Virtualization Software for Flash and NVRAM

Session D11
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Data Center Challenges

- Data centers dealing with huge amounts of data
  - 4 zettabytes\(^1\) of world wide digital data being stored
  - As much as 40% data growth rates
  - 8 million data centers by 2018, 70% of which will be mega datacenters\(^2\)

- Need to rapidly and non-disruptively scale compute and storage resources

- Focus on technologies and products that reduce system wide costs and increases automation and operational efficiency

\(^1\) 1 zettabyte = 1 billion terabytes or 1,000,000,000,000,000,000,000 bytes
Trends

• Dramatic shift in the way we are building large scale storage systems
  • Massively scalable data requires new architectures
  • Automation and adaptability has become a key requirement
  • Merger of compute and storage (hyper-convergence)

• Flash based storage gaining a firm foothold in data centers
  • All flash arrays now a ~$1bn market¹
  • Hybrid Flash Arrays (HFAs) ~$10bn¹

• Software defined data centers
  • Relying more on open/commodity hardware storage-servers, software and devices
  • Mostly still a flash caching or flash-primary storage world
  • Few “stack independent” software virtualization offerings addressing scale-out

¹ Source: IDC via web
Storage Virtualization

• Storage virtualization history
  • Designed into “big-iron” shared storage systems
  • Ultimate purpose is to facilitate 24/7 operation through storage move/change/adds i.e. increase operational efficiency of enterprise storage systems
  • Opened up new capabilities: thin provisioning, tiering, replication…
  • Tied to hardware and a vertical software stack

• Hyper-convergence and webscale
  • Based on commodity, commonly available building blocks
  • Software defined storage (SDS) gets us part of the way
  • Ceph, Swift Stack yet another approach

• Simplicity “it-just-works” is key for all virtualization
Options for Integrating Flash into Servers

• Put everything on flash or storage class memory
  • 600-700K random IOPs or 3GB/s+ streaming data
  • NVDIMM/NVRAM memory class with flash backup options promising higher performance
  • In-memory for extreme performance databases (several millions of transactions/sec)

• Flash caching software
  • Most common and least risky approach for integrating server-side flash
  • Focus is on speeding up legacy hard disk systems
  • Sacrifice SSD capacity and performance for ease of integration
  • Limited so far to classic SAN architectures and some DAS applications
  • More complex versions appearing, but still essentially caching

• Full flash optimized virtualization software
  • Highest performance – flash and NVRAM primary storage in a hybrid storage pool
  • Greatest capacity efficiency – flash contributes to the user pool
  • Least amount of latency and overhead as non-CPU intensive
  • Most recent use real-time tiering and file pinning
All Flash or Hybrid?

• All-flash provides best performance but too costly for broad deployment
  • A large portion of data is not being accessed – so why pay for it to sit there

• Flash as a cache is limited to narrow set of legacy applications
  • Not suited to webscale/big data unstructured and streaming files
  • Capacity is “lost” as flash only holds copies of data – important for larger SSDs
  • Often demonstrates no visible application improvements

• Flash optimized virtualization provides broader options
  • Treats flash or memory class storage as direct attached primary storage
  • Typically 80% less than all-SSD costs
  • Handles moves/changes/adds more efficiently
  • Broader combinations of devices: memory-flash, flash-flash, flash-hard disk
**Flash Optimized Virtualization and Tiering**

Storage Devices

- **Fast**
  - Flash (SSD)
  - Cost: $2-4/GB

- **Slow**
  - Hard Disk Drives (HDD) or RAID
  - Cost: 4-8¢/GB

Files → Folders → Virtual Disk

- Intelligently places active data on flash
- Use File Pinning to tag work files for SSD performance or simply let it automatically migrate after first access

**Flash Memory Summit 2015**
Santa Clara, CA
Example Virtual NVMe Flash-HDD Hybrid Performance

- Up to 260x faster in raw performance than RAID 6 for same capacity (NVMe drives)
- Proprietary PCIe SSDs (e.g. MicronP3/4xx) demonstrate as high as 3.8GB/s off a single SSD

System Setup: Supermicro X9 server class motherboard, Linux CentOS 7 36-bay storage-server,
Single PCIe NVMe SSD fuzed with RAID6 8-drive 6TB drives

Flash Memory Summit 2015
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Virtual Flash Benchmark Factory 7.1 Score: TPC-C

TPC-C Transactions Per Second

- SuperMicro Server X9DRW7
- Windows 2012 R2
- Micron P420m 1.4TB SSD x1
- 6x RAID 5 Toshiba AL13SEB450 hard drive 450 GB 10K RPM SAS 6Gb/s
- Enmotus FuzeDrive Server 1.03c
- SQL Server 2012 with 1GB RAM Setting
- Intel Xeon CPU E5-2697, 16G DDR3

Virtualized Flash Can Achieved same performance as pure flash but with large capacity and lower cost
Virtualized Flash TCO Benefits Analysis

• Storage Setup
  • 532 TB total storage
  • 2 replicated sites
    • 266TB/site
  • 38 servers per site
    • 7TB/Server
  • Replica 2 Configuration yields 66.5 TB useable storage

• Server Configuration
  • Dual XEON 2.4GHz CPUs
  • 32 GB DRAM per server

TCO does not include Application SW costs
Enmotus FuzeDrive fast tier = 20% of volume

Flash Performance for $1.2M Less
Other Benefits of Flash Virtualization

- **File pinning**
  - Ability to pre-pin specific files to flash when needed
  - Example – accounting needs specific records on flash by 4PM on Friday for report generation

- **Non disruptive add/move/changes**
  - Ability to add more flash and increase capacity
  - Replenish flash that is close to wear out
  - Migrate data in real time

- **Low CPU tax and dependency**
  - Mapping takes far less CPU cycles than caching
  - Run more VMs
Enmotus:

Delivering a new class of flash and memory optimized virtualization for massively scaleout servers

Come see Flash Optimized Virtualization in action at Booth 834!