Optimizing FUSE for Cloud Storage

Parallels™

Profit from the Cloud

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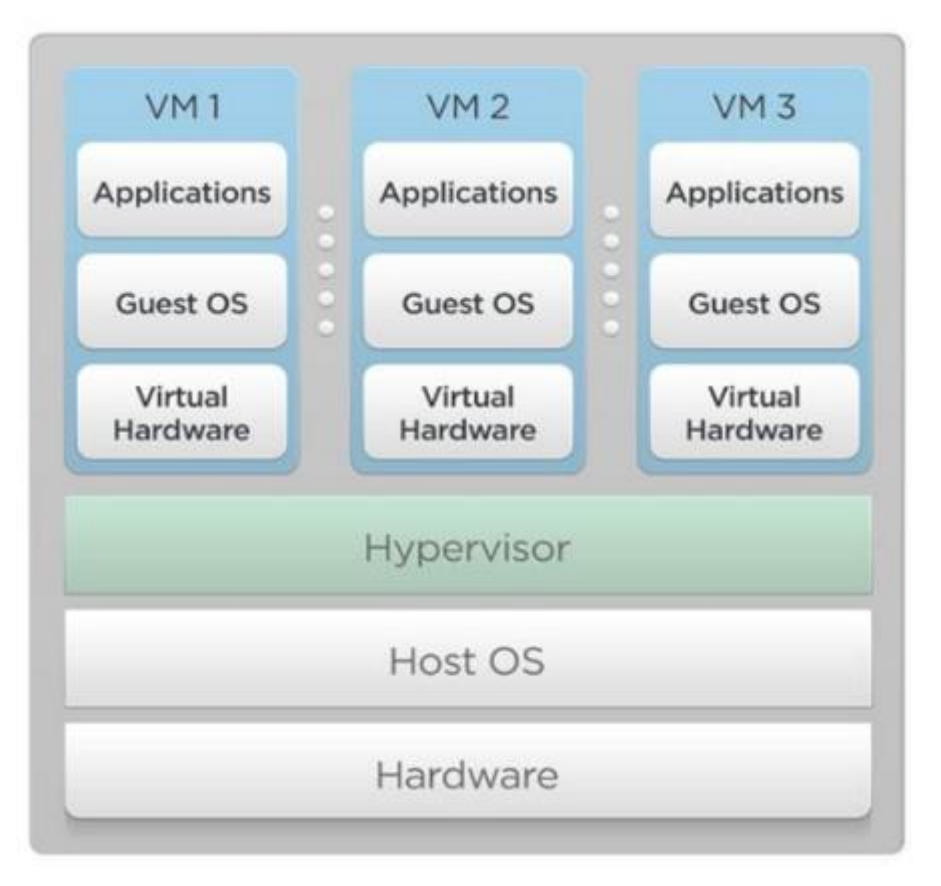
Agenda

1. Parallels Cloud Storage
2. FUSE concept
3. FUSE optimizations
4. Performance achieved
5. Future improvements

Parallels Cloud Storage

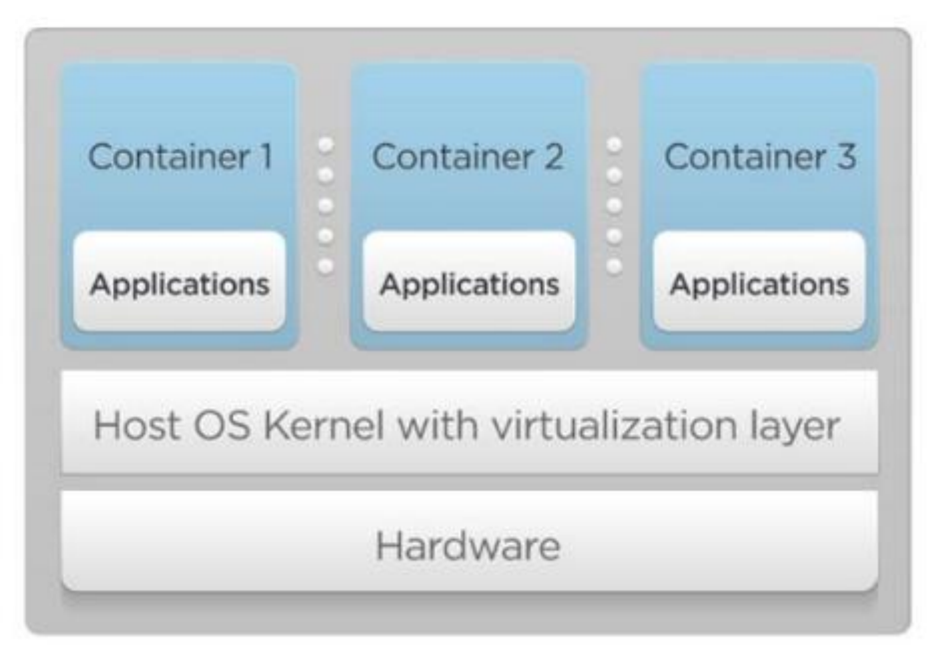
Parallels Hypervisor Virtualization

- OS flexibility
- HW emulation
- Bare metal installation



Parallels Containers

- More efficient memory management
- More efficient caching reduces I/O
- CT resource management
- Easy migration
- Easy backups&snapshots



Storage requirements

Key requirements for VM and Container's needs:

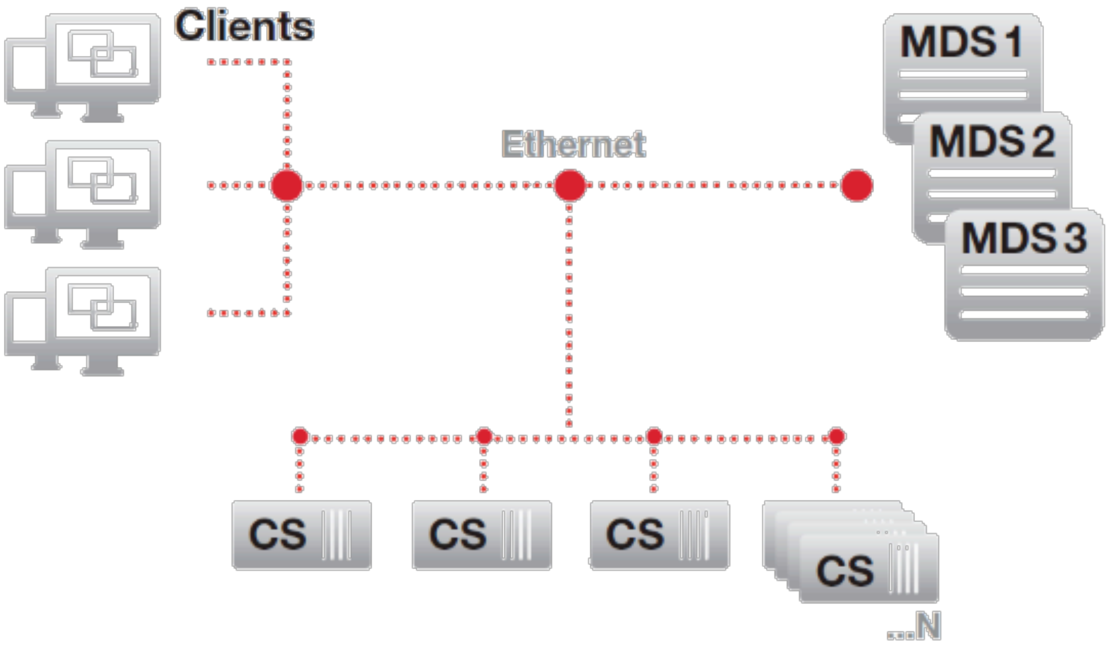
- Strong consistency
- High performance
- Fault tolerance
- Fast recovery
- Address all space from any node
- Commodity hardware
- In-flight reconfiguration and update

Parallels Cloud Storage solution

Key decisions made:

- Optimize for big files
- Union of all local storages
- Replication for fault tolerance
- Keep data and metadata separately
- Multiple metadata servers

PStorage architecture



Meta Data Server (MDS)

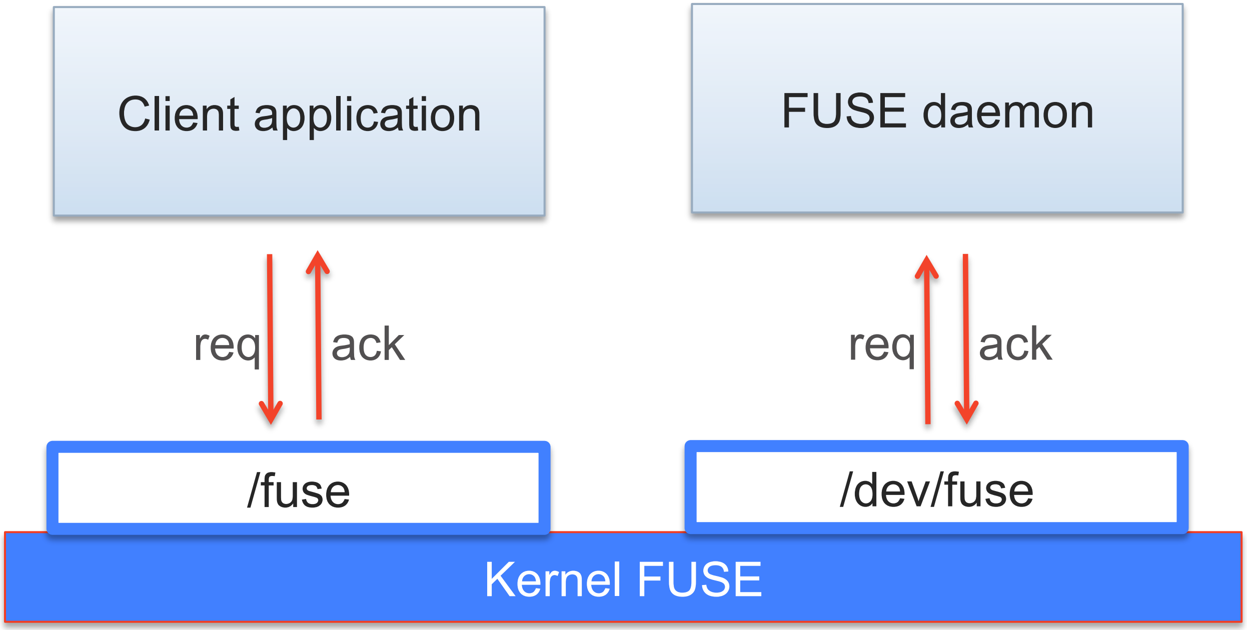
- Stores metadata in memory
- Tracks data chunks and their versions
- Is highly available
- Can run on the same server as the chunk server and client

Chunk Server (CS)

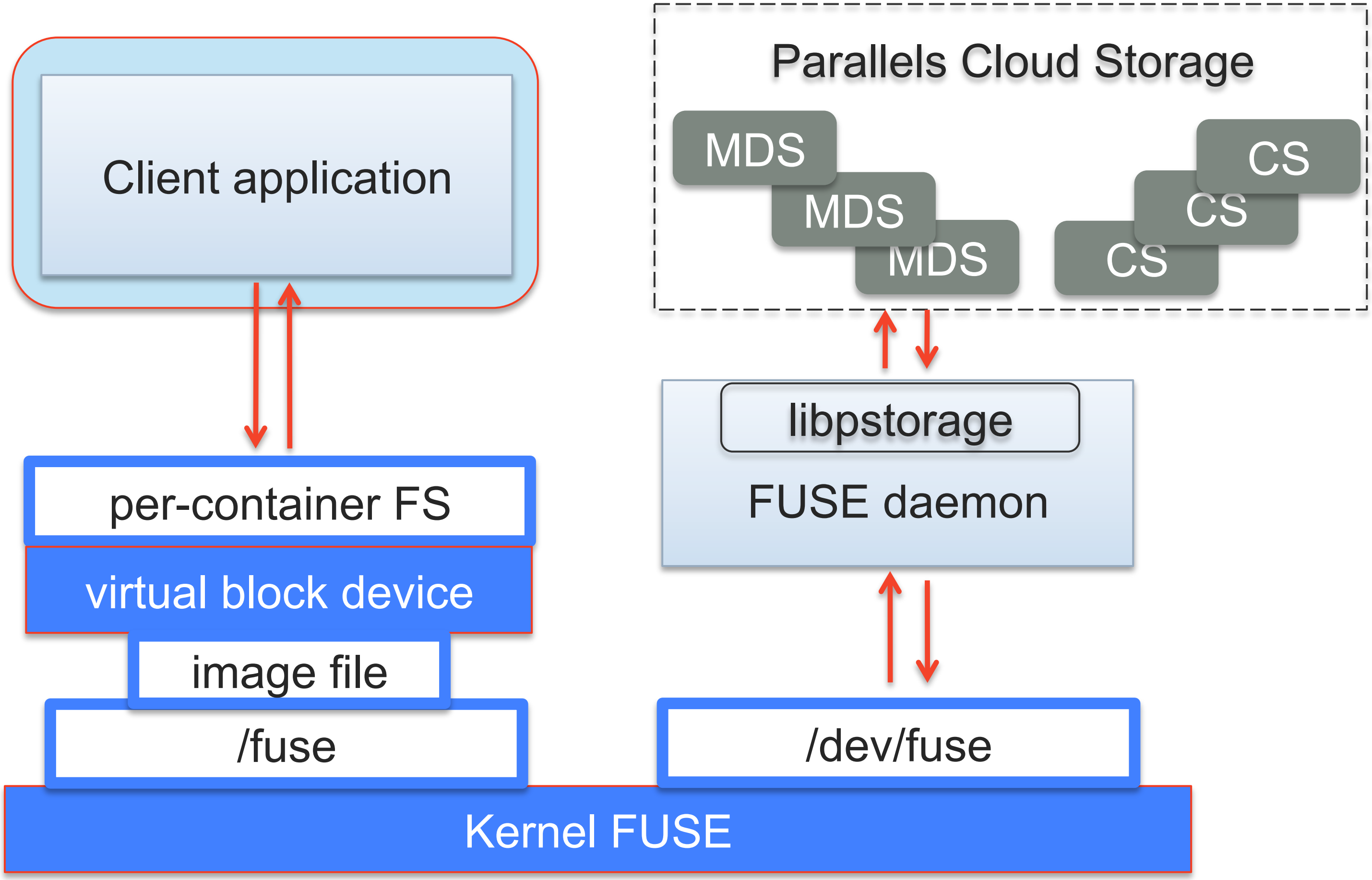
- Stores data chunks
- Manages data chunks
- Performs read/write operations on data chunks
- Can run on the same server as the client

FUSE

FUSE framework



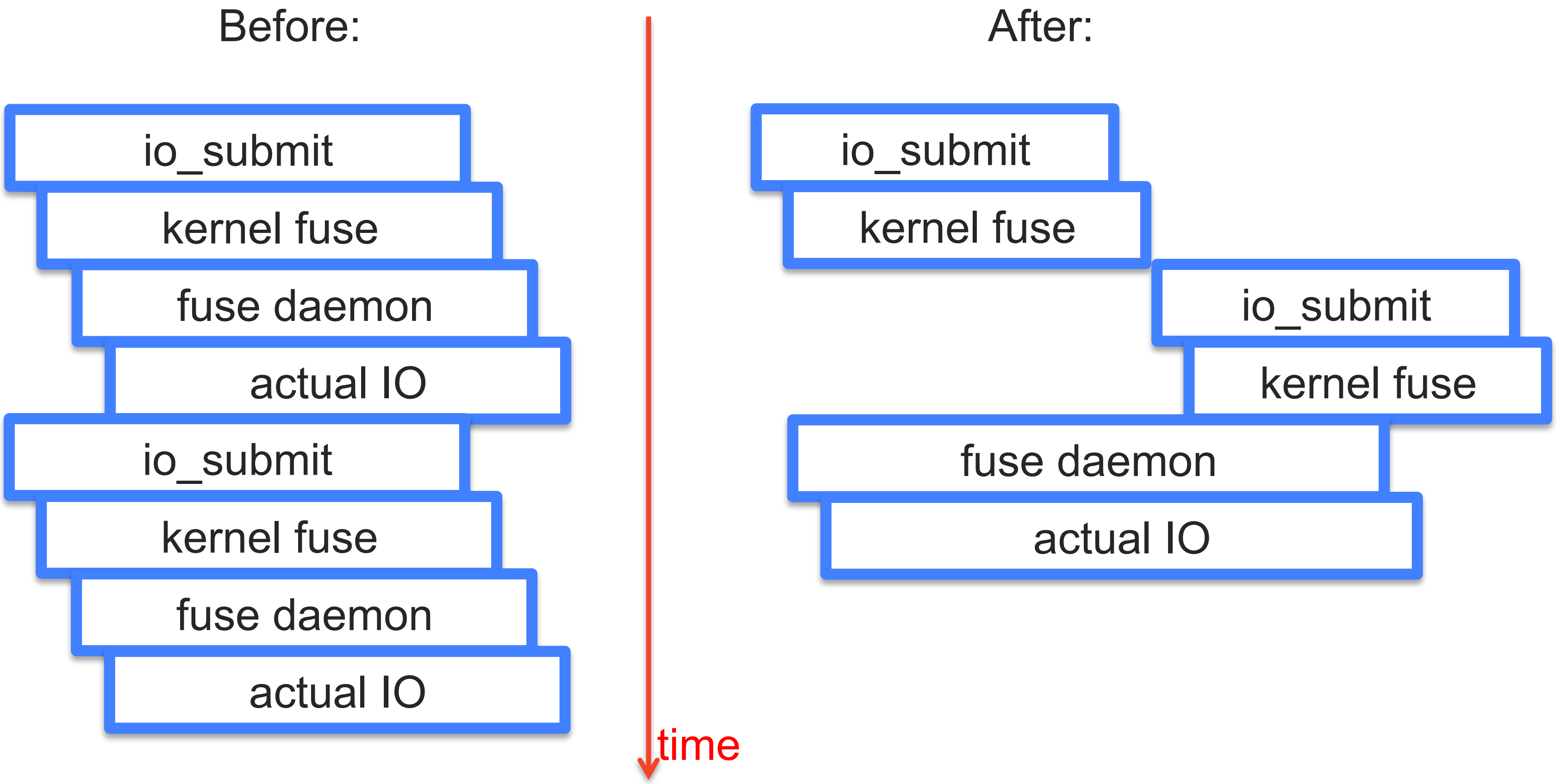
FUSE: Containers on PStorage



FUSE optimizations

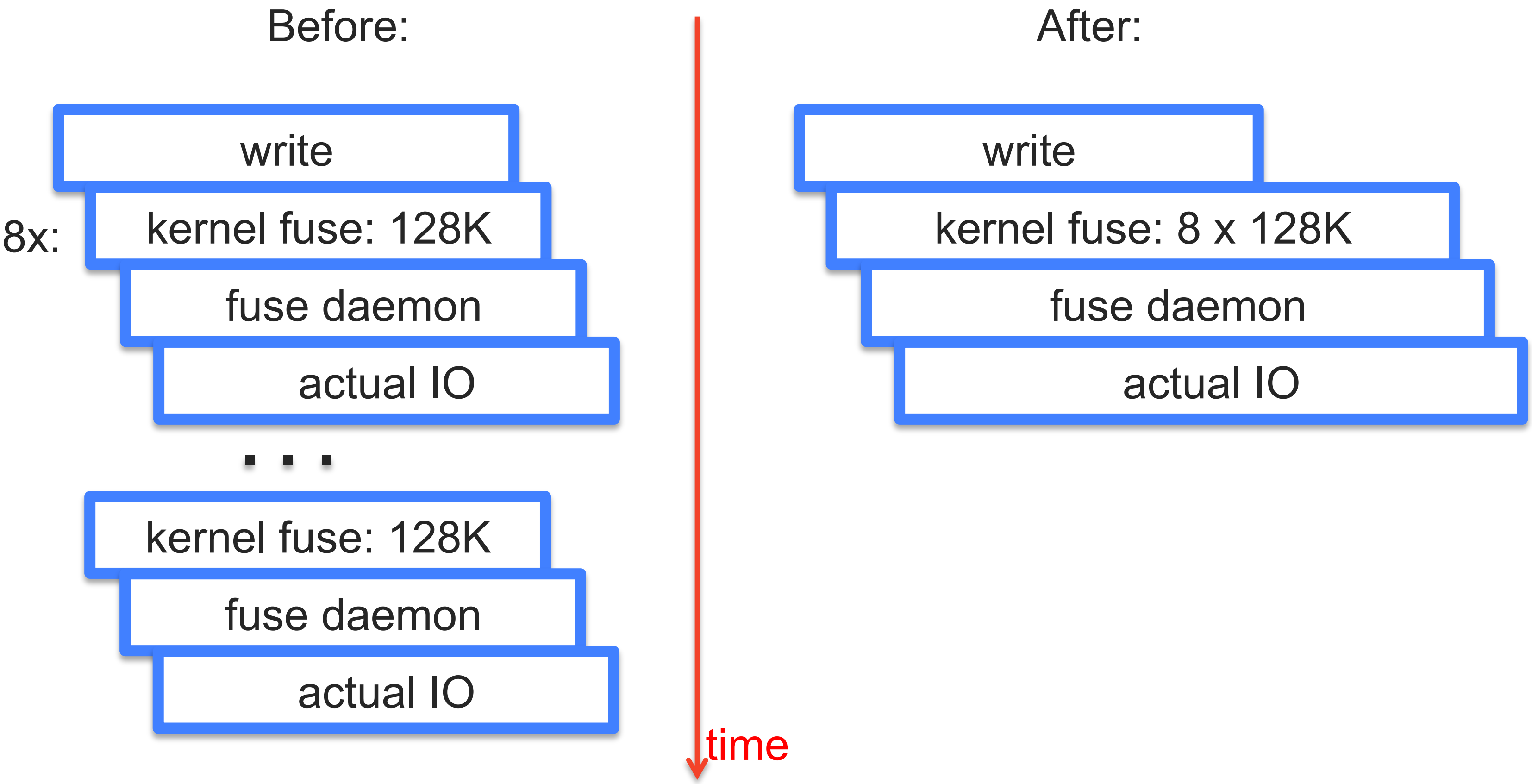
Asynchronous direct IO

Application: io_submit(&iocb1); io_submit(&iocb2);



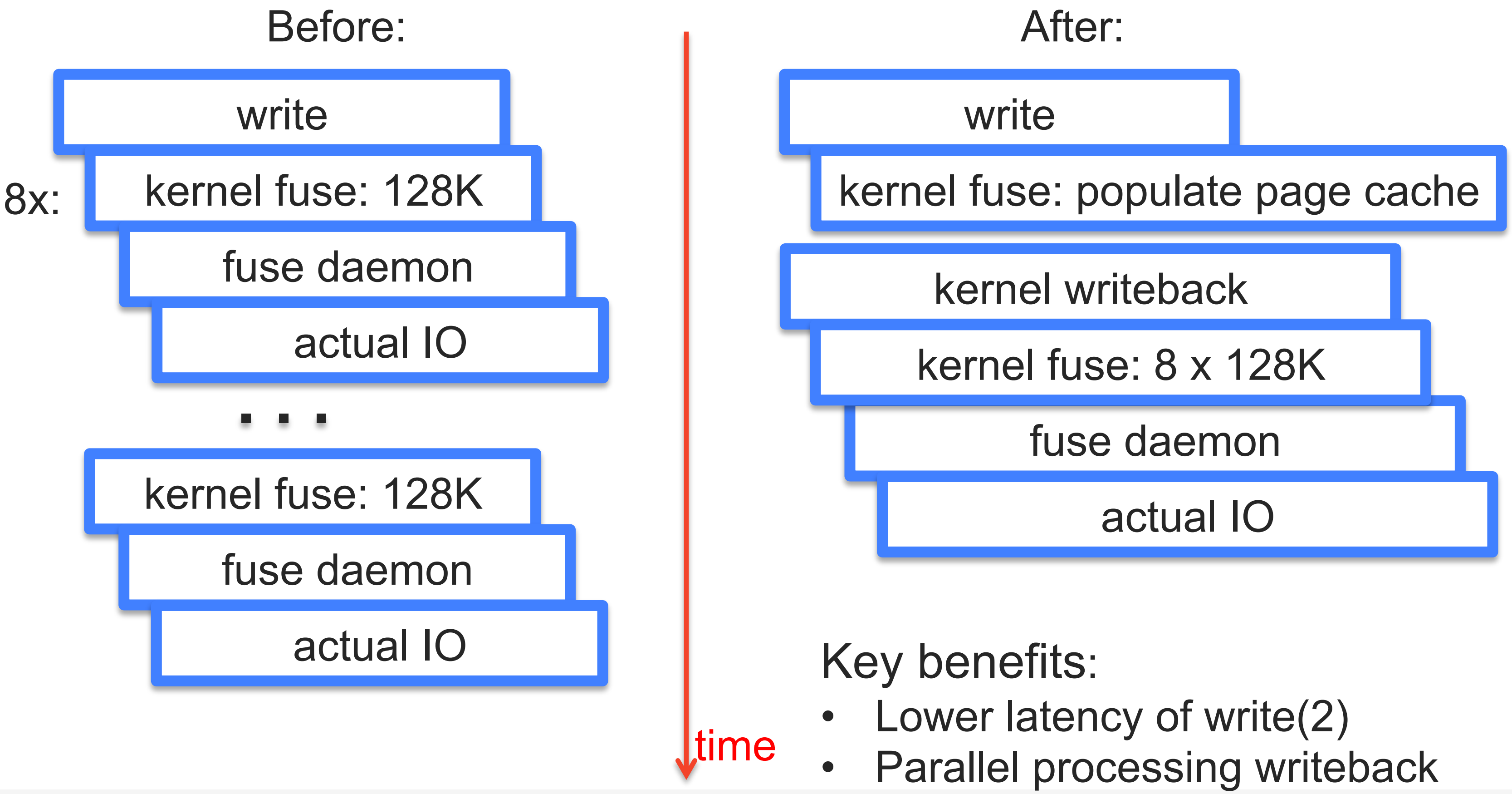
Synchronous direct IO

Application: fd = open(O_DIRECT); write(fd, buf, 1<<20);



Writeback cache

Application: buffered write(fd, buf, 1<<20);



Key benefits:

- Lower latency of write(2)
- Parallel processing writeback

Performance Comparison :: HW

iSCSI SAN Storage
DELL EqualLogic PS6510E

x1 HW SAN EQL PS6510E

48 SATA Disks: 1TB 7200rpm
(Seagate ST31000524NS)

Network: **10Gbit**
(Dell Force10 S4810)

vs.

Parallels Cloud Storage
(FUSE based)

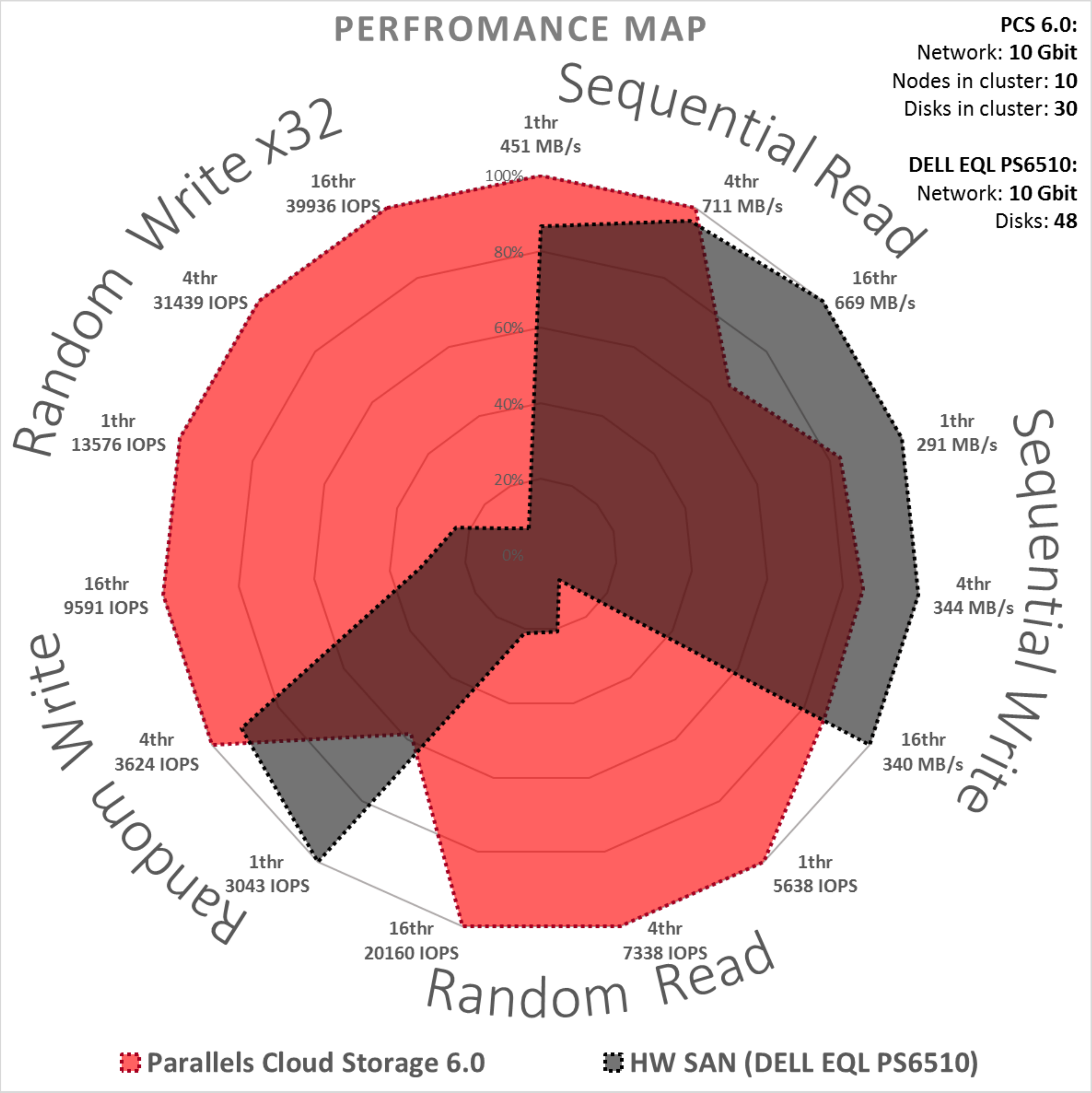
x10 compute nodes

30 SATA Disks: 2TB 7200rpm
(Seagate ST2000DM001)
+ 10 SSD for caching
(Intel SSD 520)

Network: **10Gbit**
(Brocade FastIron SuperX SX-F42XG)

PCS FASTER
than
HW SAN

Just 10 nodes PCS cluster faster than DELL EQL SAN ($97000) in most workloads



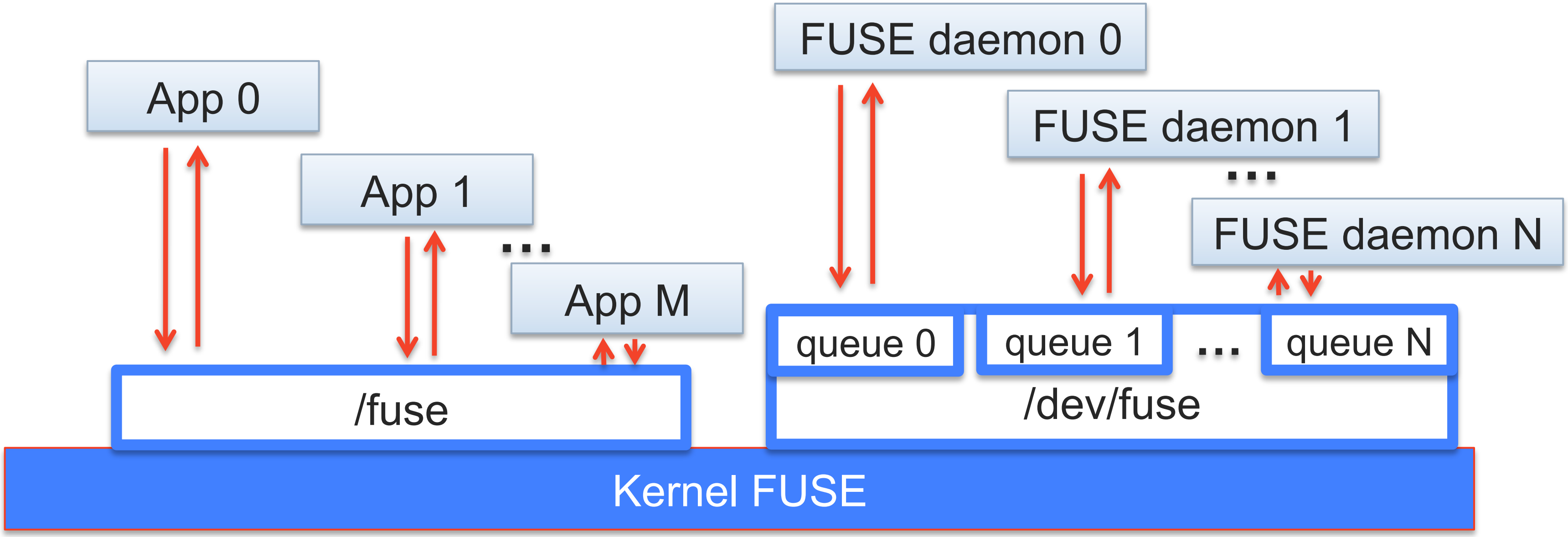
PCS 6.0:
Network: **10 Gbit**
Nodes in cluster: **10**
Disks in cluster: **30**

DELL EQL PS6510:
Network: **10 Gbit**
Disks: **48**

FUSE: what's next?

FUSE: future improvements

- Variable message size (currently 128K)
- Eliminate global lock
- Multi-queue
- CPU and NUMA affinity



Q&A