Challenges of Distributed Storage with Data Protection

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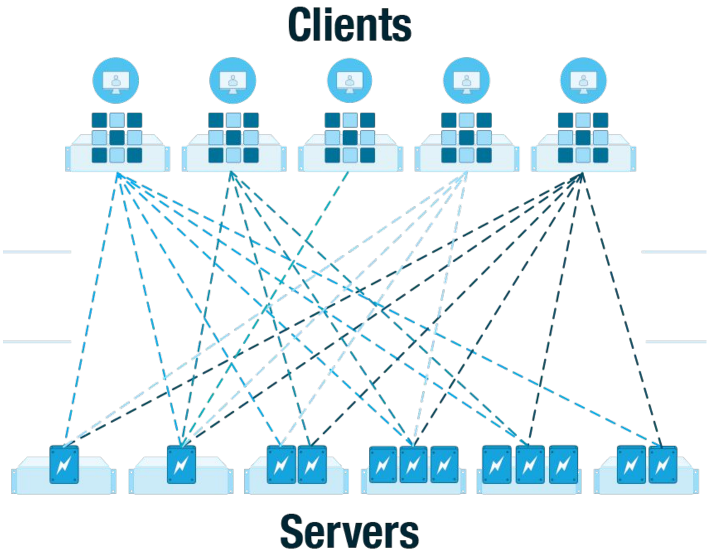
Who is Daniel H. Sh.?

Director of Algorithms at Excelero

- 15 years of software development and architecture experience in various aspects of high performance, multi-platform and distributed systems including machine learning, storage and computer vision.
- Links: Linkedin Stackoverflow
- www.excelero.com

Distributed Shared Storage HW Setup

- Single rack
- Clients: Hosts/Initiators (CPU, NIC,RAM)
- Targets: Servers (+NVME Drives)
- ~~NVRAM, NV-DIMMs, Cache~~
- RDMA notation
- RAID6 (say 8+2)



Full dis-aggregation

Targets: hold full state
Clients: do the full compute

- Target CPU is idle in data path
- Stateless client
  - C_1 crashes, C_2 continues

Benefits of dis-aggregation

- Scalability: Storage / IOPs / Recoveries
  - 50K clients <--> 500 Targets
- Mathematical fairness
- Easy migration
- Control path is not a bottleneck to datapath

Flash Memory Summit

Data Path Basics

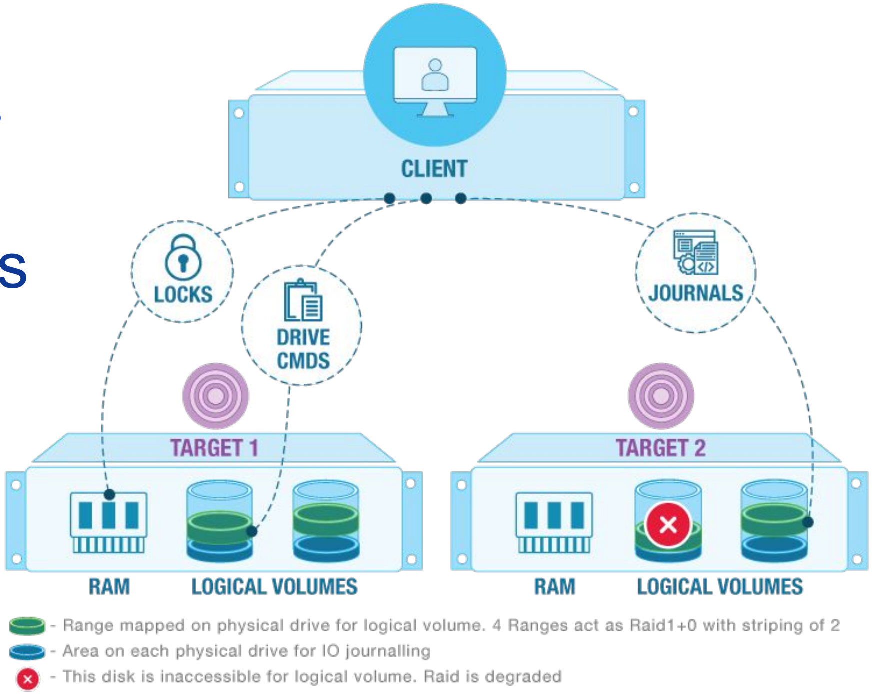
- Transactionality of 4K I/O:
  - Client managed journaling
  - Mutually exclusive clients

- State:
  - Drive Block & Metadata
  - Volatile RAM (Locks, etc)
    - Same redundancy as data on disks

Execution Plans
Basic I/O (good path, degraded mode) **Failed I/O fixups** (client disconnection fixups) **Raid-Rebuilds** (boot, recoveries)
Maintenance (scrubbing, wrap-around, migration) **Control Path**

Components of EC algorithm

- Virtual Block mapping
  - May differently for 2 cpu cores
- Cmds to drives
- Locks + RAM data structures
  - 1+P backup
- Journals
  - Write atomicity, no write-hole
  - IO atomicity
  - Written to same disks as IO



Execution Plan for data-path

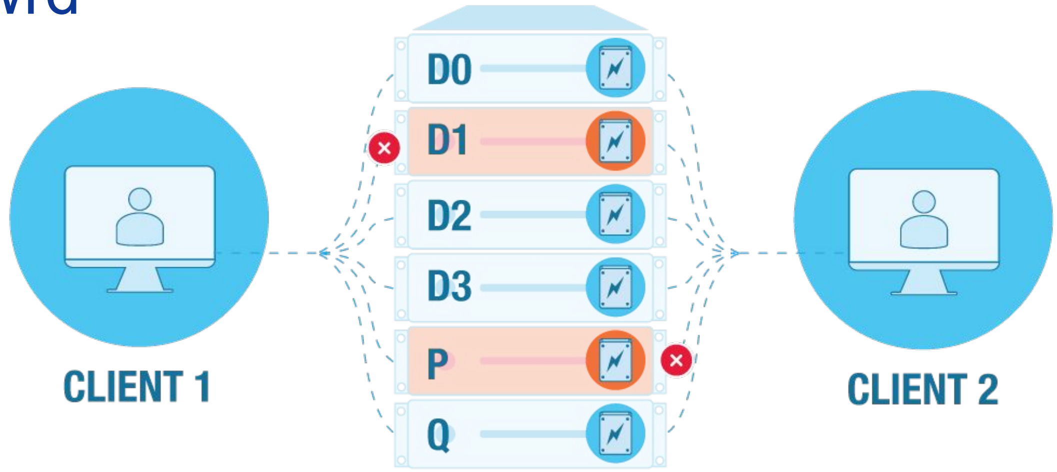
Write of 1[blk] execution	Failed I/O fixup By C_1
1. Build plan {VLBA, topology} 2. Acquire locks 3. Reads old data 4. Locally allocate journals 5. RAID6 GF/CRC calculation 6. Write journals to drives 7. Update RAM data structures --- Here RollFwd is possible --- 8. Commit Data to drives 9. Unlock the lock	1. C_1 (recoverer), C_2 (recoveree) 2. C_1 detects abandoned lock of C_2 3. Acquire locks 4. Get const access to C_2 resources 5. Analyzes RAM, journals, drives 6. Solve write-holes hazards 7. Solve Topology C_1-C_2 discrepancy 8. Solve natural disasters 9. Solve Topology transitions

Issues: Simplicity, Performance

Raid 4+2 Example

- C_1 8K Write:{D_0, D_1, P, Q}
- C_2 "roll-fwds" D_0
- C_2 updates dirty markers
- Crash in "roll-fwd/bkwrd"
- Cold Recovery?

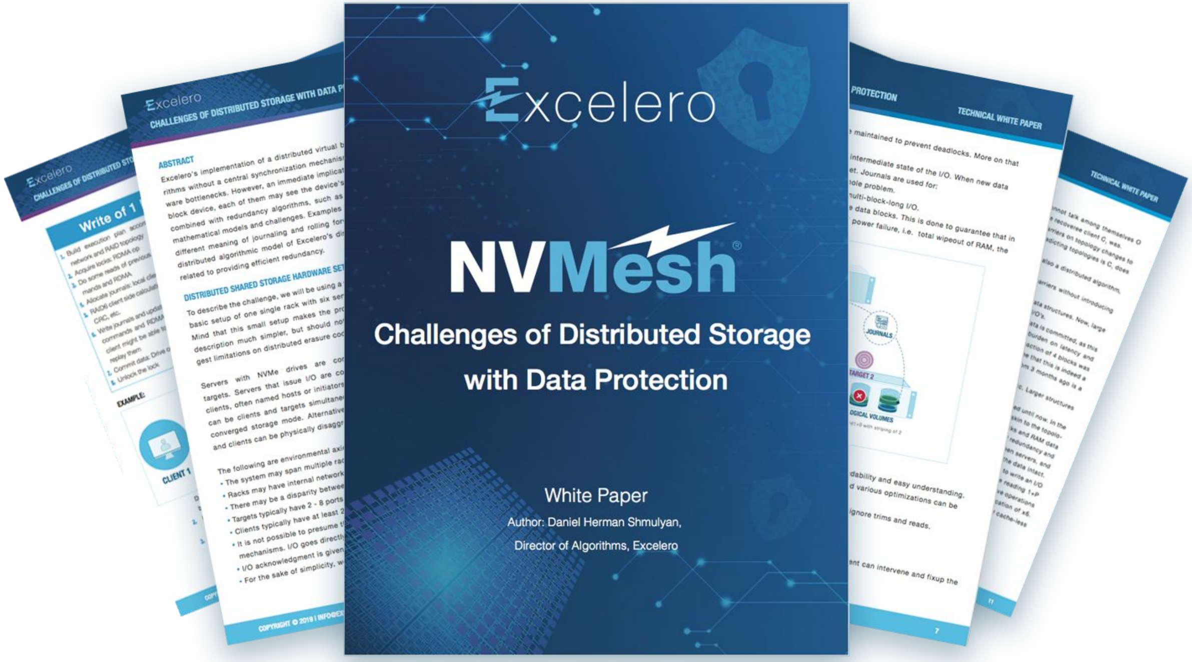
{D_0, P} succeeds



Summary of the Challanges

- No $\{C_1,C_2\}$ Talks
- Control path topo barriers, with datapath.
- Scalability: Distributed Data and Control Path
- u64 rdma cmp-xchng – fast & atomic
- Datapath does not wipe journals
- Locks Topologies
- Single block IO write amplification

Q & A



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Raid 8+2 Topologies

- Drive has 3+ topos {Dead, Rebuild, OK}
- Total Raid topologies: 201
- Clients $\{C_1,C_2\}$ Topologies matrix 201^2.
  - Contradicting Topologies
  - Control Path: soft barrier on Topologies
- Locks Topologies

$$4C^{P}_{D+P}+2(D+P)+1$$