Enabling SSD and Flash for Virtualized Environments

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Technical Vision

"Eliminate memory – I/O contention in virtualized environments."

Technology Trends

- Number of CPU cores is going up
  - Need more VMs to use cores
  - I/O demands of a VM are modest, but in aggregate big

- Gap widening between CPU and disk speeds

- Flash – new point in memory hierarchy

The Trends Say…

We *must* think of storage I/O differently.

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Problem

- Virtualization exacerbates the memory & I/O issues
  - More VMs means more I/O
  - Higher application latencies, lower throughput

- Sub-optimal CPU utilization due to I/O wait times

- Virtualization drives a new requirement – shared storage

Current Solutions

- Costly and Complex
  - Add more high-end storage ($$$$$)
  - More HBAs, FC networks/switches ($$$)
  - Add RAM ($$ & watts)
  - Front primary storage with a cache ($$$)

Technology for a Better Solution

- Separate IOPS from disk-based storage without decreasing reliability
  - Continue to use primary storage for *data management*: Capacity & Reliability
  - Use Flash on compute server for *IOPS*: Performance

Technology for a Better Solution *(cont.)*

- Use Flash cache on compute server
  - Increase application performance by reducing I/O latency
    - Increase CPU utilization; run more VMs
  - Cache OS and application paging data
  - Cache I/O to persistent storage
  - Prevent IOPS surge caused by VMs
  - Transparent to applications and existing infrastructure
  - Dynamic allocation of Flash capacity as VMs come and go
  - Support hypervisor functionality such as vMotion
  - Extensible to virtualized and bare-metal environments

Why Now

- Historical evolution of Flash usage
  - Caching appliances
  - Storage arrays fronted with Flash
  - Flash/SSD as replacement to disks

- Recent trends driving this technology
  - Systems vendors are including Flash
  - Lower $/GB and watts/GB than memory
  - Lower $/IOPS than primary storage
  - Multiple Flash vendors have enterprise grade products
  - PCI card and SSD form factor options

Opportunity

- Virtualization is here to stay, but there are challenges
  - Many applications not ready to embrace virtualization given the current trade-offs
  - More CPUs, more data, but storage IOPS lag

- Incredible opportunity to:
  - Virtualize more applications
  - Accelerate VDI adoption

- 2010 is the inflection point with more virtualized servers deployed than physical servers. This trend will only continue.

–IDC, Server Virtualization Shipment Forecast

IOT Technology - Unfair Advantage

- Ability to direct the I/O performance to specific VMs, files, volumes, or disks
  - IOT is in the memory – I/O path
  - IOT is close to the application's data
  - Intercept all reasons to go to storage
    - OS paging, application paging, and persistence

- Semantic/contextual knowledge of data
  - Cache or bypass cache selectively for files, volumes, and disks
  - Shared file-level deduped cache
  - Compression on specific VMs, files, volumes, or disks
  - Enables application-specific performance profiles

- Unified solution for both server & desktop virtualization

IOT Technology - Unfair Advantage (cont.)

- Downstream caches are inclusive, including:
  – Hypervisor, caching appliances, storage

- IOT works directly on application data
  – Intelligent decisions made in the guest OS
    - *For example:*
      – *Cache pagefile.sys for Windows*
      – *Cache only one copy of a mirrored volume*
      – *Cache only one kernel32.dll in the compute server*
      – *Do not cache database redo*

- Agnostic
  – SSD / Flash
  – Storage: SAN, NAS, & DAS
  – Hypervisor
  – Transparent to Guest OS / Applications

Summary

Virtualization is here to stay

IO Turbine

- Enables SSD / Flash to participate in virtualization market

- Enables directing I/O performance to specific VMs, files, volumes, disk

- Semantic / contextual knowledge enables application specific performance profiles

About our Speaker

- Systems software engineer spanning multiple CS disciplines: OS, parallel and distributed systems, databases, storage, media, and computer graphics
- Oracle: Doubled database TPCC perf. on 64-way SMPs; formed Exadata group & led initial effort
- SGI: Developed video on demand server; led Shared Worlds video game server effort at CosmoSoft
- Sun: Parallelized the Solaris virtual memory system to demonstrate linear scalability from 1-12 processors; worked on machine bringup; Spring microkernel (SunLabs)
- Founded PixBlitz Studios in 2006: virtual advertising technology
- MS (Hons.) Physics 1984, BE Engineering in 1984, Birla Institute of Technology and Science, Pilani, India

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