Increasing Storage Performance

High Performance MicroTiering for Server DAS Storage

Andy Mills

President/CEO, Enmotus

andy.mills@enmotus.com

Summary

- Review of challenges of adopting SSD-hard drive tiering in general purpose virtual servers

- Direct attach and primary storage I/O focus

- Topics covered
    - Macro/Micro problems that tiering solves
    - Challenges of integrating into virtual server environments
    - Introduction to MicroTiering™ - a high performance DAS approach to SSD-HDD tiering

Macro Problem

- Over the next decade*:
  - 10x more servers (virtual and physical)
  - 50x more information managed by enterprise datacenters
  - 75x more files in the data center
- <1.5x more IT professionals in the same timeframe*
- Full and complete automation of data management is becoming crucial to balance the work per IT professional load
- Movement of SSD tier inside the server
  - No easy-to-use performance solution for server centric storage users
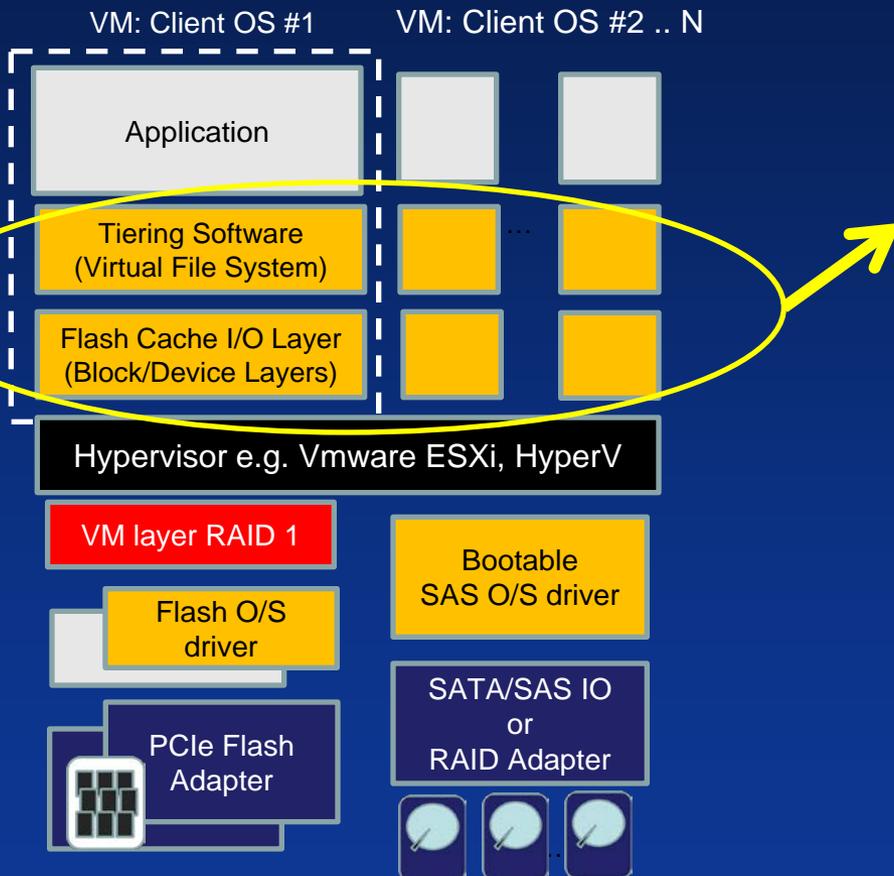 - Next generation Hadoop-like architectures not well served

Data Tiering

- Data Tiering common place is networked storage appliances and/or specialized server file systems

- Data Tiering automatically moves *frequently accessed* data to the faster storage layer and *least accessed* to the slower, lowest cost layer

- Why the need to tier storage?
  - Too costly to put 100% of the data on the faster, most expensive storage
  - Exaggerated by virtualized and cloud systems by files, changing too frequently

Number of Times a File is Accessed

Move to faster storage

Move to slower archive storage

Days or Months
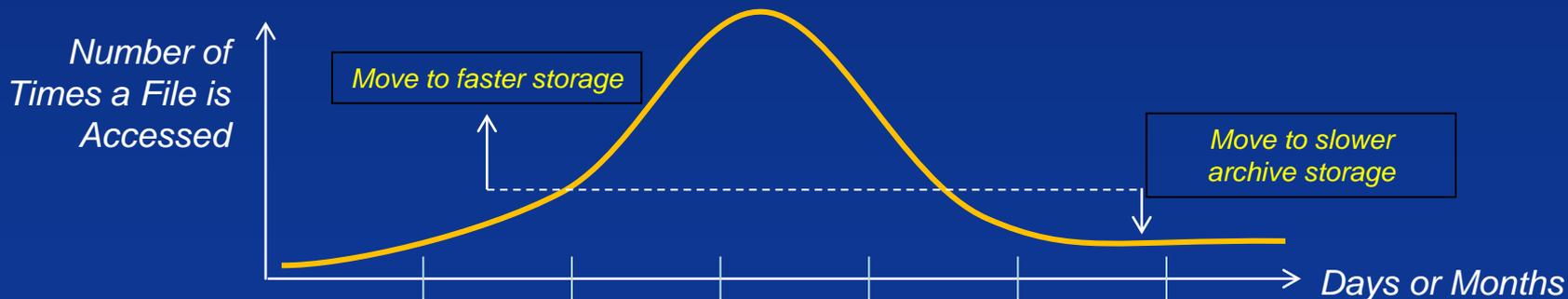
Server Key Trends

- More than 50% of all servers are now virtualized*
  - Represents around 18-20% of new annual physical server shipments*

- CPU utilization targets are changing (again….)
  - Pre virtualization – target 30-40% max
  - Post virtualization – 90%+ utilization

- VM has a large impact on traditional server storage I/O
  - Increasing trend toward hardware accelerated I/O
  - Cannot assume spare CPU cycles are available for software RAID and other caching functions

Hypervisors and Storage I/O Today

Diagram labels (left panel)

VM: Client OS #1   VM: Client OS #2 .. N

Application

Tiering Software
(Virtual File System)

Flash Cache I/O Layer
(Block/Device Layers)

Hypervisor e.g. Vmware ESXi, HyperV

VM layer RAID 1

Bootable
SAS O/S driver

Flash O/S
driver

PCIe Flash
Adapter

SATA/SAS IO
or
RAID Adapter

Not generally available today

Storage I/O <u>above</u> the Hypervisor

- Everything done on a per VM basis
- Each VM client has to be responsible for it's own data tiering
- No ultra performance access to raw disk devices
- Severely limits performance of any "block" based utilities in VM

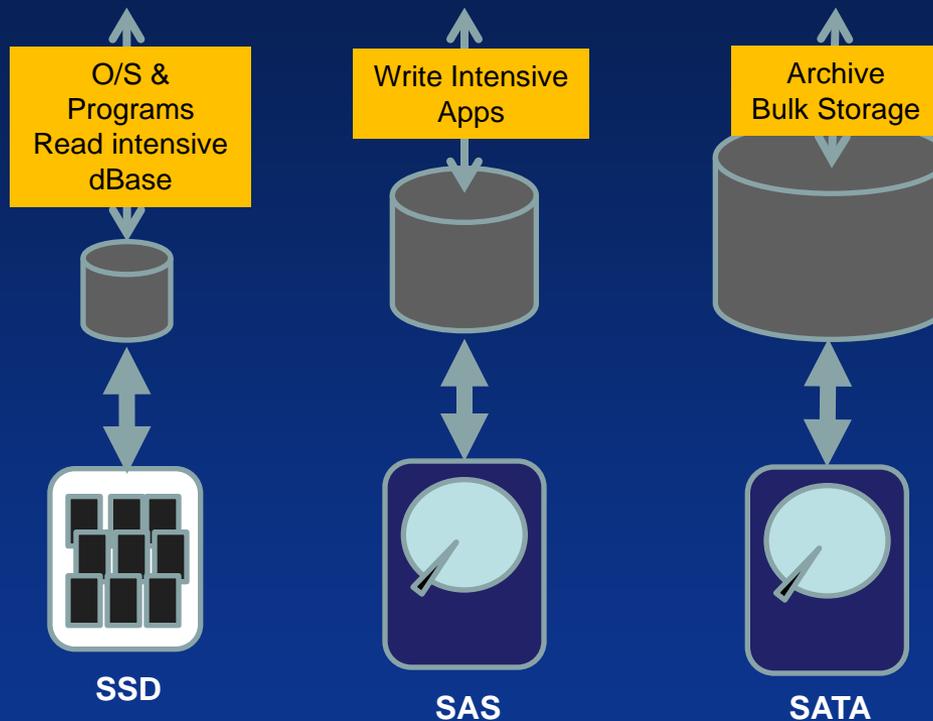## Storage I/O <u>below</u> the Hypervisor

- Better access to raw blocks
- Requires several block layer drivers to work, including a VM-RAID solution
- Ability to be VM agnostic and provide shared functionality across all VMs

DAS Islands Inside Servers

Computer Sees Individual Disks
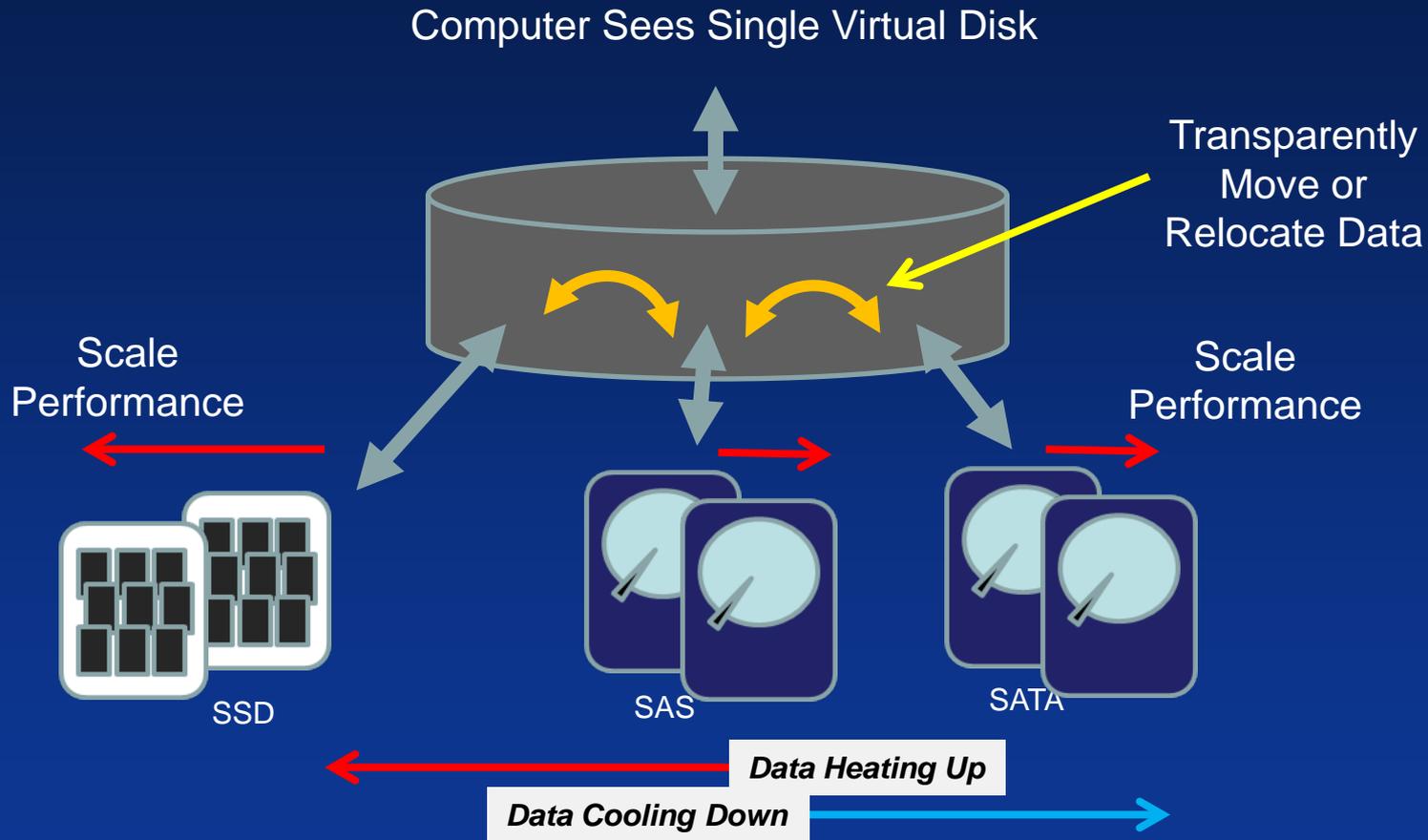
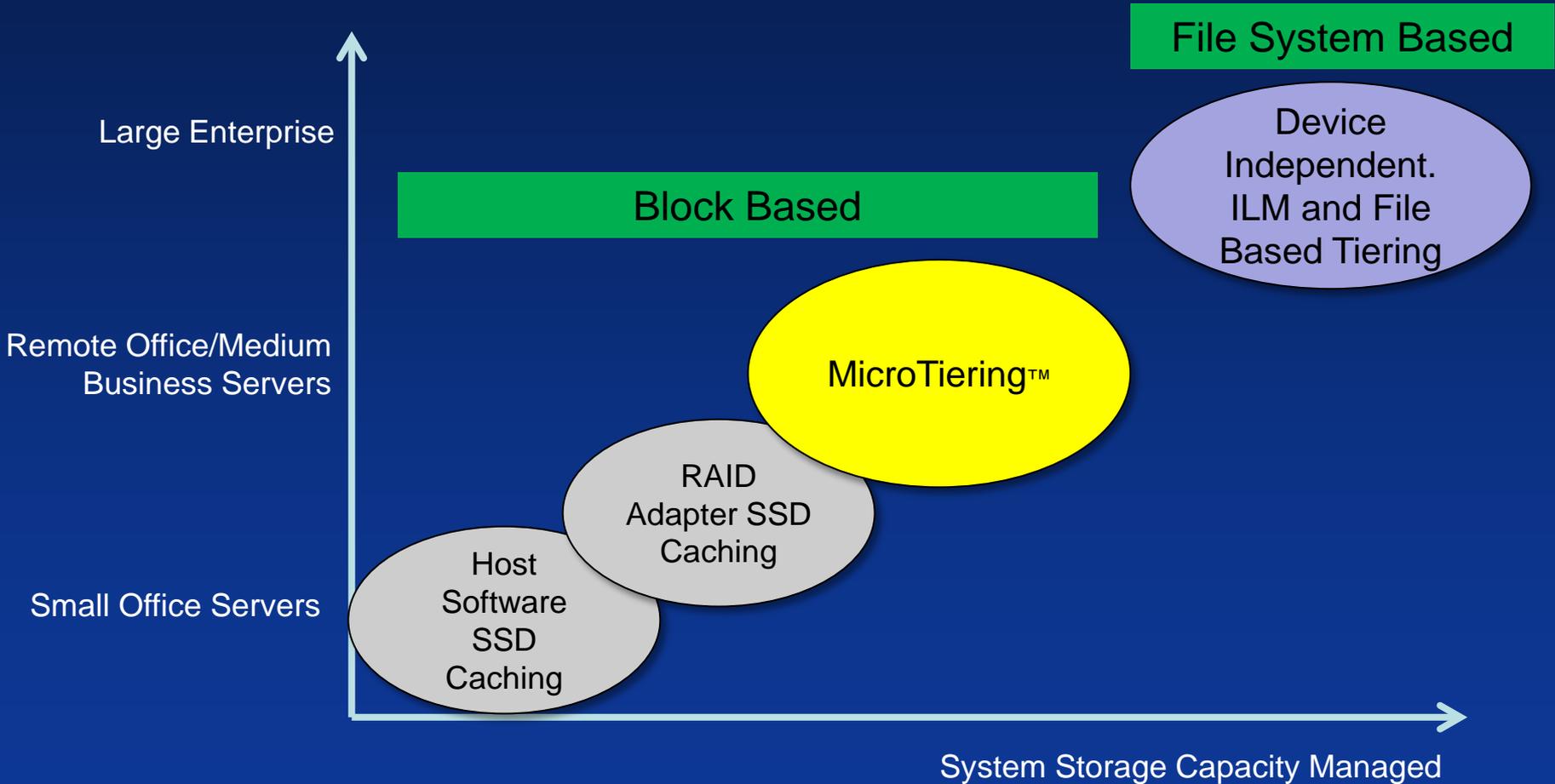|	**SSD**	**SAS**	**SATA**
	O/S & Programs Read intensive dBase	Write Intensive Apps	Archive Bulk Storage
Capacity:	200G	600G	3TB
Cost:	$11-40/GB	$0.90/GB	$0.08/GB
IOPS:	25,000+	280	80-100

- *No Single Media Fits All Applications*

- *Data becomes "hot and cold" over time*

- *Manually optimize data location*

DAS Virtualization

Computer Sees Single Virtual Disk

Transparently Move or Relocate Data

Scale Performance

Scale Performance

SSD

SAS
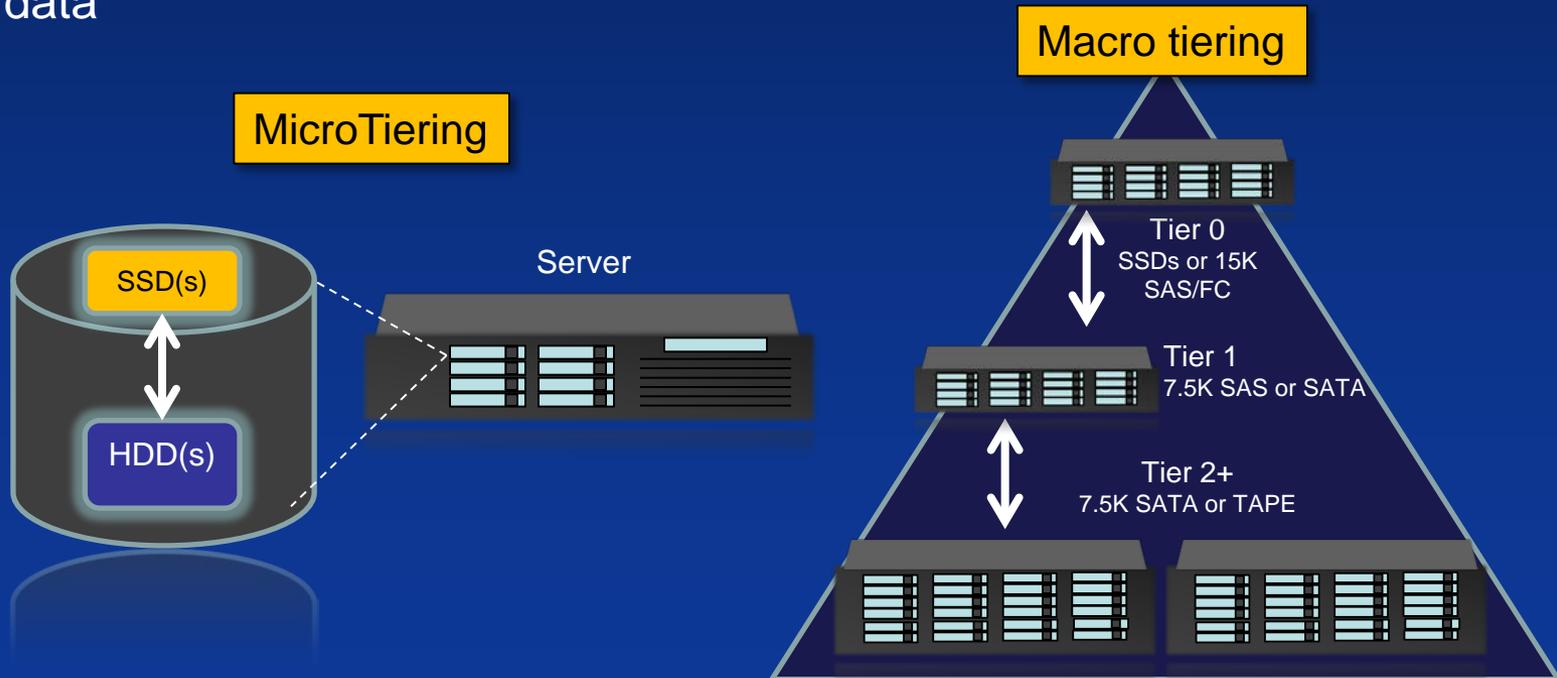
SATA

Data Heating Up

Data Cooling Down

Auto-tiering transparently matches data-blocks to the appropriate media based on frequency of access and access patterns

Server Caching and Tiering

Large Enterprise

Remote Office/Medium Business Servers

Small Office Servers

File System Based

Block Based

Device Independent. ILM and File Based Tiering

MicroTiering™

RAID Adapter SSD Caching

Host Software SSD Caching

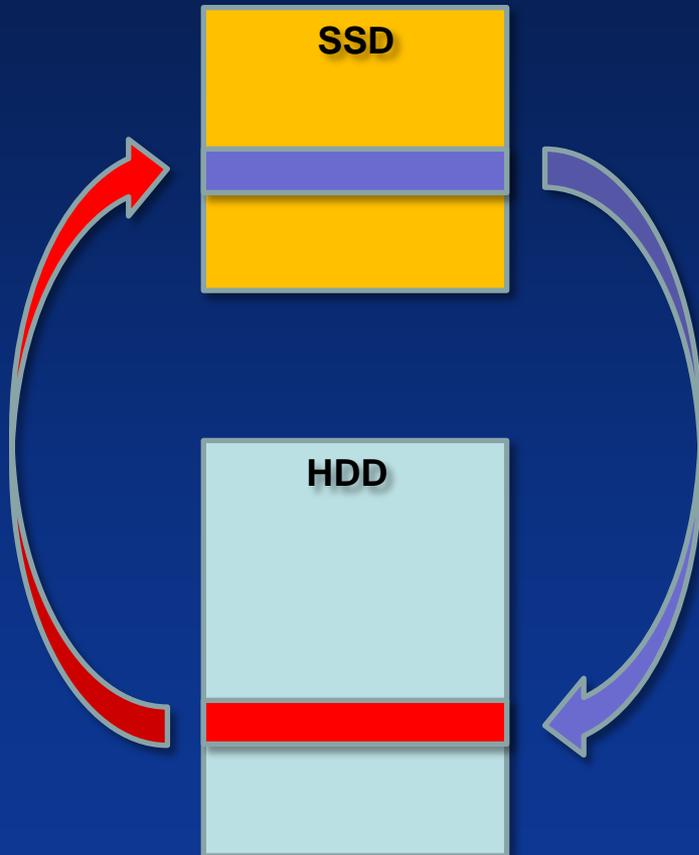System Storage Capacity Managed

MicroTiering™

- High performance automated data tiering at the primary DAS server level
- Transparently moves data to the optimum storage device inside the server
- 100% hardware accelerated and bootable
- Integrated SSD and SAS/SATA storage I/O replacing two adapters in one
- Provides full read and write performance of SSDs to host volume for hot data
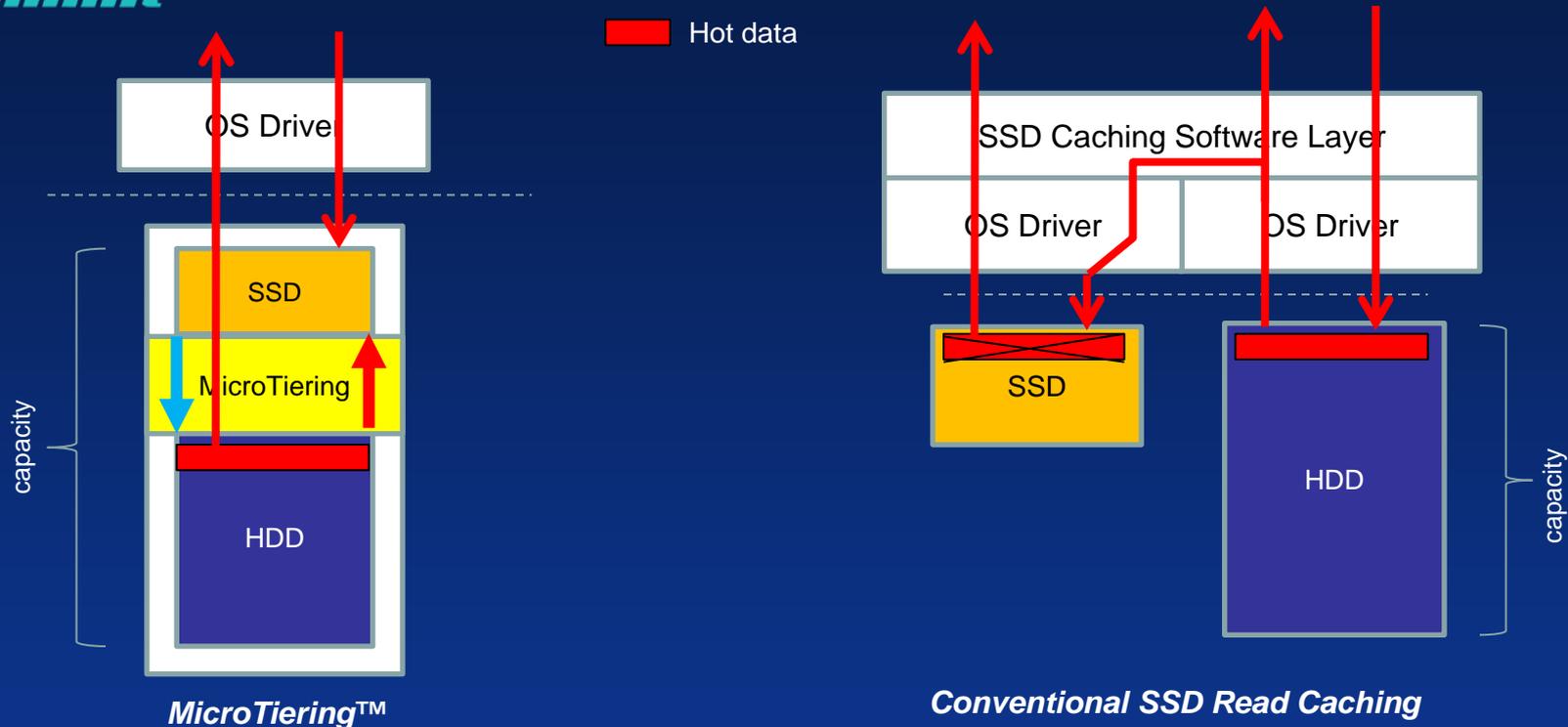
Macro tiering

MicroTiering

SSD(s)

HDD(s)

Server

Tier 0
SSDs or 15K SAS/FC

Tier 1
7.5K SAS or SATA

Tier 2+
7.5K SATA or TAPE

MicroTiering Basic Operation

SSD

HDD

- "Hot" data on HDD tier is moved to SSD tier

- "Cold" data on SSD tier is moved to HDD tier

- No large incremental space or pool needs to be reserved on the disk(s)

- Non-traditional algorithms employed - full Read and Write SSD speed available to host

- Real time scanning of statistics used for other move based decisions

MicroTiering™ vs. Caching

Hot data

OS Driver

SSD

MicroTiering

HDD

capacity

MicroTiering™

SSD Caching Software Layer

OS Driver | OS Driver

SSD

HDD

capacity
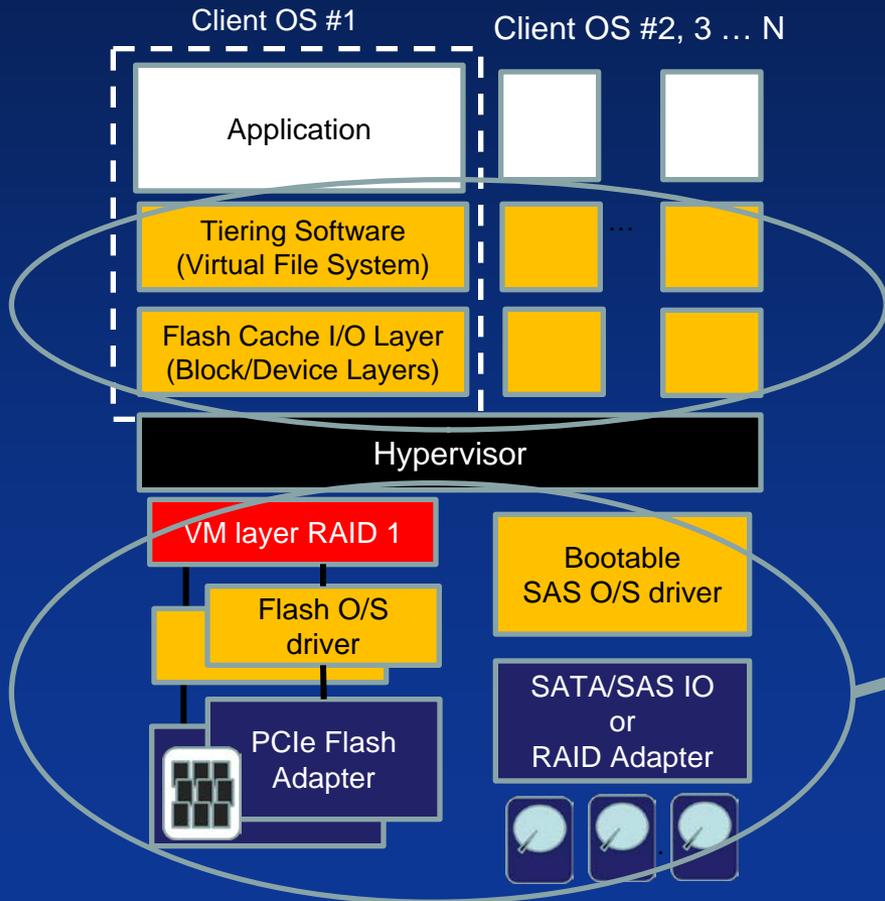
Conventional SSD Read Caching

- <u>Moves</u> data to SSD
- Accelerates read <u>and</u> write I/O
- All capacity is visible
- Virtual drive avoids multiple software/driver layers in the host
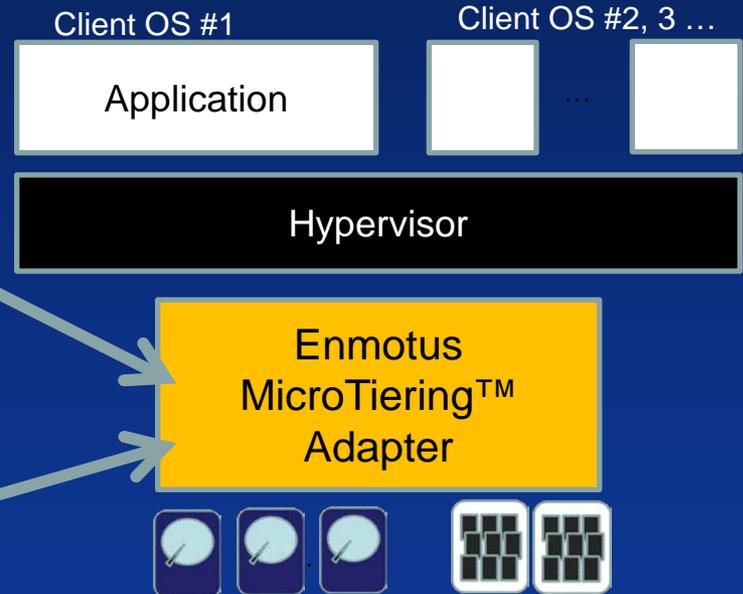- Easy integration with hypervisors

- <u>Duplicates</u> data in SSD
- Typically accelerates read I/O only
- SSD capacity is invisible
- Requires system level software to operate above base driver level
- Custom approaches for hypervisors
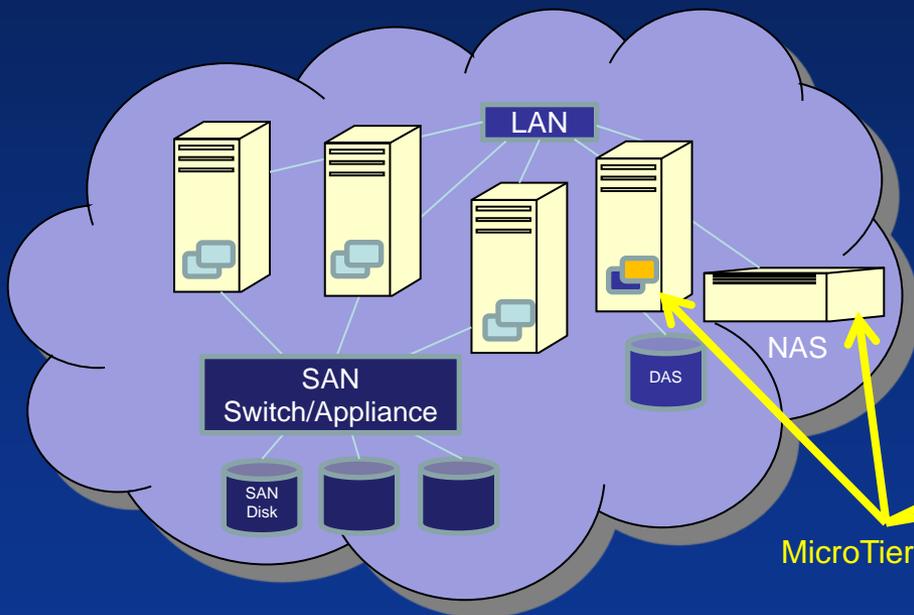
MicroTiering™ Adapters

Conventional Approach

Client OS #1   Client OS #2, 3 … N

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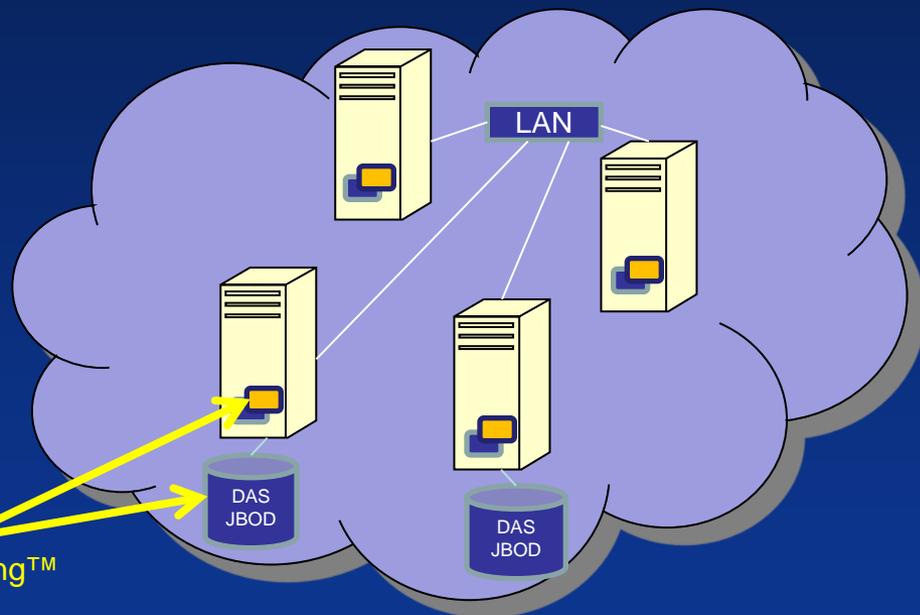
Hypervisor

Enmotus
MicroTiering™
Adapter

MicroTiering™ Applications

Traditional Enterprise Shared Storage

Data Intensive, Web Servers Cloud/Grid Clusters
(Social Networks and Emerging Enterprise)

LAN

SAN
Switch/Appliance

DAS

NAS

SAN
Disk

MicroTiering™

LAN

DAS
JBOD

DAS
JBOD

- Classic shared SAN network
- Data protection relies on SAN devices and multi-path network connections
- MicroTiering a component of the server, NAS or open storage-server

- Emerging distributed grid storage leveraging approaches developed for web applications
- Data protection based on replication across multiple nodes (node= server + DAS storage)

Summary

- Challenges exist with SSD caching or tiering in virtualized servers
  - Has led to highly custom caching solutions for hypervisors
  - Hypervisors don't see full benefit of SSD writes
  - Forces separate boot drive for smaller virtual server environments
- MicroTiering™ solves several issues
  - No client software required
  - No hypervisor caching layers required
  - Fully auto-balancing amongst existing and newly migrated VMs
  - Full read and write performance exposed to host/hypervisors for hot data