PRESENTATION TITLE GOES HERE

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STORAGE INDUSTRY SUMMIT

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“Putting NVM to Work”

The Future of Computing: The Convergence of Memory and Storage through Non-Volatile Memory (NVM)

SNIA
Solid State Storage Initiative
Storage Used to Be Simple

- **DRAM**
- **DISK**
- **TAPE**

The diagram shows a comparison between different storage types based on their access latency and cost. DRAM is on the top left, representing high access latency and high cost. TAPE is on the bottom right, indicating low access latency and low cost. DISK is in the middle, with moderate access latency and cost. The diagram also distinguishes between volatile and persistent storage types.
Diversity in Storage Options Exploding

- DRAM
- SCM
- FLASH
  - SLC
  - eMLC
  - MLC
  - cMLC
  - TLC
- DISK
  - Nearline
  - Cloud
  - Archive
- TAPE
- Access Latency

$\text{Access Latency}$

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Fast Persistent Storage is Disruptive

Access Latency

- DRAM
- SCM
- SLC
- eMLC
- MLC
- cMLC
- TLC
- FLASH
- DISK
- Nearline
- Cloud
- Spin down
- TAPE
- Archive

Volatile vs. Persistent

$$$$
NVM Dual Access Models

NVM.FILE & .BLOCK

NVM block capable driver

NVM device

Application

File system

Native file API

User space
Kernel space

NVM.FILE mode

NVM.BLOCK mode

NVM.PM.*

PM-aware kernel module

PM-aware file system

PM device

PM device

PM device

PM device

…

PM device

NVM PM capable driver

Native file API

User space
Kernel space

NVM.PM.FILE mode

NVM.PM.VOLUME mode

Load/store

MMU Mappings

Nice Job!
“Transparent” NVM Adoption Drivers

- SCM/NVM treated as storage OR DRAM
- Every app benefits from ‘faster flash’
- Every app benefits from more ‘memory’
  - DRAM cache in front of SCM
- Likely that mobile use cases will drive cost of SCM technologies down
“Transparent” NVM Applications

- Application characteristics
  - Memory-based or Flash-based today
  - Real-time latency / Hi TX rate Databases
  - Performance at any cost

Online Gaming  Financial Trading  Social Media Trending
“Disruptive” NVM Adoption Drivers

- Persistent memory is a new design center
  - New database models
    - Role of logs will change
    - End of serial thinking
    - Graph DBs? Spatial models?
  - New data protection and recovery models
    - Integrity of NVM data structures under failure
    - Off-system replication without latency hit
    - Rapid rebuild from disk for DR
  - New hardware service models
  - New security concerns
“Disruptive” NVM Applications

- Memory-based or Flash-based today
- Real-time latency / Hi TX rate
- Larger datasets than today’s in-memory apps
- Apps that need zero downtime and instant recovery
Disruptive NVM Applications

Commercial Drone Traffic Control
Disruptive NVM Applications

Medical/Wearable/Embedded
Closing Thoughts

- Persistent memory is disruptive
- Analytics and Stream-based applications will drive adoption
- New data structures and programming practices will be required
- Data management will span host and backing stores
- This will be high-impact innovation
Thank you