How Open Channel SSD Benefit Datacenter and Enterprise Applications

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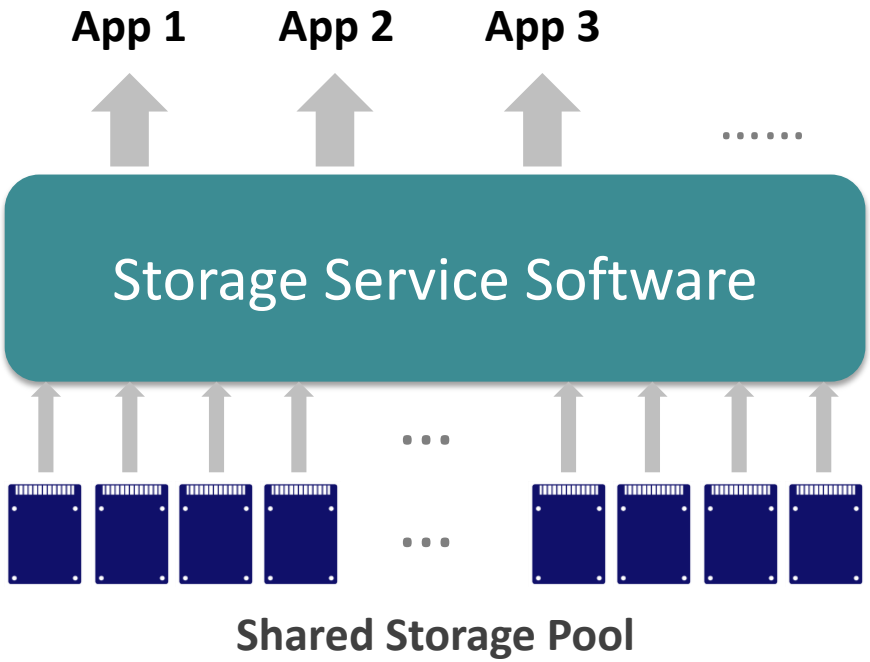
Shared Storage System



Datacenter and Enterprise Storage

- Datacenter (Cloud Service Provider, CSP)
  - Requirements changes rapidly and varies with applications
  - Internal engineering capable for optimization and maintenance
- Conventional Enterprise (or SME)
  - Prefer an integrated system solution of HW alliance and SW
  - Ease purchase and maintenance complexity

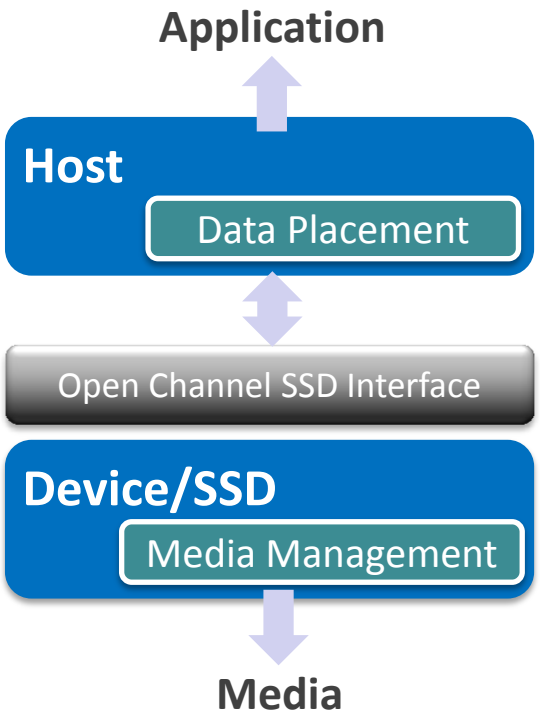
Considerations for Next-gen Storage

- Various kinds of application on the shared devices
  - Required workload specific optimization
- Quick adoption of new generation NAND
  - Reduced complexity and efforts for qualification and deployment
- Diversified supply and vendors
  - Simplified device design and efficient/reliable NAND enablement

Open Channel SSD (OC SSD)

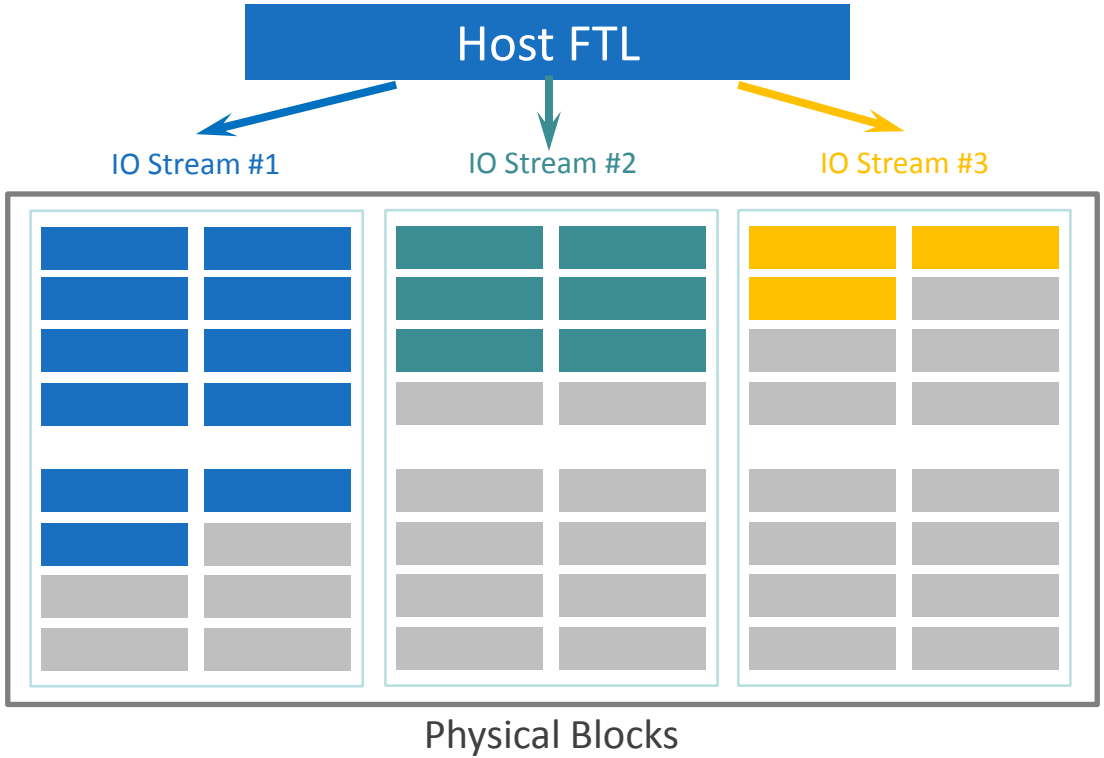
- **OC SSD provides the solution to address the considerations**
- A differentiated SSD architecture – host and device
  - Added “interface” commands leveraging NVMe protocol
- Another approach to optimize storage performance
  - From system level, not only at device
  - Shift more data management to host
  - Ease design requirement of device

OC SSD – Roles between Host/Device



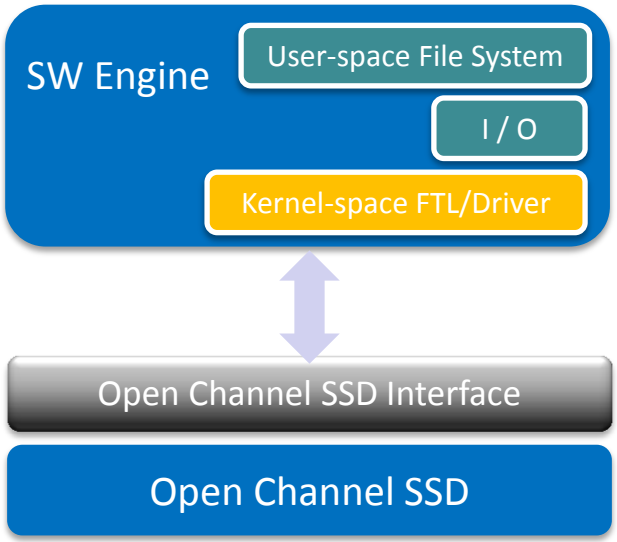
- Data placement -> near application
  - Host software optimizes data placement
- Reliability -> near media
  - SSD takes care of media management
- Expose SSD internal parallelism to host
  - Efficient data placement and IO scheduling

OC SSD – Data Path Control



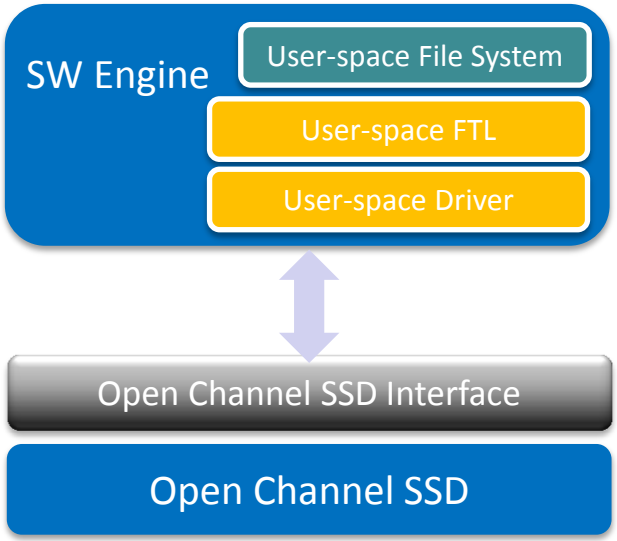
- Manage data streams
- Control entire data path down to physical
  - IO isolation
  - Predictable latency

OC SSD Platform – Legacy Usage



- FTL/Driver at Kernel-space
- Easy adoption as block device
- Smooth transition for legacy usage

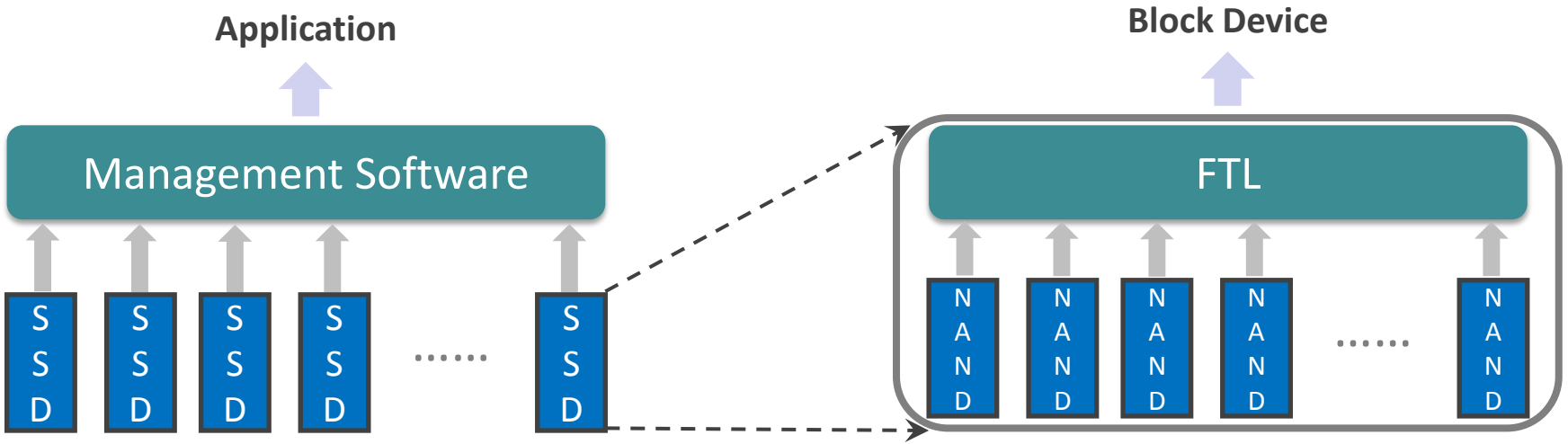
OC SSD Platform – Advanced Usage



- FTL/Driver at user-space
  - FTL as a component of SW application
  - Good for maintenance
- To reduce redundant mapping
  - Combine GC/WL to reduce WA
  - E.g. object storage (KV)

OC SSD Platform – Further Optimization

- Management SW for SSD devices
- Another “FTL” on top of block devices
- Management SW inside SSD
- An FTL to manage NAND devices



Device – Simplified but Flexible

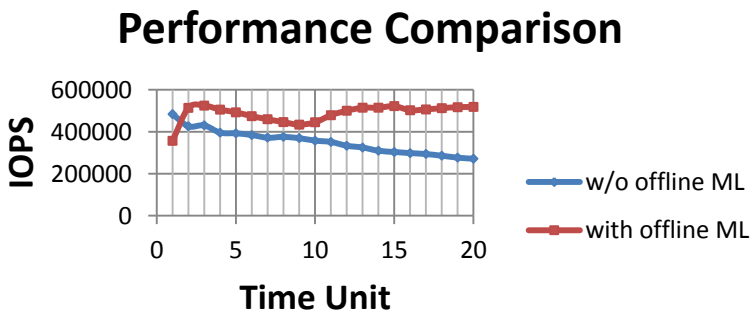
- Device focus on media management for reliability
  - Ease and simplify some controller requirement
  - CPU / Memory / Power
- HW/FW design flexible for differentiated customization
  - Different OC SSD interfaces
  - Customized FTL partitions between host and device

Device – Diversified NAND Enablement

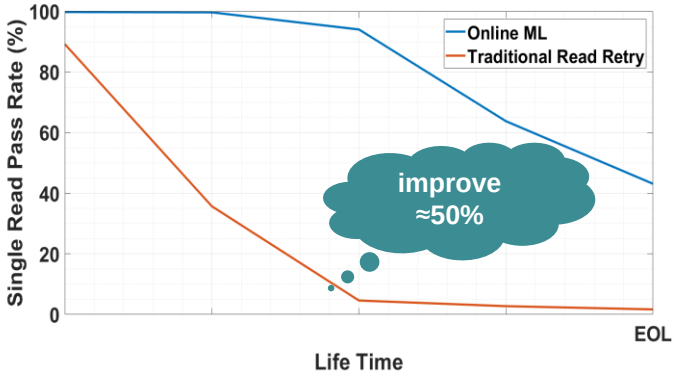
- Deep knowledge on NAND characteristics for reliability
- Intelligent FW algorithm for optimized device BOM cost
  - DRAM-less
  - Latest 3D TLC and QLC
- Efficient and reliable enablement for diversified NANDs
  - Stronger ECC, e.g. 4KB LDPC
  - Off-line / Online Machine Learning algorithm

Device – Offline/Online ML Error Recovery

- Practical data collection to build up database NAND characteristic
- **Offline** develop/adjust algorithm with **modeling and updated data**



- **Online** training to optimize with **real-time user scenario**
- Increase read performance and improve QoS



Device – Approaching Error-Free

- Bit errors, read disturbance, retention, program failure, …
- Device to record error statistics, and address errors as much as possible
  - Comprehensive error avoidance/recovery schemes
  - The more device to address, the less host to take care

Summary

- OC SSD addresses the needs of datacenter and enterprise storage
  - Optimization per application, quick NAND enablement, diversified supply
- OC SSD architecture provides the flexibility
  - Host to optimize data placement for IO isolation and latency
    - Combined GC and further optimization for software defined storage
  - Device to deal with media reliability to approach error-free
    - Simplified and diversified for optimized device BOM cost

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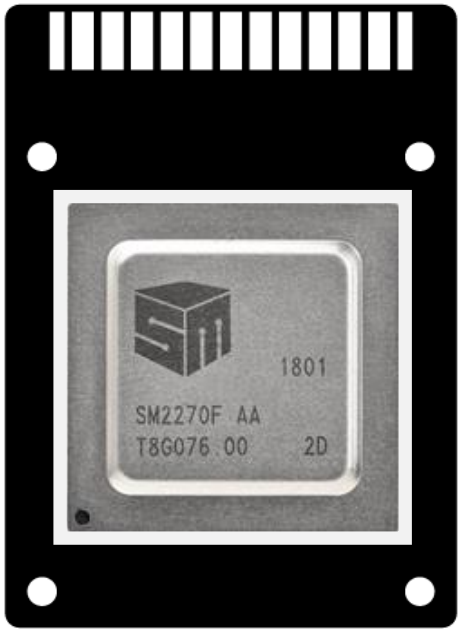

- Dual-mode SSD – NVMe and OC SSD
- Supports several OC SSDs
  - OC SSD V1.2/V2.0 spec
  - Customized interfaces for A* and B*
  - Project Denali pre-standard
- Enabling latest and coming 3D TLC/QLC

Thank You

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