



NetApp®

3.1 Architecture and basics

Intro

Network Attached Storage (NAS)

FiberChannel SAN (FC-SAN)

Ethernet-based SAN (IP-SAN and FCoE-SAN)

3.2 RAID levels

RAID 0, RAID 1, RAID 5, RAID 6, RAID 10

3.3 Enterprise storage subsystems

Example Storage Appliance (NetApp)

Enterprise Storage Features

Software-Defined Storage (SDS)

NetApp Storage Systems

■ Hardware

- Multiple expansion drawers supported
- Hundreds of SATA/SAS/Flash drives
- Hundreds of TB up to PB raw capacity
- Up to 16/32x FC or FCoE ports
- Up to 8/16x Ethernet ports (10/25/100 Gbit/s)
- All components redundant and hot-swappable



■ Supported protocols

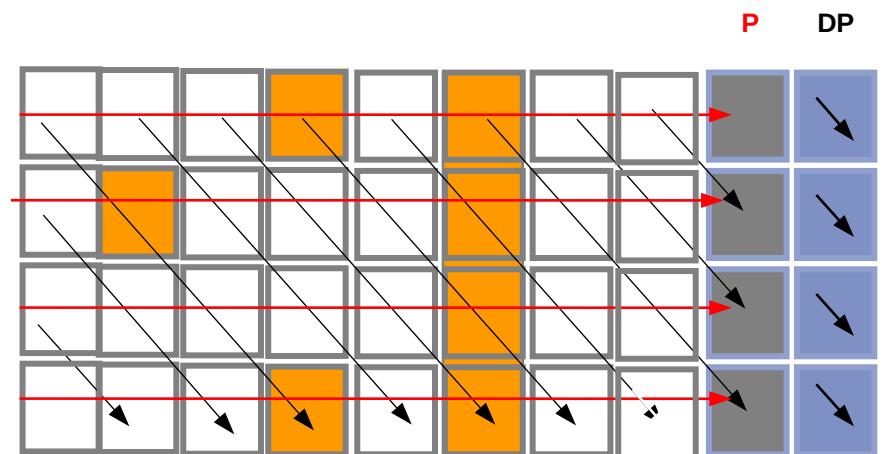
- NAS (CIFS and NFS), Object (S3)
- FC-SAN (FCP) and IP-SAN (iSCSI)



■ Operating systems

- NetApp: ONTAP
- RAID-DP (double parity, custom RAID 6)
- RAID-TEC (triple erasure coding)

Thin provisioning	SnapMirror asynchronous replication
Compression	SyncMirror data protection
Compaction	Trusted Platform Module (TPM) support
Deduplication	MetroCluster IP
Snapshots	NVMe over FC Protocol
Encryption*	NVMe over TCP Protocol



ONTAP System Manager (Return to classic version)

SR-A800 Version 9.7.0

Health

All systems are healthy

AFF-A800

Shelf 1.0
Model: FS4483PSM3E
Serial Number: SHFGG1811000151

Capacity

8.37 TB USED | 23.8 TB AVAILABLE

1 to 1 Data Reduction

No cloud tier

Network

Hosts

SAN 23

NVMe/FC 23

Storage

Ports

Ethernet 22

NVMe/FC 8

Interfaces

NFS

SMB/CIFS

ISCSI

FC

NVMe/FC 17

Storage VMs

Volumes 33

LUNs

Namespaces 24

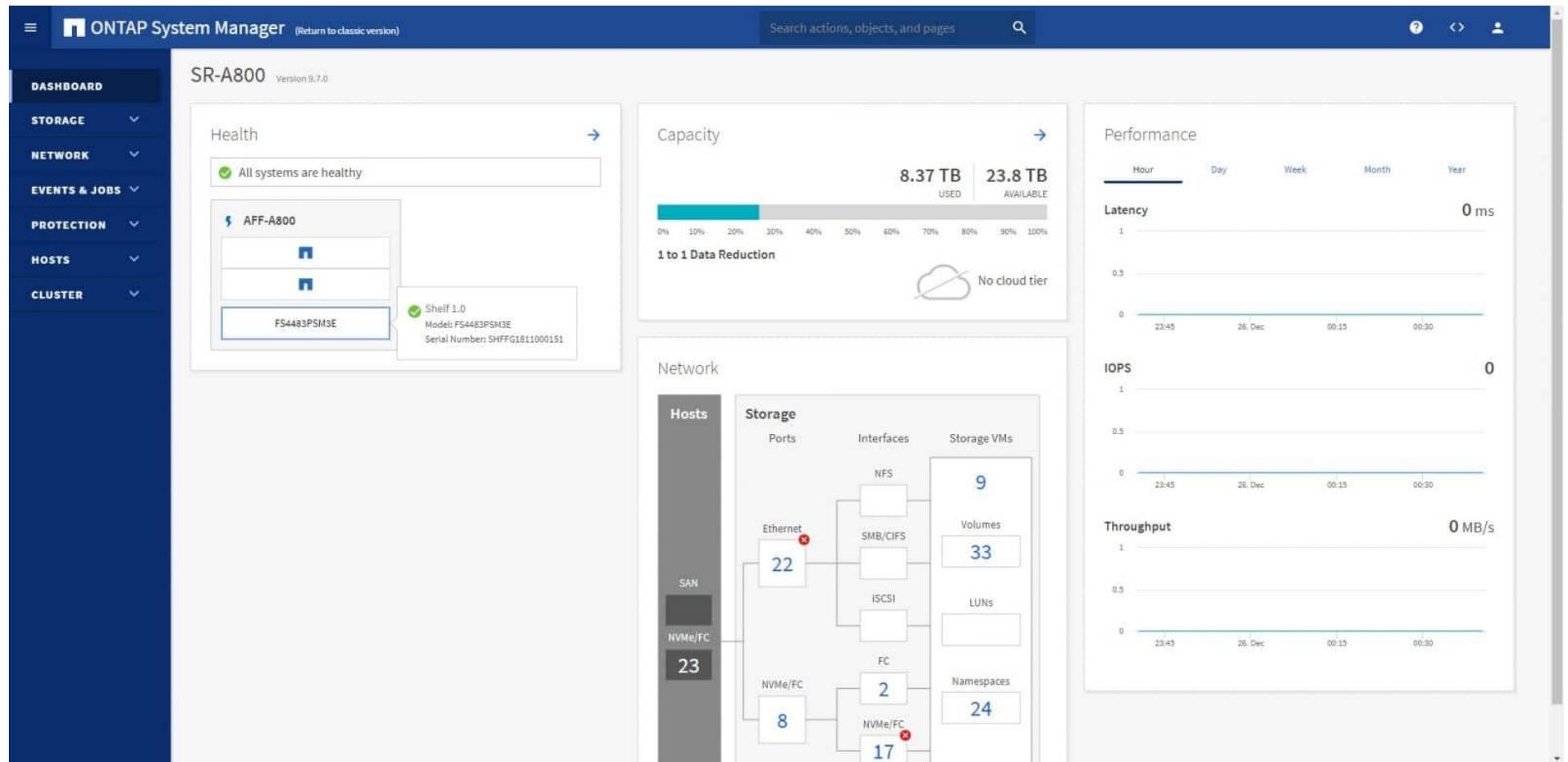
Performance

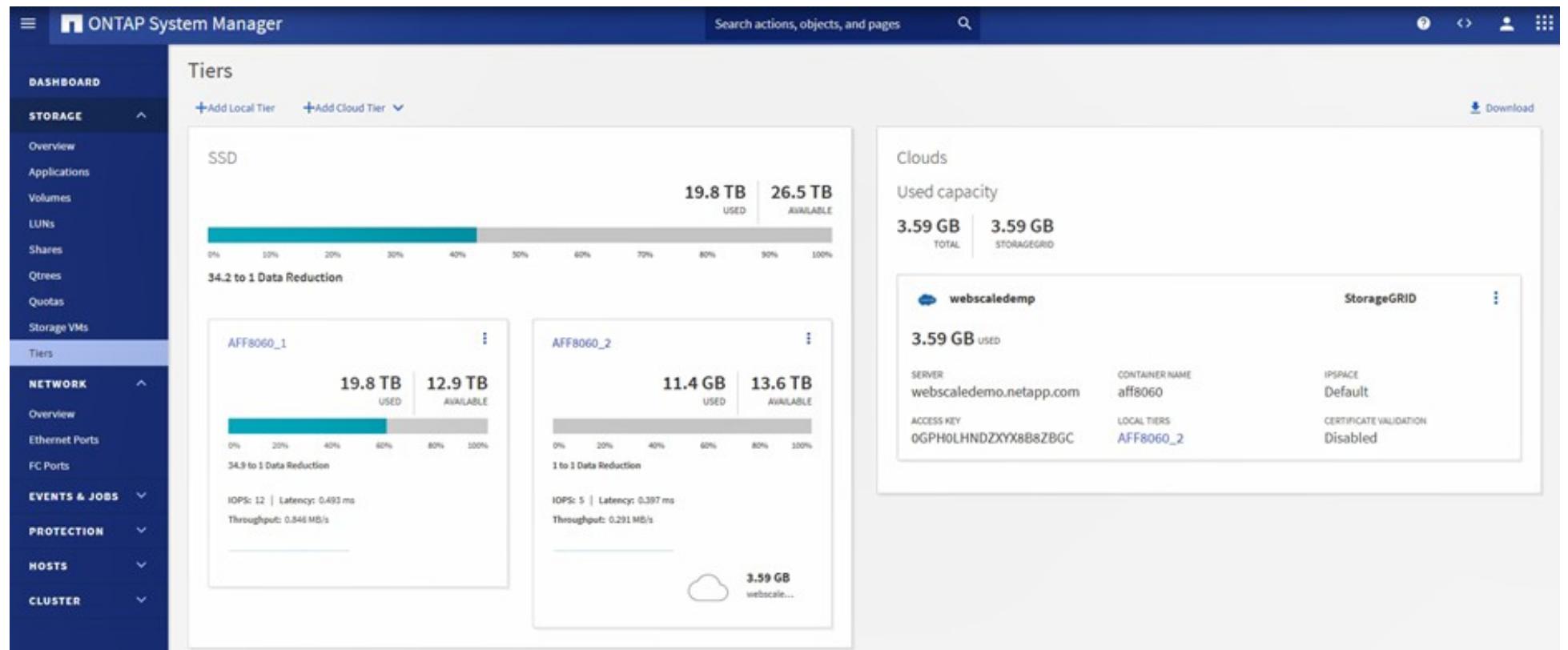
Hour Day Week Month Year

Latency 0 ms

IOPS 0

Throughput 0 MB/s





The screenshot shows the ONTAP System Manager interface with the 'Tiers' page selected. The left sidebar includes sections for DASHBOARD, STORAGE (Overview, Applications, Volumes, LUNs, Shares, Qtrees, Quotas, Storage VMs, Tiers), NETWORK (Overview, Ethernet Ports, FC Ports), EVENTS & JOBS, PROTECTION, HOSTS, and CLUSTER.

Tiers section:

- SSD**:
 - Used: 19.8 TB
 - Available: 26.5 TB

34.2 to 1 Data Reduction
- AFF8060_1**:
 - Used: 19.8 TB
 - Available: 12.9 TB

34.9 to 1 Data Reduction

IOPS: 12 | Latency: 0.493 ms
Throughput: 0.846 MB/s
- AFF8060_2**:
 - Used: 11.4 GB
 - Available: 13.6 TB

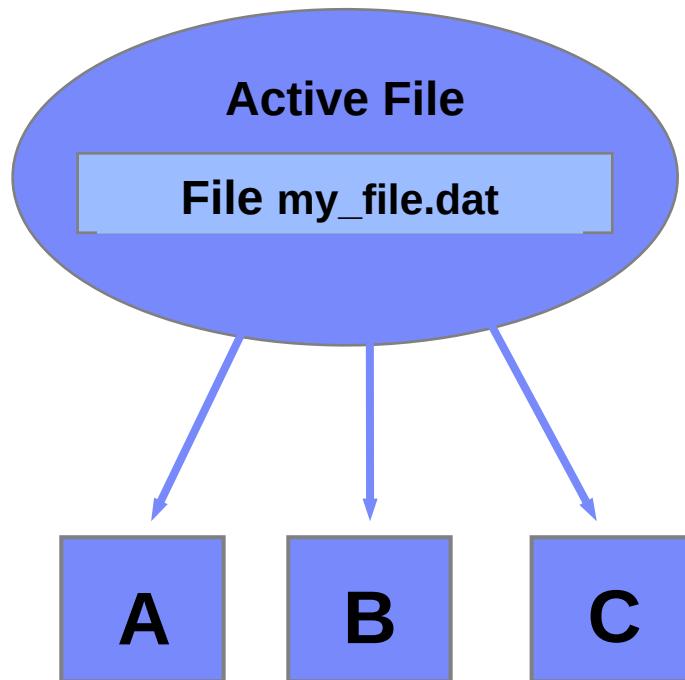
1 to 1 Data Reduction

IOPS: 5 | Latency: 0.397 ms
Throughput: 0.291 MB/s

Clouds section:

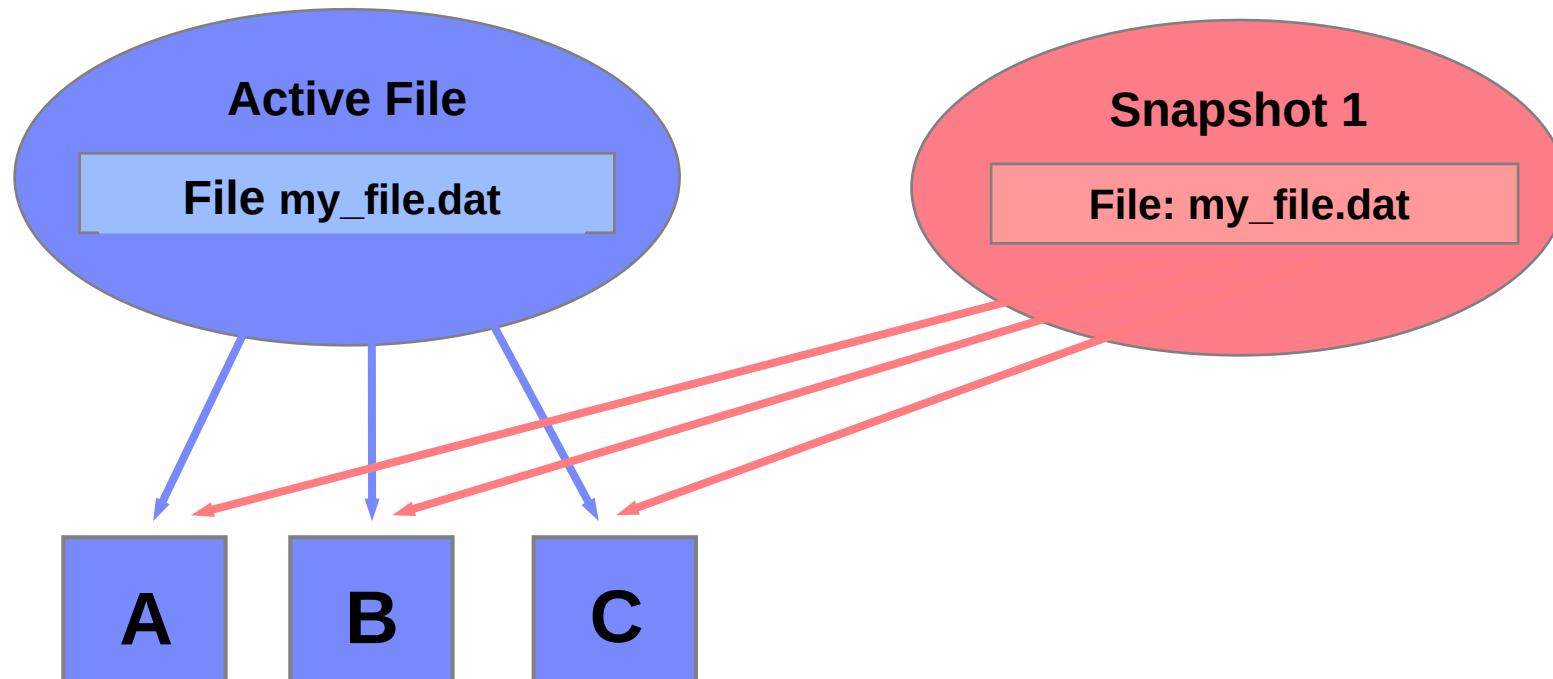
- Used capacity**:
 - Total: 3.59 GB
 - StorageGRID: 3.59 GB
- webscaledemp**:
 - Used: 3.59 GB
 - StorageGRID
 - SERVER: webscaledemo.netapp.com
 - CONTAINER NAME: aff8060
 - ACCESS KEY: 0GPH0LHNDZXYX8B8ZBGC
 - LOCAL TIERS: AFF8060_2
 - IPSPACE: Default
 - CERTIFICATE VALIDATION: Disabled

Example NetApp feature: backup with SnapShot (1)



- **Single file**
- Physical blocks A, B and C comprise file my_file.dat

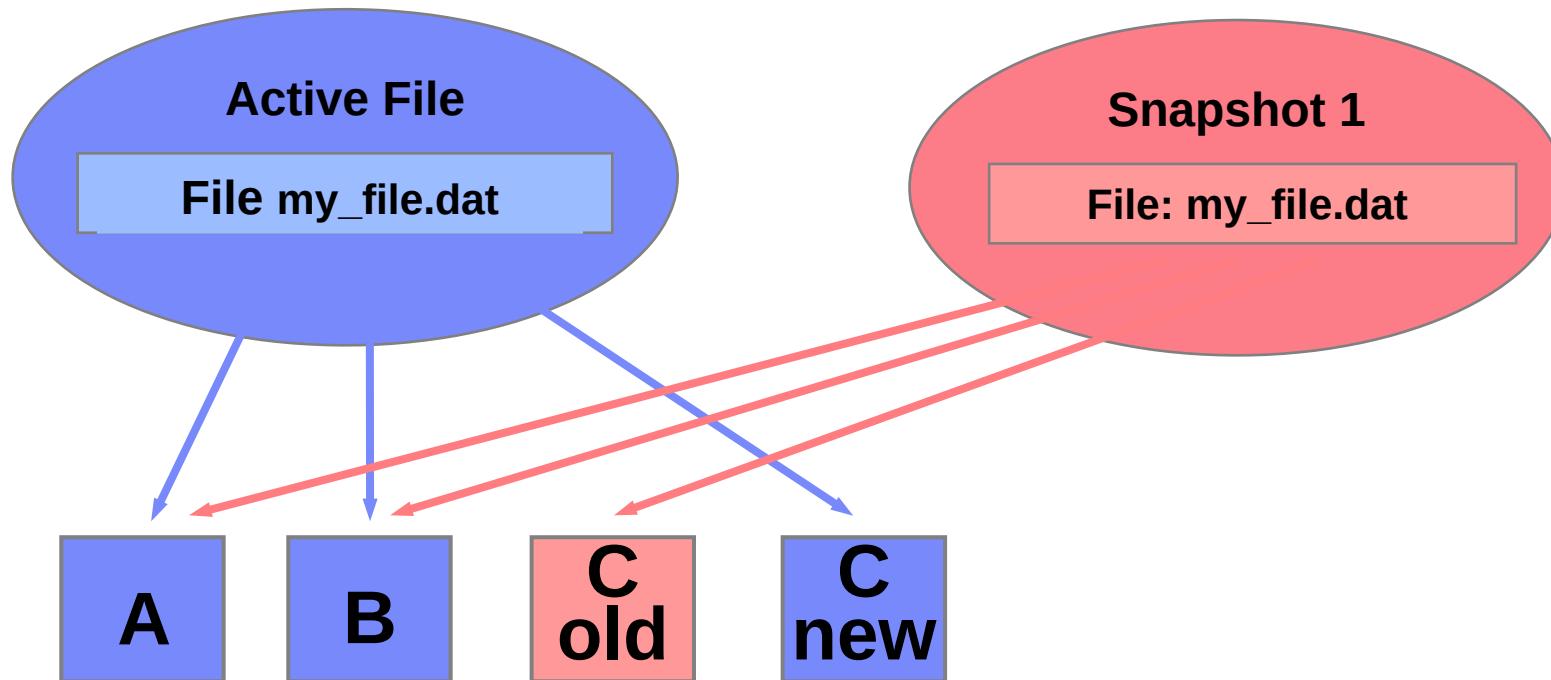
Example NetApp feature: backup with SnapShot (2)



▪ First snapshot

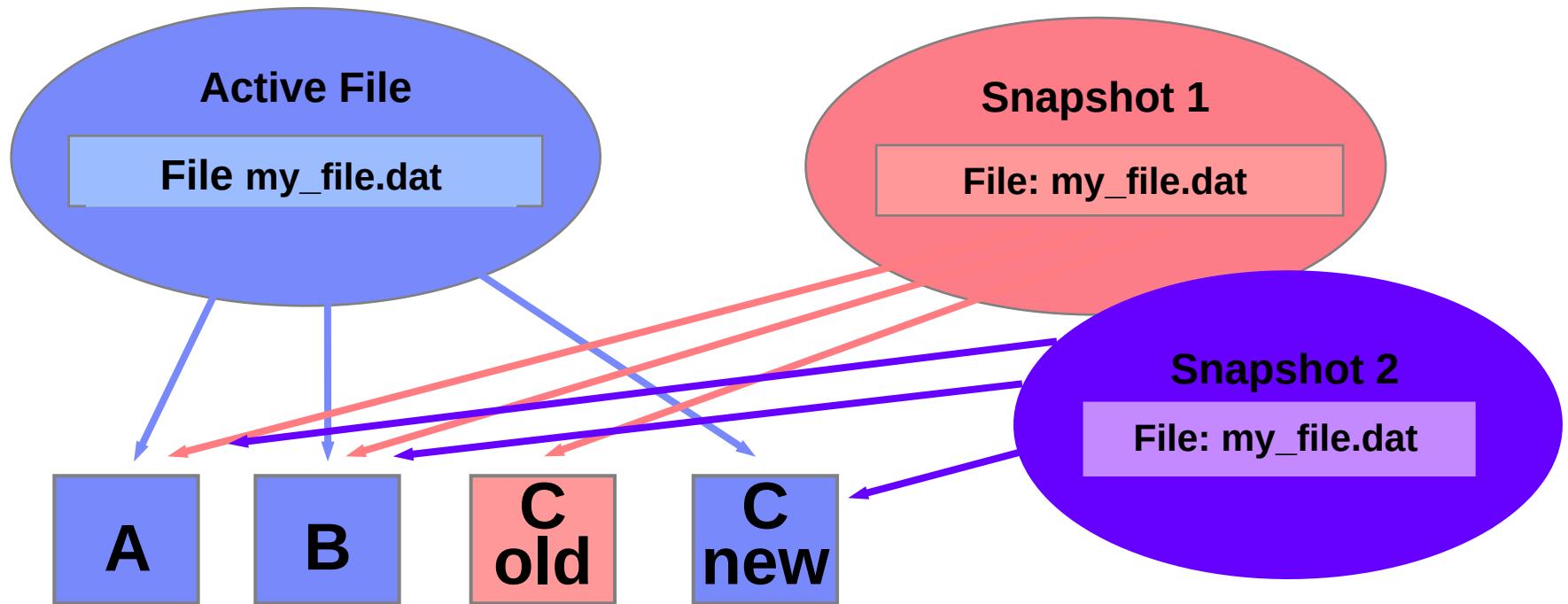
- Comprised of physical blocks A, B und C
- Very fast creation time for a consistent copy (point-in-time copy)
- No physical copying of data blocks, only snapshot i-Nodes are created
- No additional disk storage required for data blocks, only small amount for metadata
- Snapshot can be immediately used for read-only operations (like backup)

Example NetApp feature: backup with SnapShot (3)



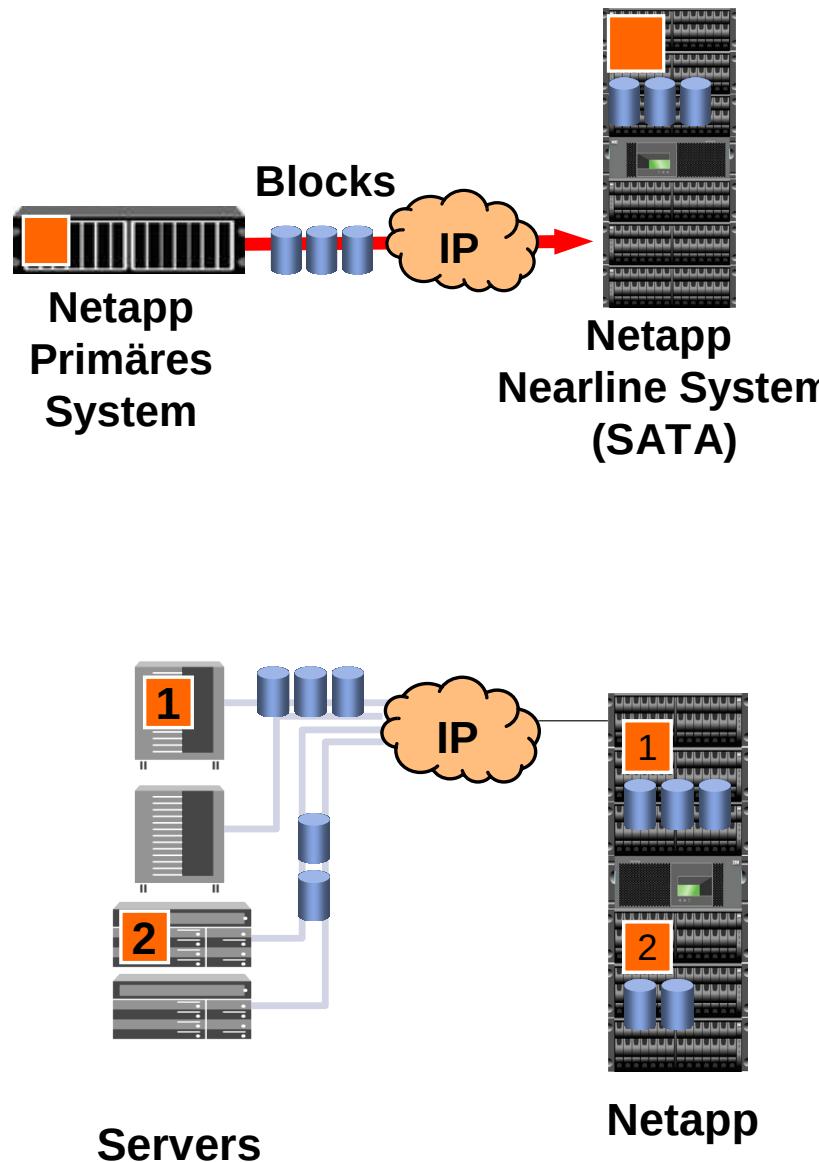
- **Write operation to active file**
 - User modifies content of data block C
 - New data block C created, original block C not modified
 - Active file now: A, B and C new
 - Snapshot 1: A, B and C old

Example NetApp feature: backup with SnapShot (4)



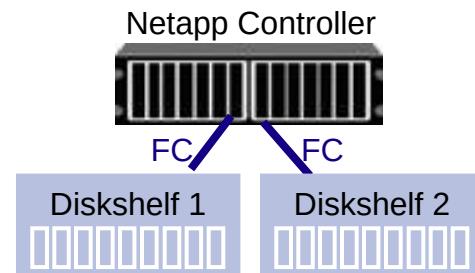
- Additional snapshots can be created
 - Active file: A, B and C new
 - Snapshot 1: A, B and C old
 - Snapshot 2: A, B and C new

Example NetApp feature: SnapVault and Open Systems SnapVault



- **SnapVault** is an online Disk-to-Disk backup and recovery solution:
 - On a regular basis one Netapp transfers data snapshots to a backup Netapp system. The backup Netapp can use cheap SATA disk drives with higher capacity.
 - No intervention from OS required.
- **Open Systems SnapVault** software allows server to push their backups (file or block) onto NetApp systems and restore from there. This works also when using external SAN volumes as source.
 - First backup is a full volume copy, after that only changed blocks get transferred.

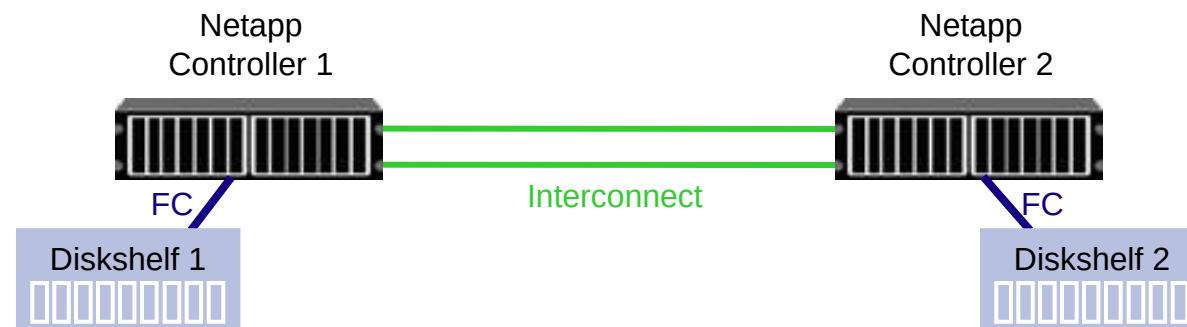
Example NetApp feature: SyncMirror



SyncMirror guarantees high availability:

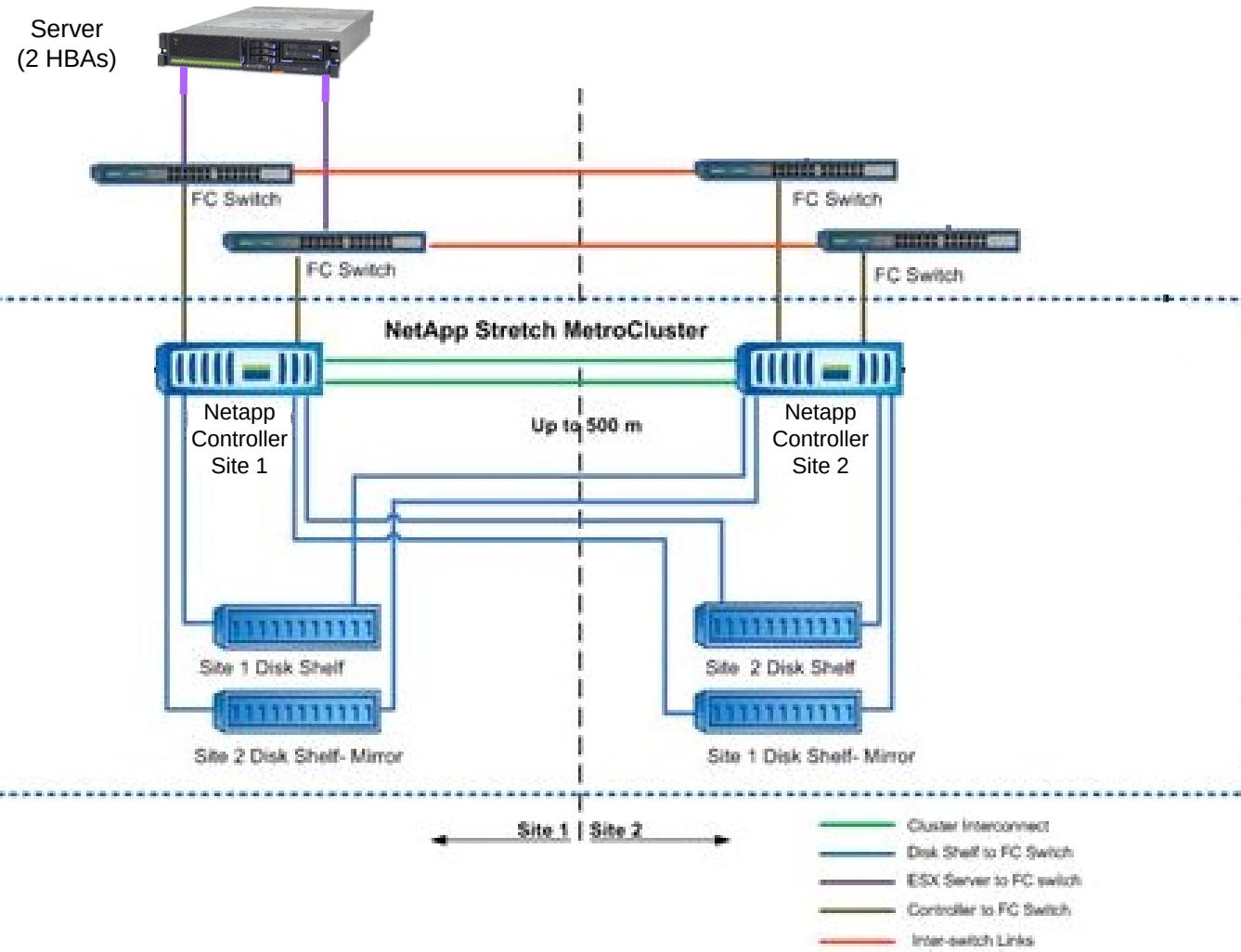
Synchronous mirroring across enclosures on one controller

Synchronous mirroring across enclosures on two different controllers (very popular)



Example NetApp feature: Metrocluster

MetroCluster enhances SyncMirror to **synchronous mirroring** beyond a local data center (site 1 and site 2)



MetroCluster synchronously mirrors data in 2 sites:

- Compensates outage of one controller
- Compensates outage of one disk shelf

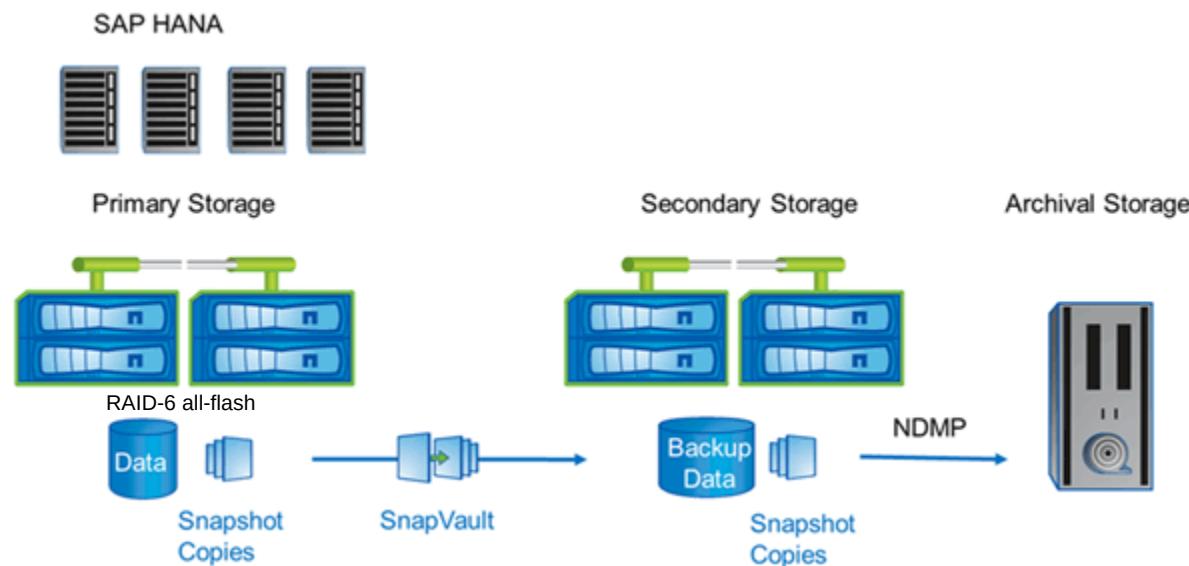
Features:

- **Stretch Metro-Cluster** up to 500m
- **Fabric Metro-Cluster** up to 100km

Example architectures for different use cases (1/2)

Example 1: critical company infrastructure, central SAP ERP database

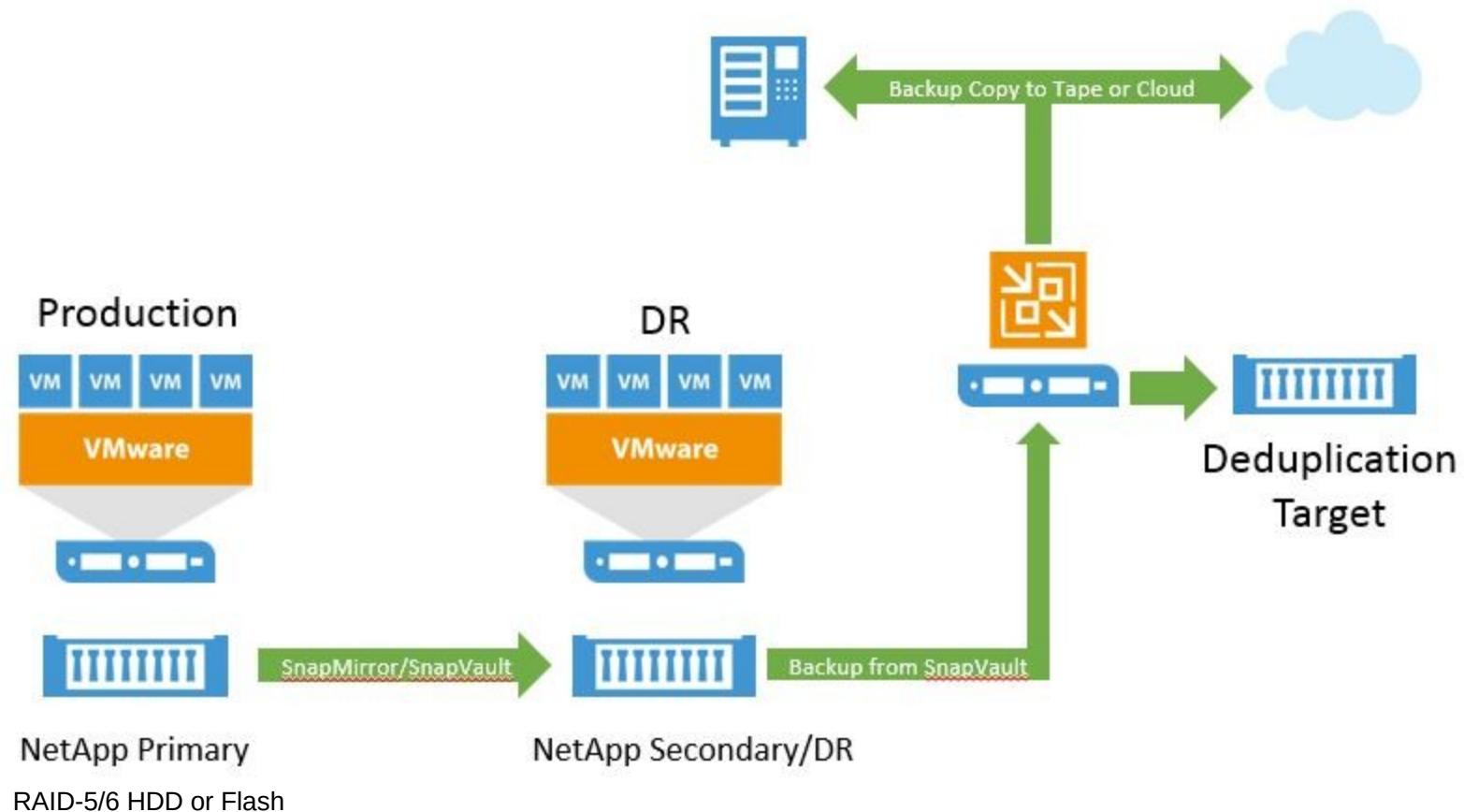
Ultimate availability required, multiple layers of safety.
About 4x to 5x of actual storage capacity required to purchase.



Example architectures for different use cases (2/2)

Example 2: standard company applications, based on Vmware

About 2x/3x of actual storage capacity required to purchase.

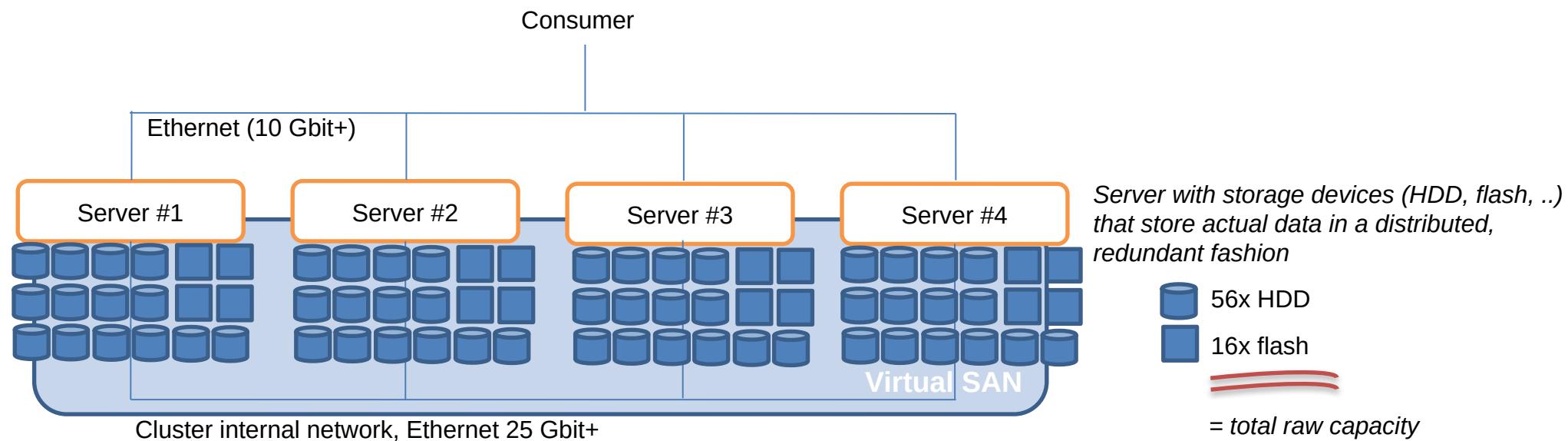


Software-Defined Storage (SDS)

Standard x86 server, with disk drive or flash storage.

Software turns multiple servers into a virtual storage with SAN-like features.

Examples: HDFS (Hadoop), Ceph, VMware vSAN, MS Storage Spaces Direct (S2D)

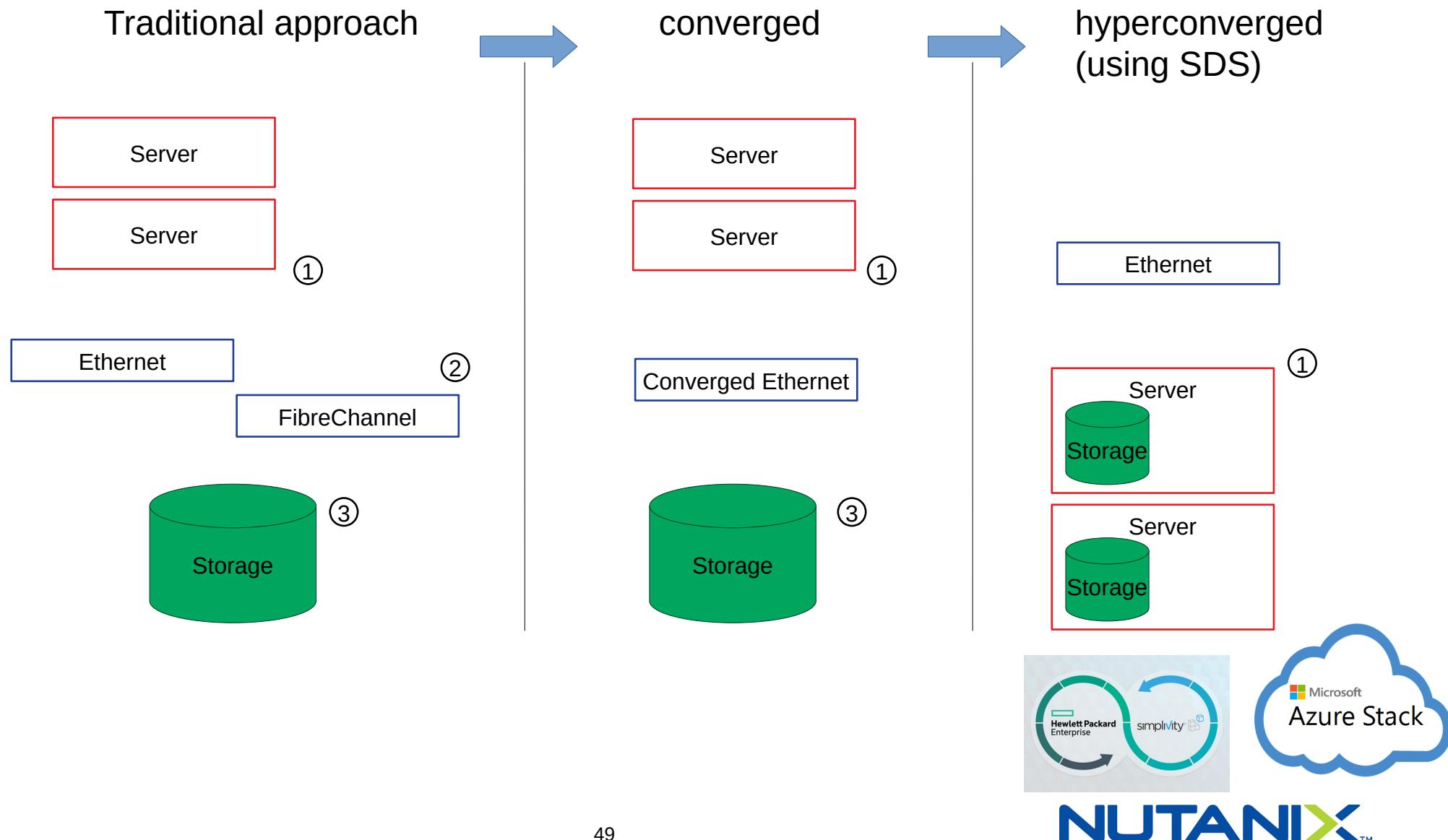


Usable capacity depends... examples:
3-way data replication: 1/3 of raw or 33%
Erasure coding: 4 data + 2 parity => 4/6 of raw or 66%

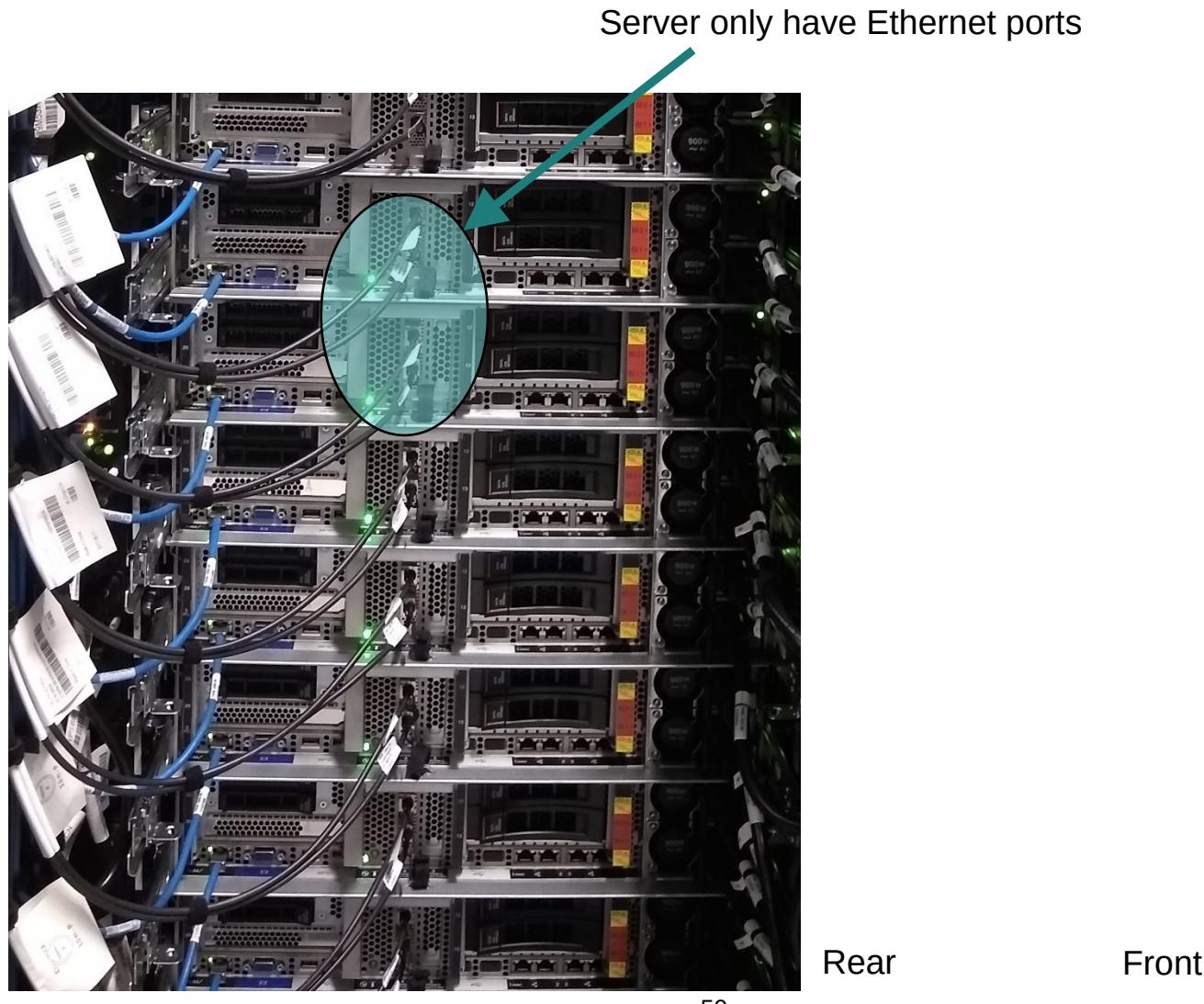
Latest architectural option:
hyperconvergence

HCI – hyperconverged infrastructure

Current market trend



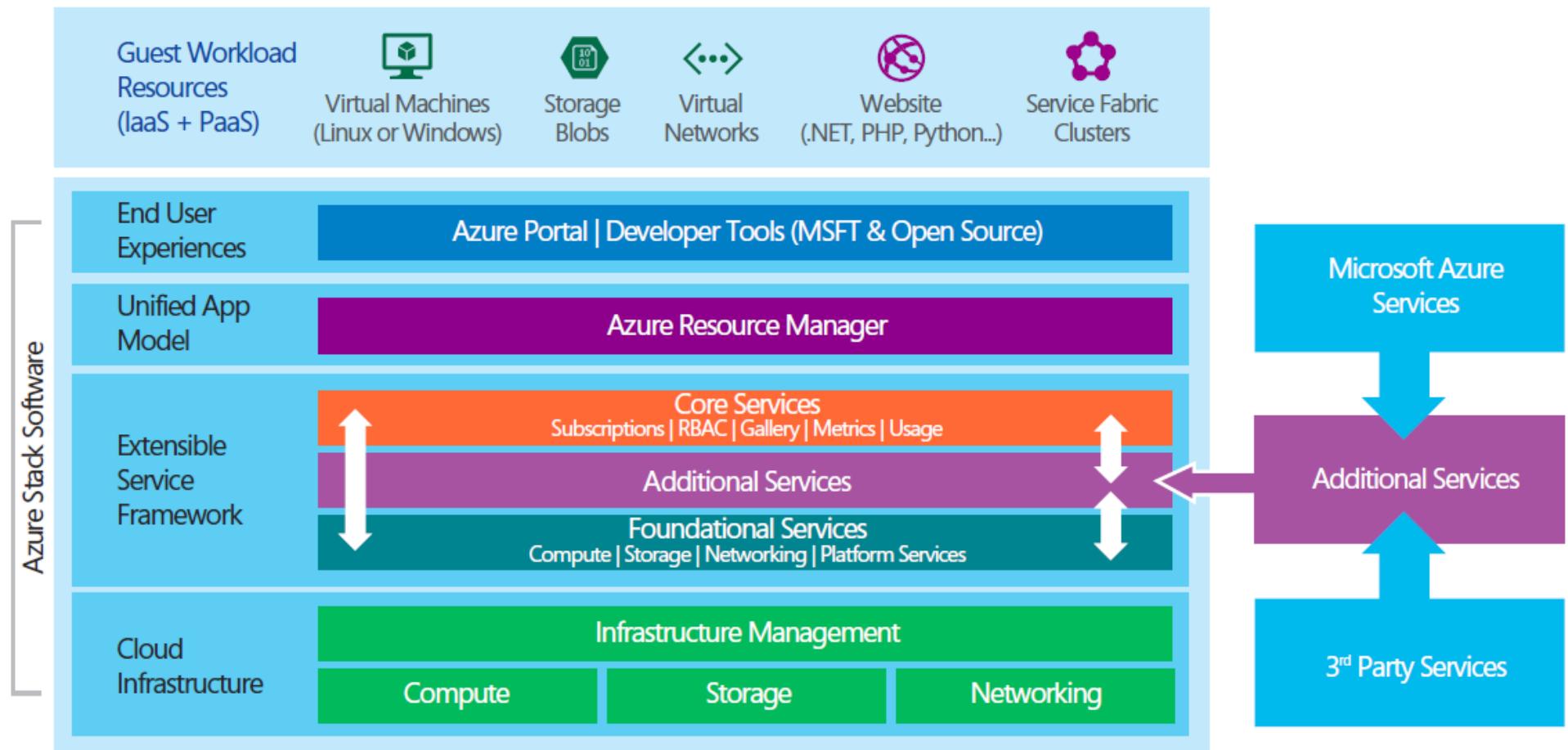
Example of a hyperconverged rack: MS Azure Stack



Example of a hyperconverged cloud stack: MS Azure Stack

Azure Stack architecture summary

Together with Azure public cloud → **Microsoft Arc** (think: vCenter)



<https://azure.microsoft.com/en-us/products/azure-stack/hub/>



Source: Microsoft