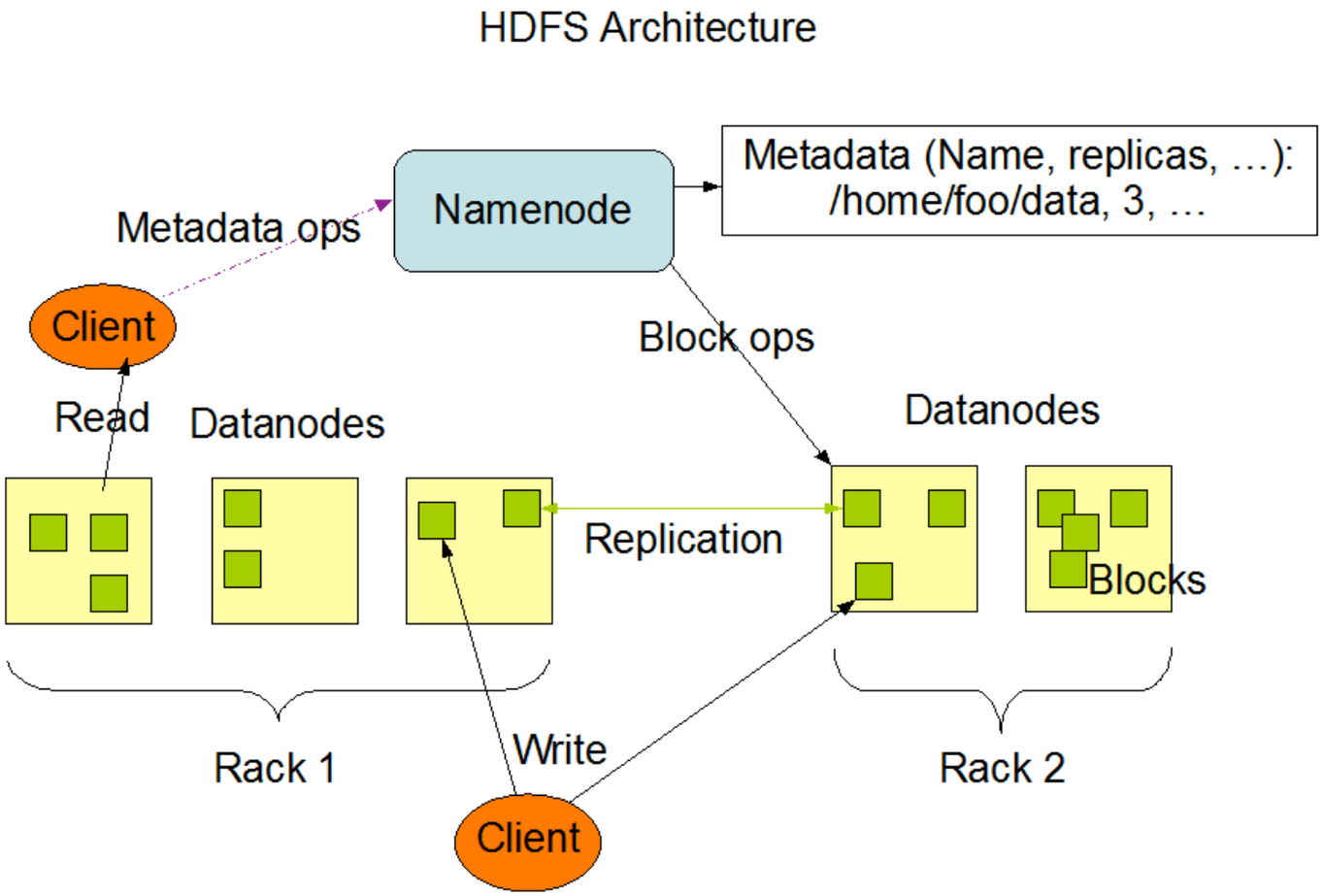
AWS EBS - “Block-devices-as-a-Service”

- Scale-out SAN (sort of)
- Block scheduler
- Async replication
  - Some failure tolerance
- Scheduler:
  - Allocates customer block devices across many failure domains
- Customer run RAID inside VMs to increase redundancy



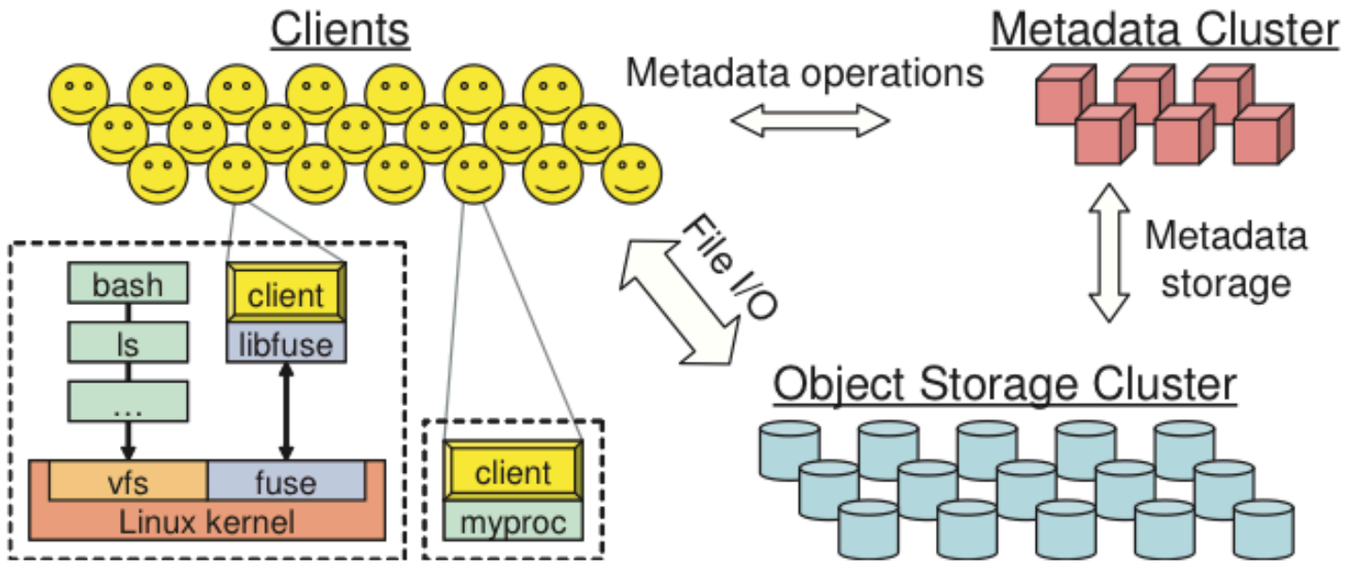
DAS + Big Data
(Storage + Compute + DFS)

- Storage capability:
  - Replication
  - Disk & server failure
  - Data rebalancing
  - Data locality
    - rack awareness
  - Checksums (basic)
- Also:
  - Built in computation



Distributed File Systems (DFS) over DAS

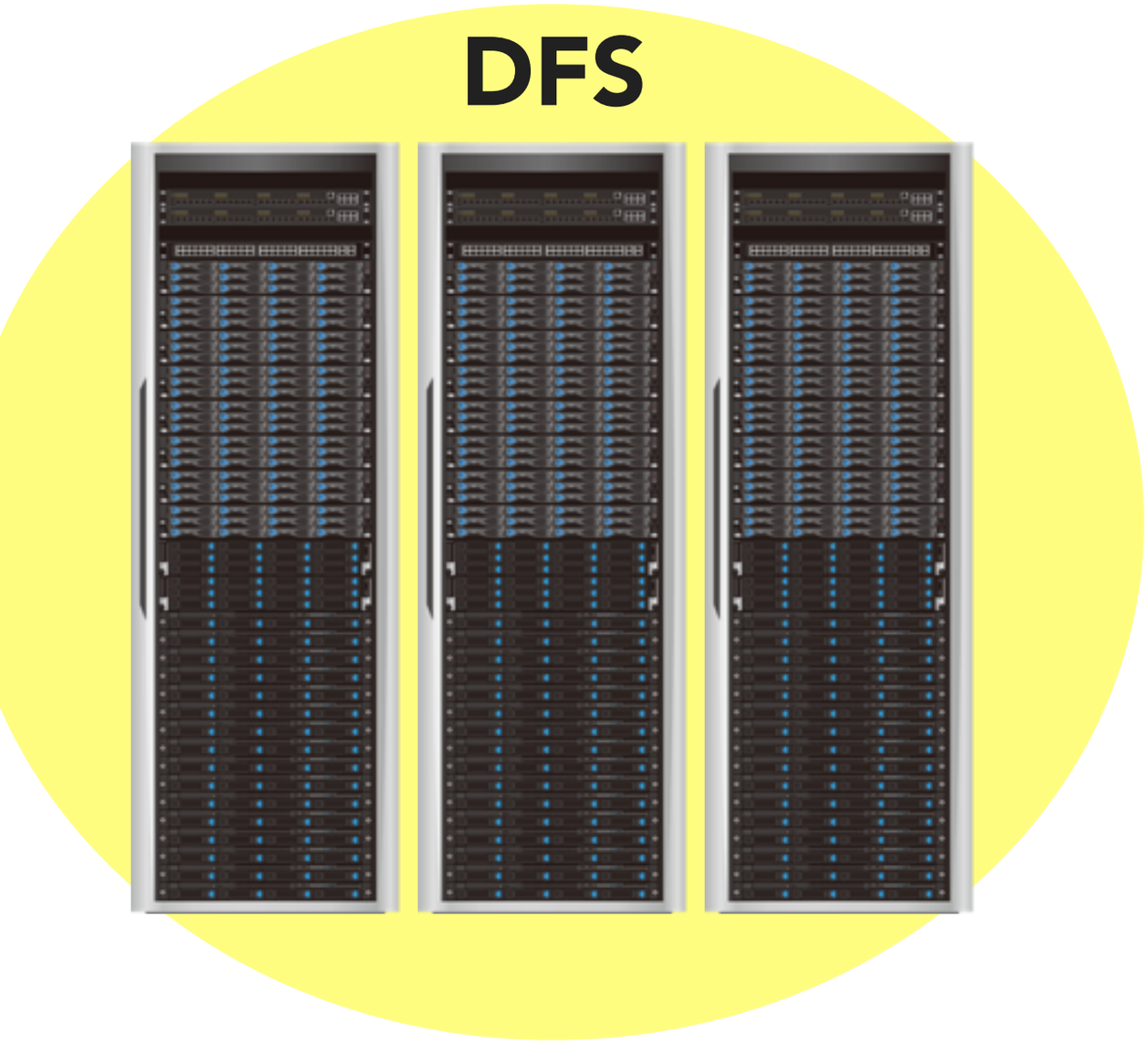
- Storage capability:
  - Replication
  - Disk & server failure
  - Data rebalancing
  - Checksums (w/ btrfs)
  - Block devices
- Also:
  - No computation



ceph architecture✴

✴ Looks familiar doesn't it?

Why is DFS at the Physical Layer Dangerous for Scale-out?



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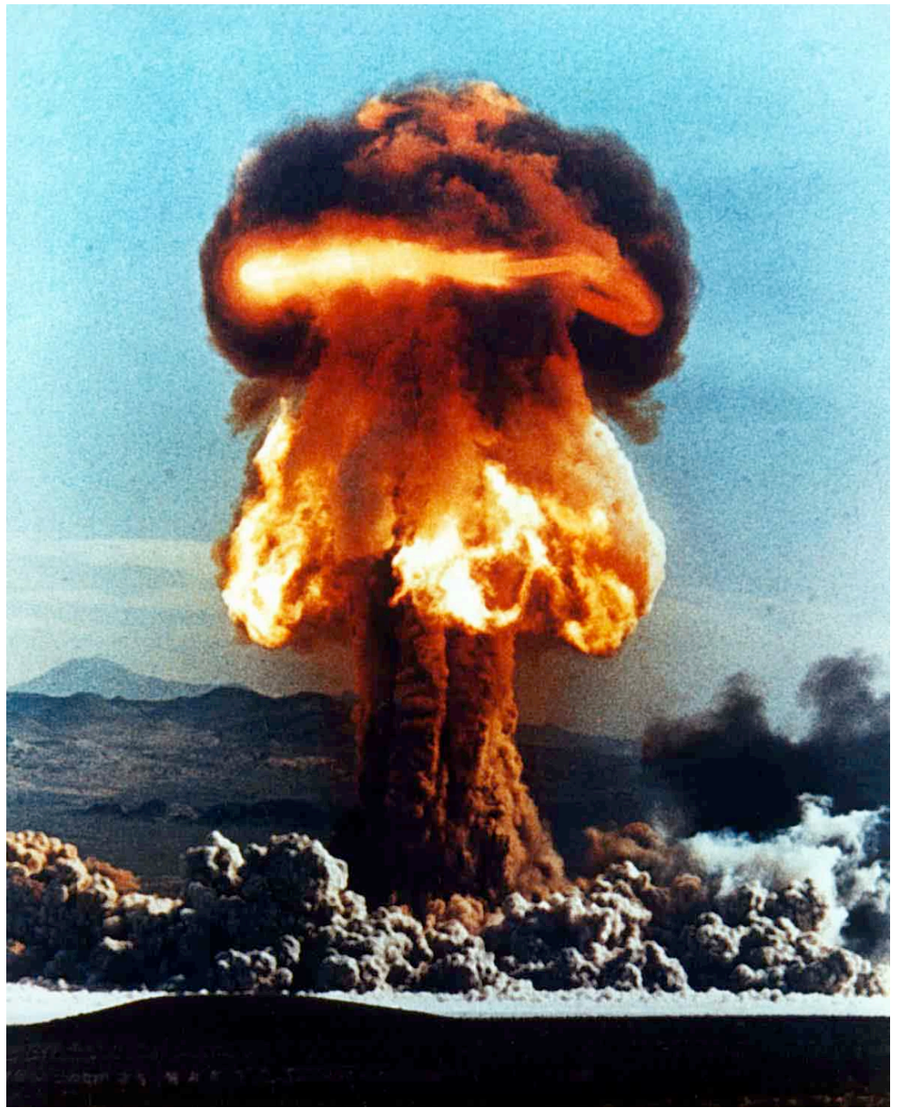
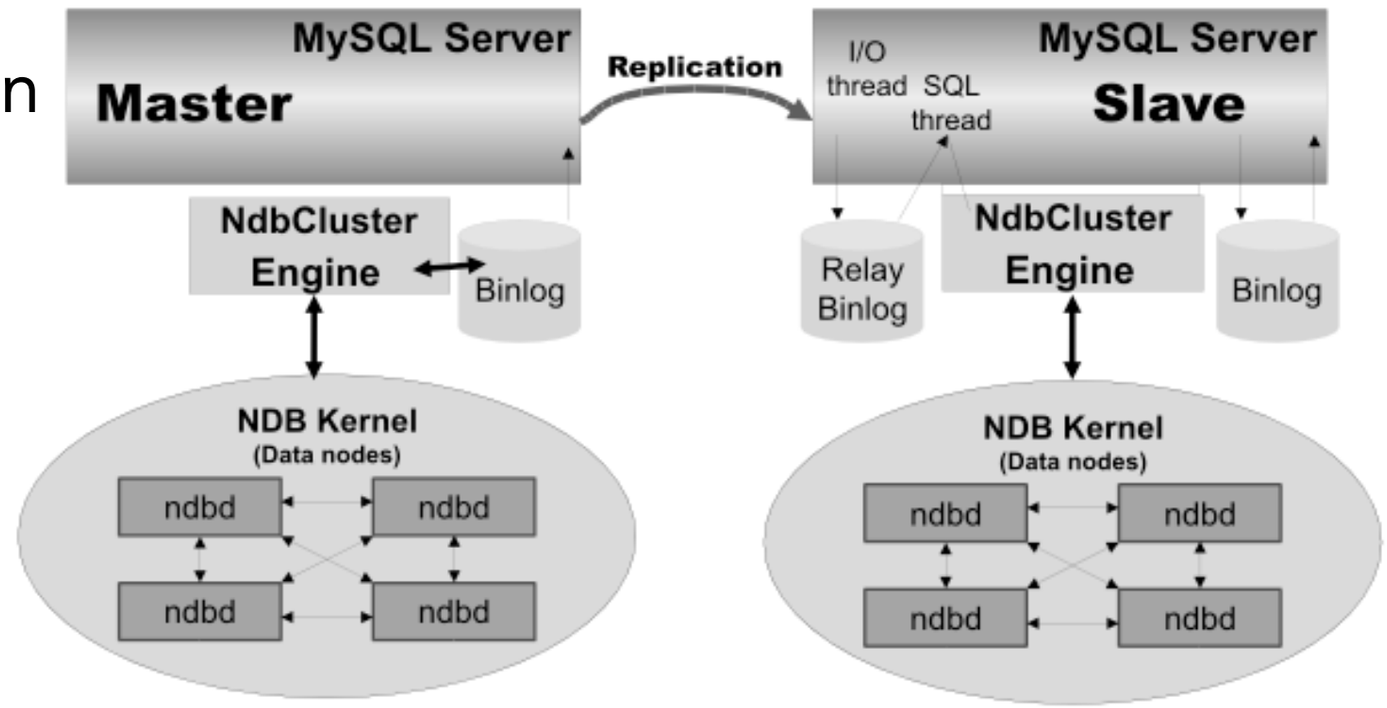


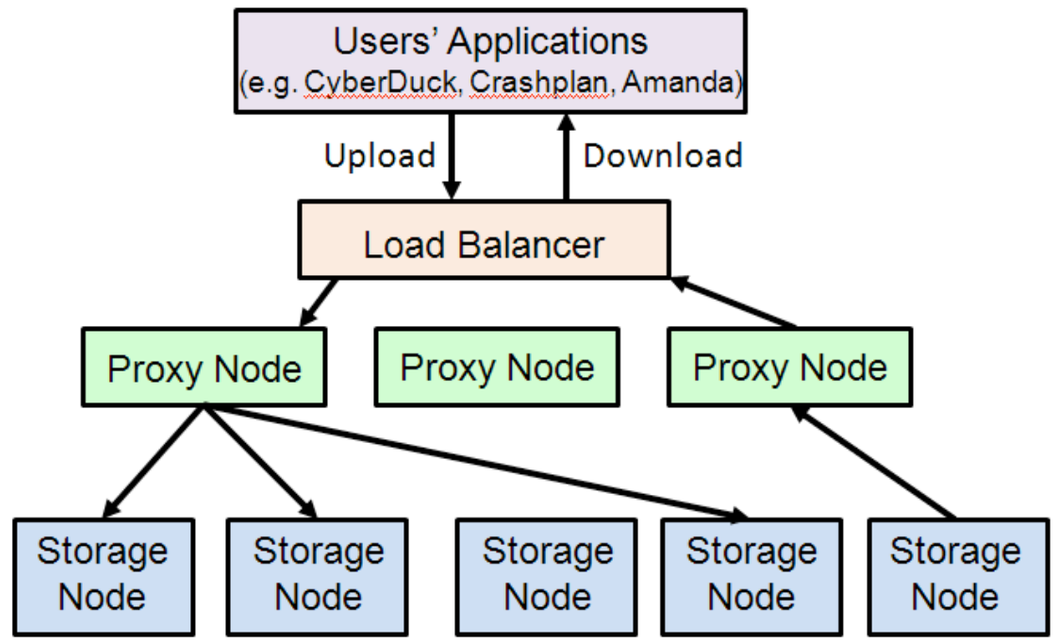
DAS + Database Replication / Scaling

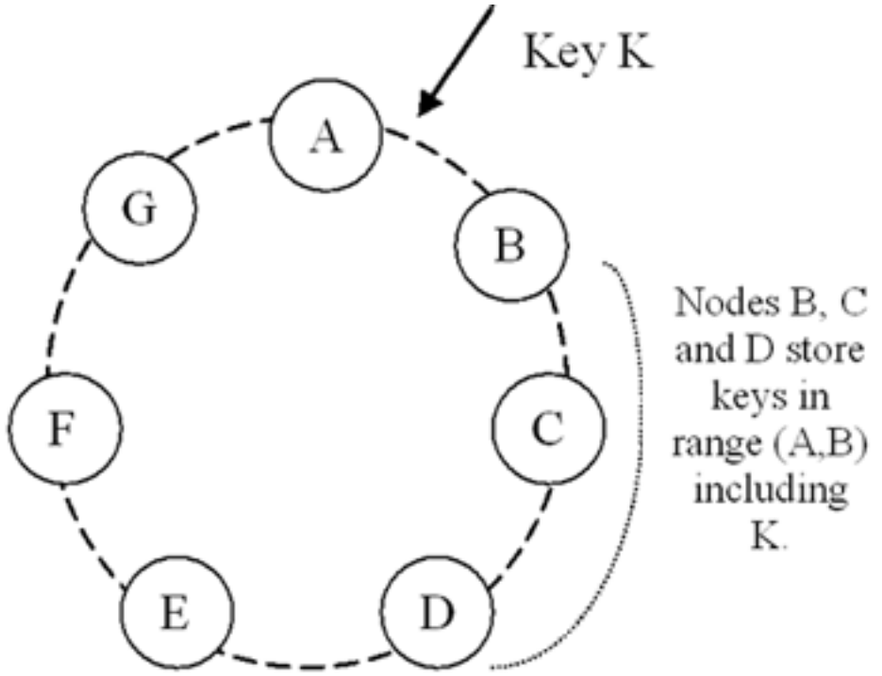
- Storage capability:
  - Async/Sync Replication
  - Server failure
  - Checksums (sort of)
- Also:
  - Std RDBMS
  - SQL i/f
  - Well understood



Object Storage

- Storage capability:
  - Replication
  - Disk & server failure
  - Data rebalancing
  - Checksums (sometimes)
- Also:
  - Looks like a big web app
  - Uses a DHT/CHT to ‘index’ blobs
  - Very simple





Where does OpenStorage Fit?

Scale-out Solution	Purpose / Tier	Virtual or Physical?	Fit
Scale-out SAN	Tier-1/2	Physical	In-rack SAN
EBS	Tier-1	Physical	EBS Clusters (scale-out SAN)
DAS+BigData	Tier-2	Virtual	Reliable, bit-rot resistant DAS
DAS+DFS	Tier-2	Physical / Virtual	Reliable, bit-rot resistant DAS (unproven)
DAS+DB	Tier-2	Virtual	In-VM reliable DAS
Object Storage	Tier-3	Physical	Reliable, bit-rot resistant DAS

Summarizing ZFS Value in Scale-out

- Data integrity & bit rot an issue that few solve today
- Most SAN/NAS solutions don't 'scale down'
- Commodity x86 servers are winning
- There are two scale-out places ZFS wins:
  - Small SAN clusters
  - Best DAS management

Summary

Conclusions / Speculations

- Build the right cloud
- Which means the right storage for *that* cloud
- A single cloud ***might*** support both ...
- Open storage can be used for both ...
- ... WITH the appropriate design/forethought

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Q&A

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