Performance Benefits of NVDIMMs in Enterprise Data Storage Platforms

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Agenda

- IntelliFlash Storage Arrays
- Write Cache
- I/O Flow Architecture
- NVDIMM Integration – IntelliFlash OS
- NVDIMM Optimal Usage Strategy
- IntelliFlash Write Cache
- Results
IntelliFlash Storage Arrays

• High performance hybrid and all flash storage arrays
• Multi-protocol support including iSCSI, FC, NFS and SMB
• Highly Available Active/Active cluster
• Designed to leverage different grades of media
  – DRAM, NVDIMM, Flash, NVMe and HDD
Write Cache

• Separate logging for incoming writes
• Write is acknowledged after persisting to the write cache
• Data flush in sync cycles
  – Coalesced data is compressed, deduplicated and synced to drives
• High performance media
  – Latency is crucial for many applications like DBT and OLTP
I/O Flow Architecture

- Low-latency devices for Write Cache
- Availability via NTB mirror
  - Ctrl 1 → Ctrl 2
  - Ctrl 1 → Ctrl 2
  - → [Ctrl 3 / …]
- Data Management
  - Fingerprinting / dedupe
  - Compression
  - Coalescing
NVDIMM integration – IntelliFlash OS

• BIOS changes to detect and verify NVDIMM during boot
  • Vendor specific driver integration
    – No standard three years ago
• Monitoring voltage, charge and temperature levels
• Block device interface for control path to fit into IntelliFlash device model
• Memory mapped I/O to local NVDIMM
• NTB based memory mapped I/O to remote (peer’s) NVDIMM
• Write mirroring failure handling
  – Write succeeds locally but may fail to mirror because the remote node or the link is down
  – Write falls back to SSD in case of such failures
NVDIMM Optimal Usage Strategy

*Effective utilization of limited size NVDIMM*

- NVDIMM can quickly fill up when applications are generating burst writes
- Throttling the incoming writes can result in high latency variation
IntelliFlash Write Cache

• Intelligently use SSD log to supplement NVDIMM space shortage
  – Small logging latency is still better than throttling

• Use of SSD is proportional to the burst size
  – The SSD usage is spread over several sync cycles

• Reduce the sync cycle window and SSD logging to achieve fair distribution
  – For example, 90% to NVDIMM and 10% to SSD
  – Dynamically adjust the distribution based on burst size and sync time

• The latency is amortized over multiple sync cycles
Results - Configuration

- IntelliFlash T4700 all flash array with 24x1TB capacity
- iSCSI protocol
- FIO benchmarking tool with 4 clients and 8 LUNs
- Each LUN is 100GB
- Test method - Fill the LUNs and 100% random read for 10 mins
  - Actual test is done afterwards
- 80:20 RW – 80% random read, 20% random overwrite
- 50:50 RW – 50% random read, 50% random overwrite
- 4k, 8k and 16k block sizes
Latency comparison
IOPS comparison

![IOPS Comparison Graphs](image-url)
Throughput comparison

Throughput @80:20 RW Workload

Throughput @50:50 RW Workload
Questions