SNIA DSI '16 DATA STORAGE INNOVATION CONFERENCE
Innovation in Storage Products, Services, and Solutions
June 13-15, 2016 | Marriott San Mateo | San Mateo, CA

Delivering Predictable Storage Performance in a Virtualized Environment

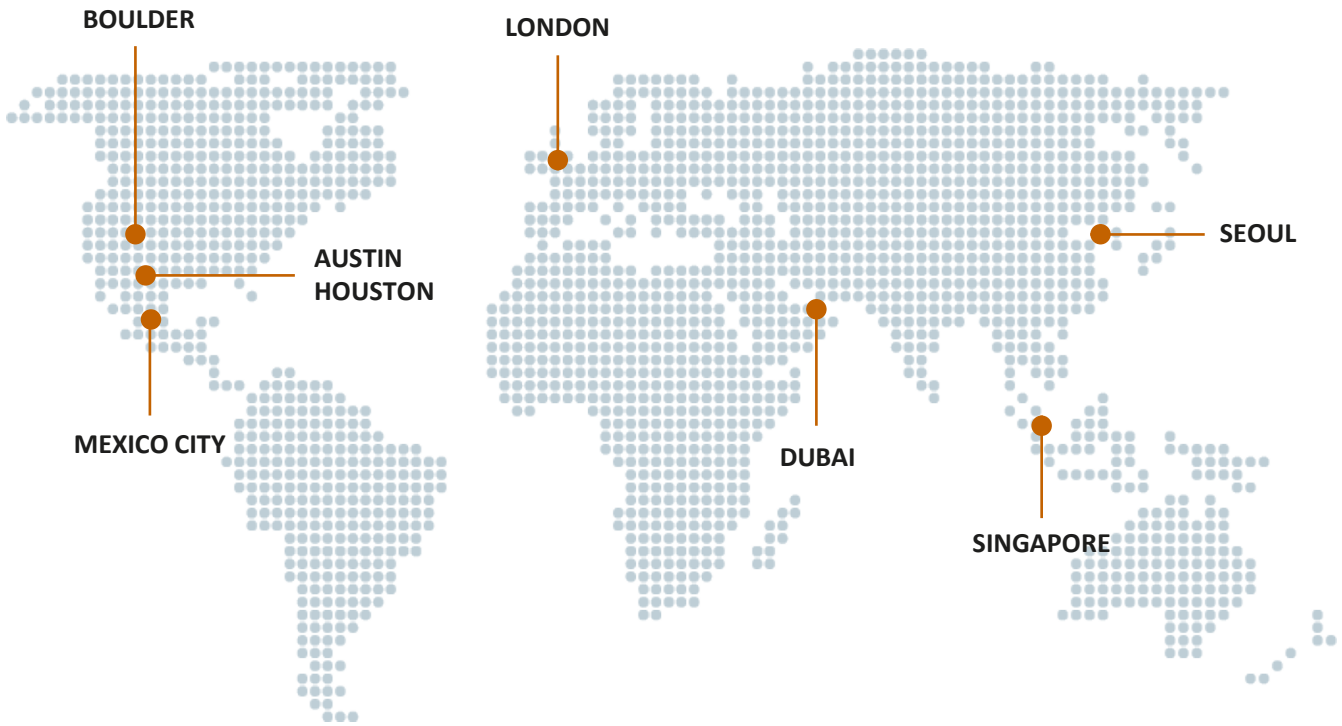
Vincent LaPaglia
Pivot3

Pivot3
PCIe Flash Storage

Vincent LaPaglia
Sr. Storage Engineer

Pivot3

Pivot3 Delivers Smarter Infrastructure



- **Proven Innovation**
  - Software Defined Storage
  - Quality of Service
  - Flash array architecture
- **30 Patents Awarded**
- **Over 16,000 systems in 53 countries**
- **Extensive technology partnerships**

BEST BUY · GM · Bank of America · USC · SAFEWAY · FedEx · U.S. ARMY · verizon · Walt Disney · MOTOROLA

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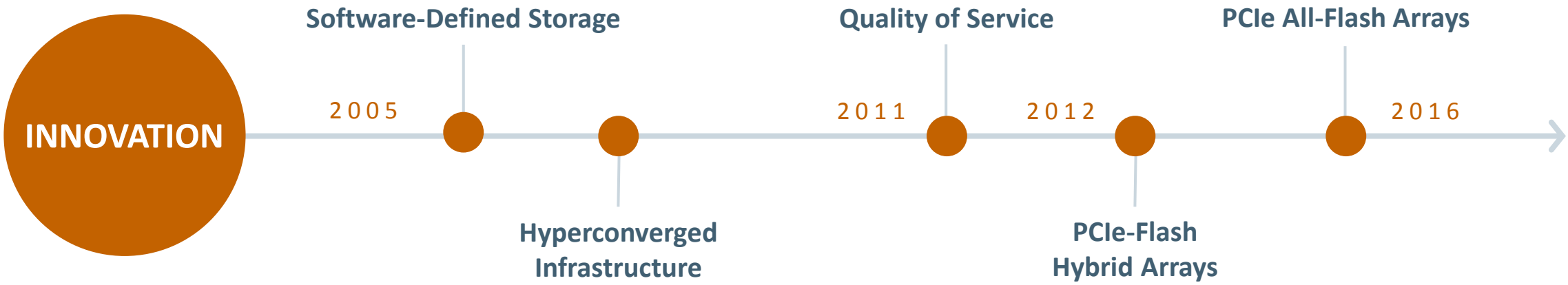
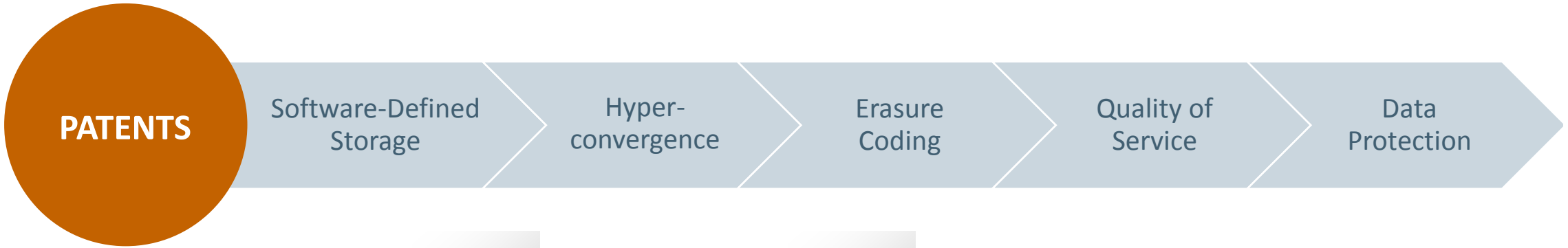
Major Innovations and Patents





30 PATENTS 10 PENDING

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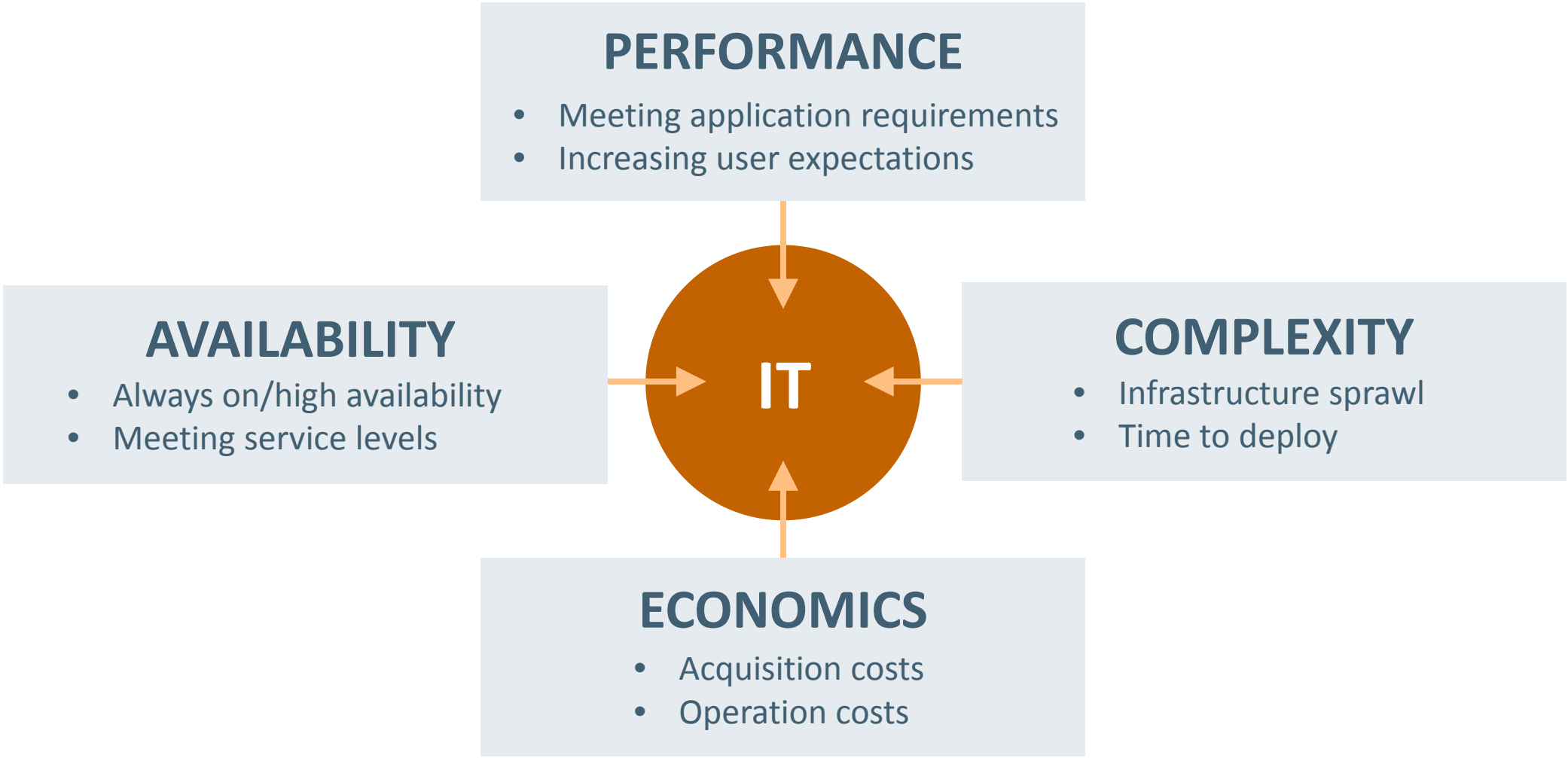
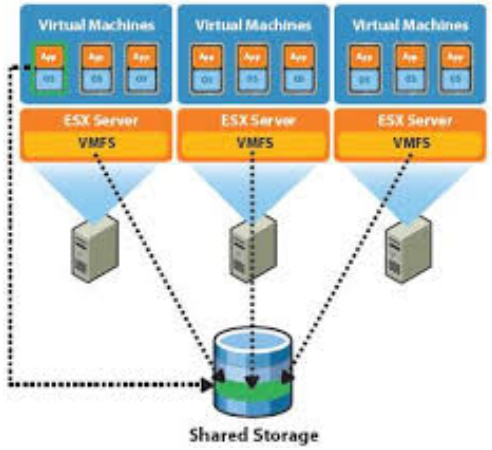
Business Innovation Puts Pressure on IT

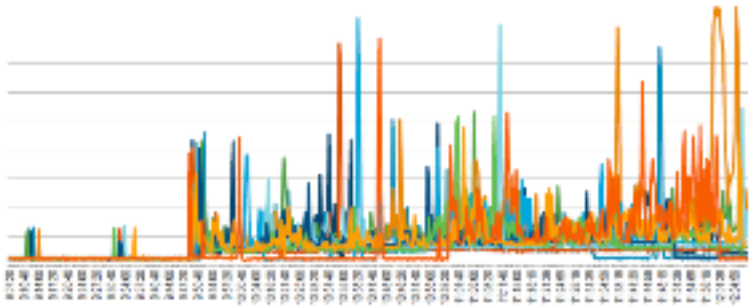


Challenges with Server Virtualization Deployment

- Meeting IOPS & especially low latency performance needs
- Mitigating blender effect: multiple VMs with unique characteristics
  - Variable block size ingestion
  - Unique IOPS and latency requirements
- Unpredictable performance due to I/O contention from heterogeneous workloads and higher VM densities
- Time and effort spent dealing with performance issues

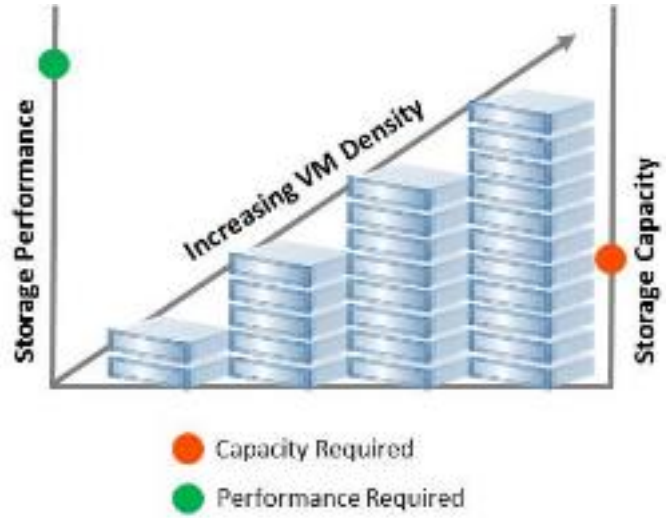


VDI Stresses Storage



VDI is a demanding workload

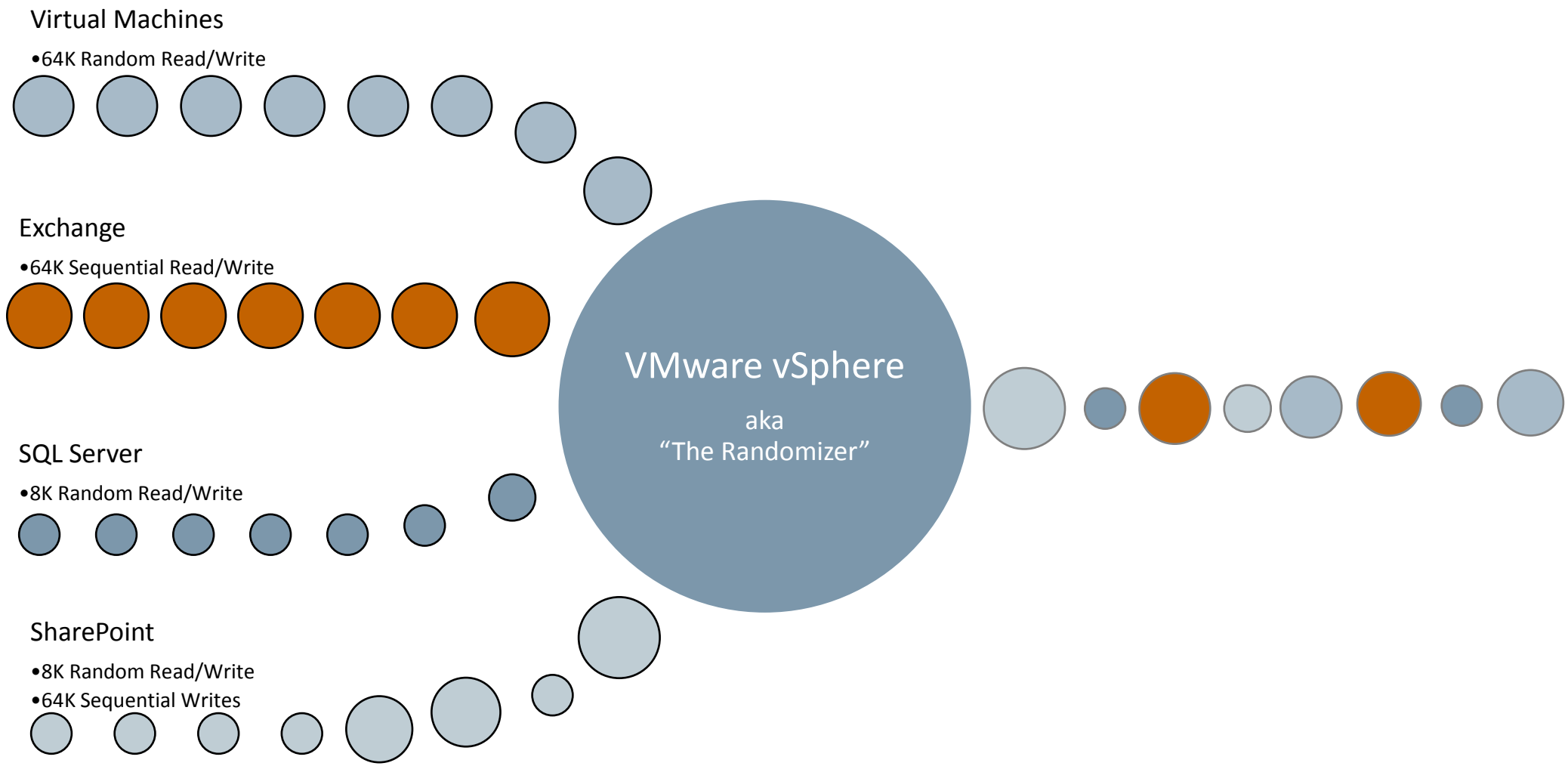
- Bursty, massive load sometimes, quiet others
- Varies by the hour, day and month
- Demands random write-heavy I/O
- Inconsistent performance impacts user experience



Cost and complexity impacts project ROI

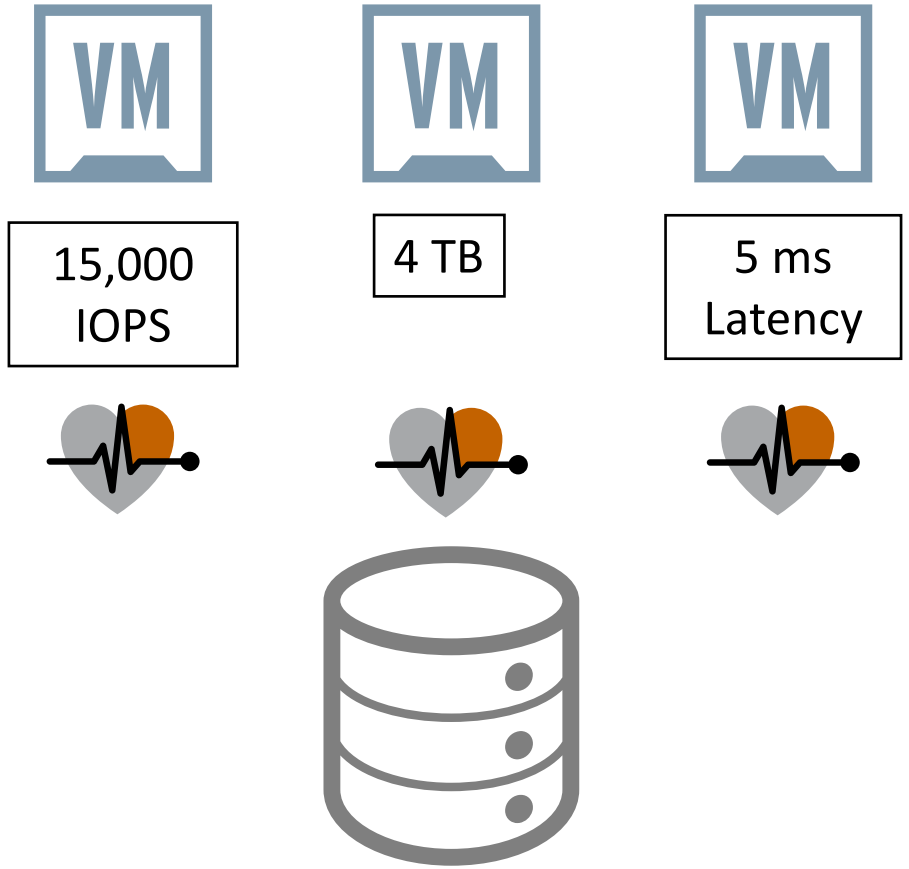
- Storage is expensive
- More disk drives increases maintenance expense
  - Excess capacity consumes more rack space
  - Higher power and cooling expenses
  - Higher maintenance costs
- Separate storage infrastructure for VDI increases costs

“I/O Blender” Alters Performance Reality

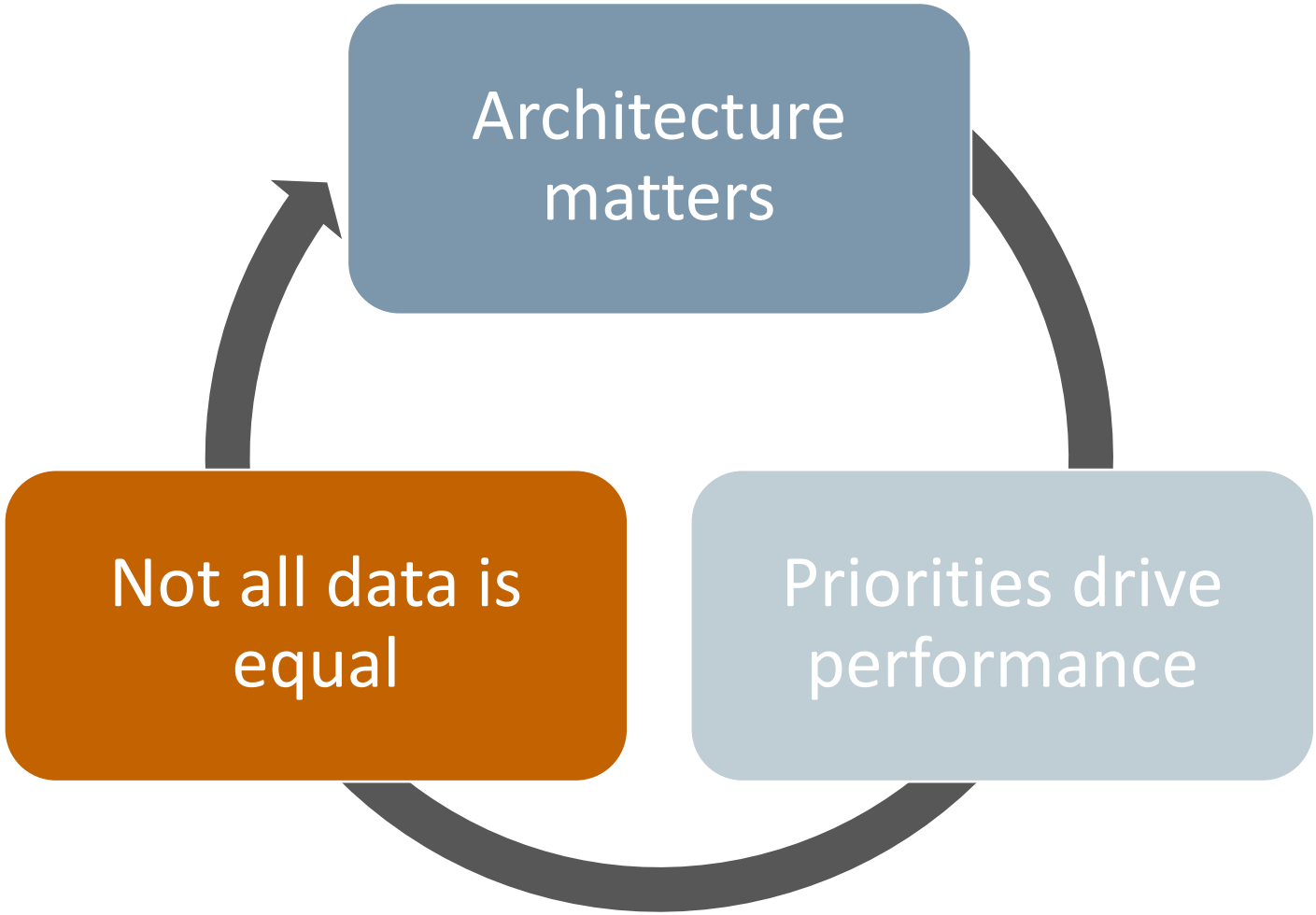


Understanding the Storage Challenge

- VMs share storage resources
- Creates contention
- VMs have unique storage requirements
  - IOPS
  - Throughput
  - Latency
  - Capacity
  - Availability

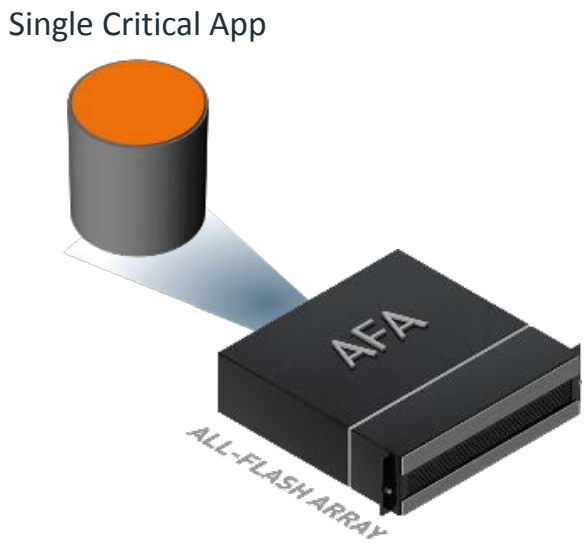


Considerations for meeting your storage goals



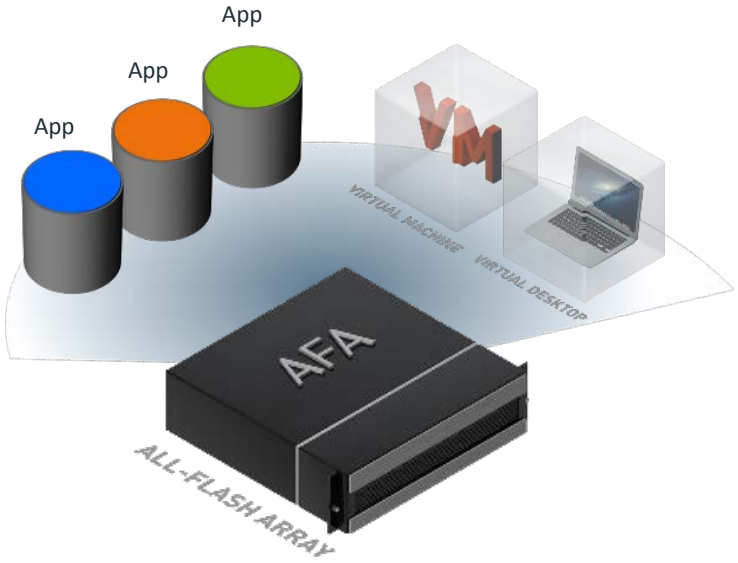
The Next Wave of Flash Arrays Are Here

First All-Flash Arrays



Want flash performance for a limited set of applications

Next All-Flash Arrays



Want flash performance for broader mixed workloads

KEY CONSIDERATIONS

- → Optimized for flash?
- → Designed for lowest latency?
- → Prioritize application workloads?
- → Ensure service levels are met?
- → VM-level Performance Management?

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Pivot3 Flash Storage Solutions

→ Ultra-low Latency Performance

- PCIe flash acceleration

→ Prioritize What Matters Most

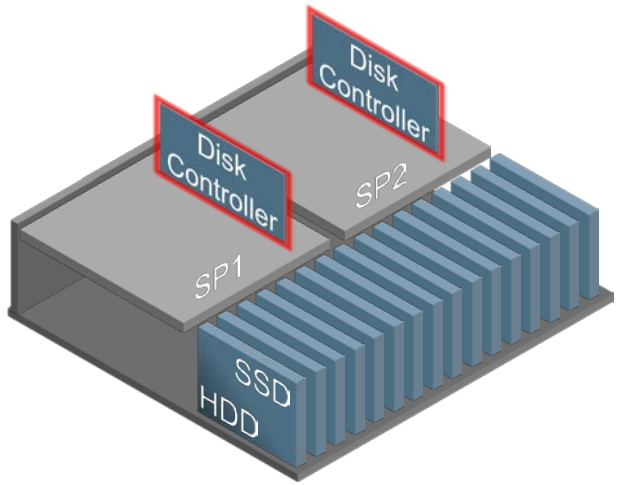
- Patented Quality of Service

→ Management Simplified

- Granular policy-based management

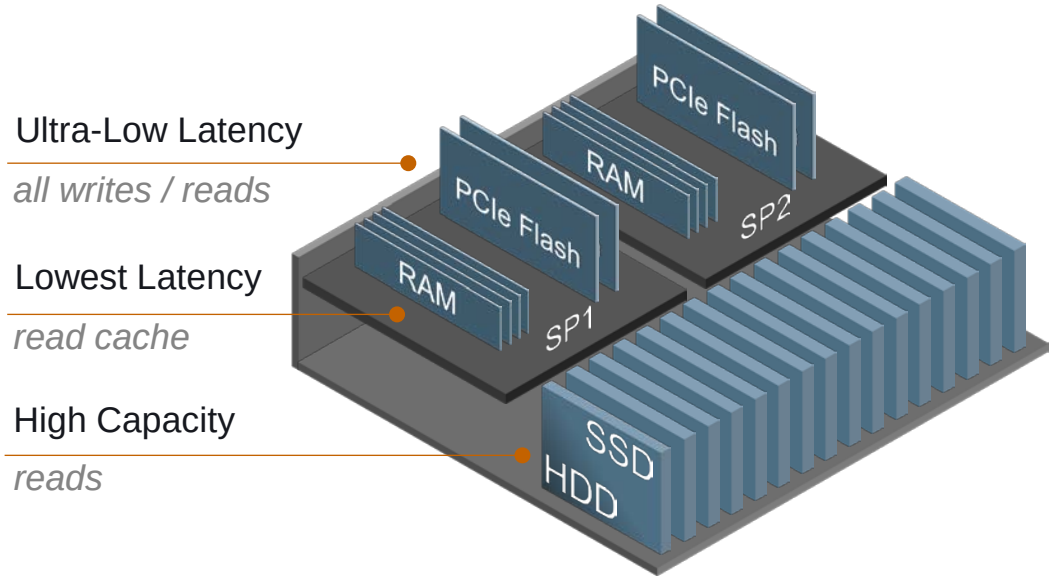
Multi-tier Flash Architecture Advantages

Conventional Arrays



- All IO traverses controller
- Bottlenecks exist

Pivot3 PCIe Flash Arrays



- Multi-tier architecture for efficient performance
- Priority-driven data placement

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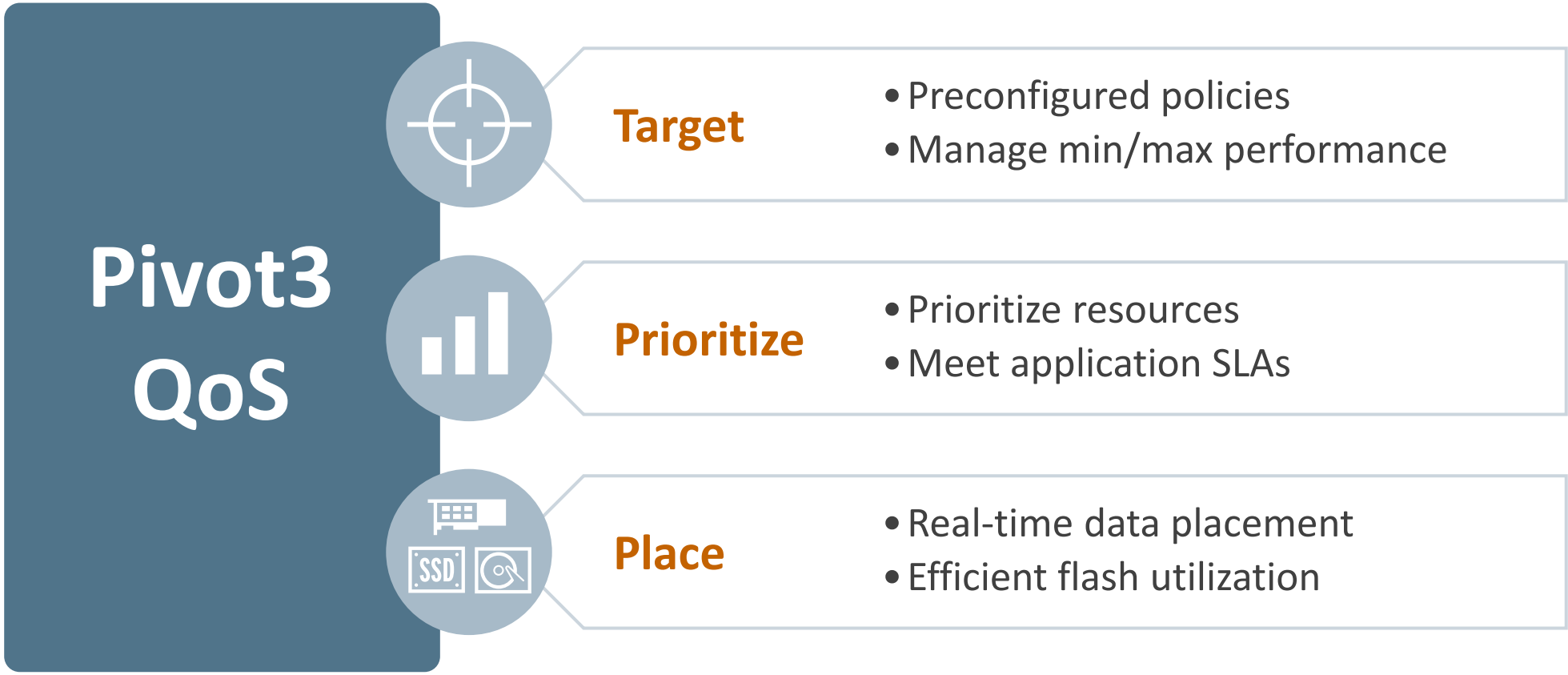
Prioritize What Matters Most With Pivot3 QoS

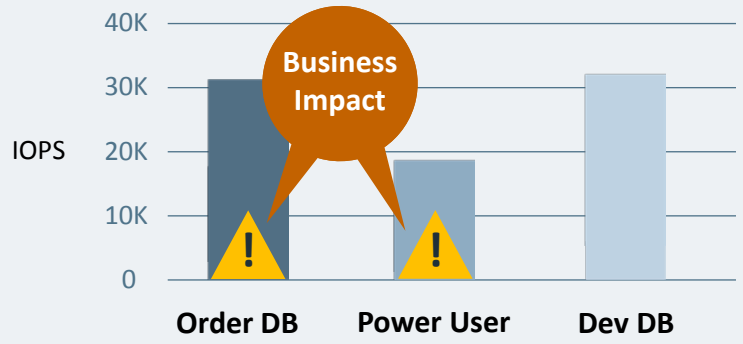


Prioritize Performance With Service Levels

	All-Flash Arrays	QoS Policy	Hybrid Flash Arrays	
				
	Rated @ 450,000 IOPS		Rated @ 250,000 IOPS	
	Min Performance Level		**Min Performance Level**	
Mission Critical	125K IOPS 1000 MB/s 1 ms max	1	100K IOPS 750 MB/s 5 ms max	*Mission Critical*
Business Critical	75K IOPS 500 MB/s 3 ms max	2	50K IOPS 375 MB/s 10 ms max	*Business Critical*
Business Critical	50K IOPS 250 MB/s 10 ms max	3	20K IOPS 150 MB/s 25 ms max	*Business Critical*
Non-Critical	25K IOPS 100 MB/s 20 ms max	4	10K IOPS 75 MB/s 50 ms max	*Non-Critical*
Non-Critical	10K IOPS 50 MB/s 40 ms max	5	2K IOPS 38 MB/s 100 ms max	*Non-Critical*

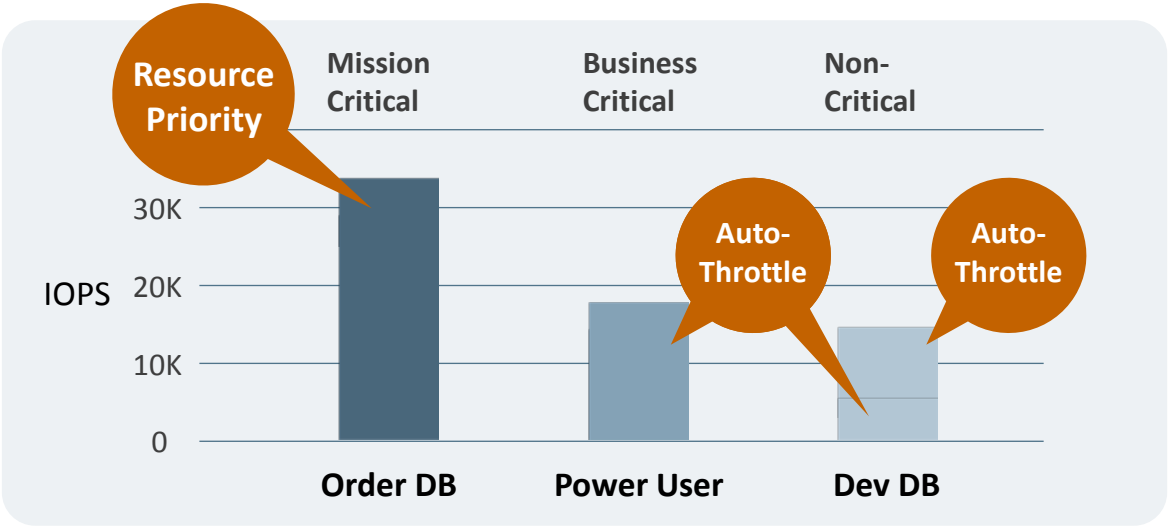
Meet Application Performance Service Levels

Storage Without QoS



- All data treated the same
- Inconsistent performance
- Impacts business operations

Pivot3's Patented Quality of Service



- Align performance with business needs
- Meet Application service levels
- Mission Critical performance is always guaranteed

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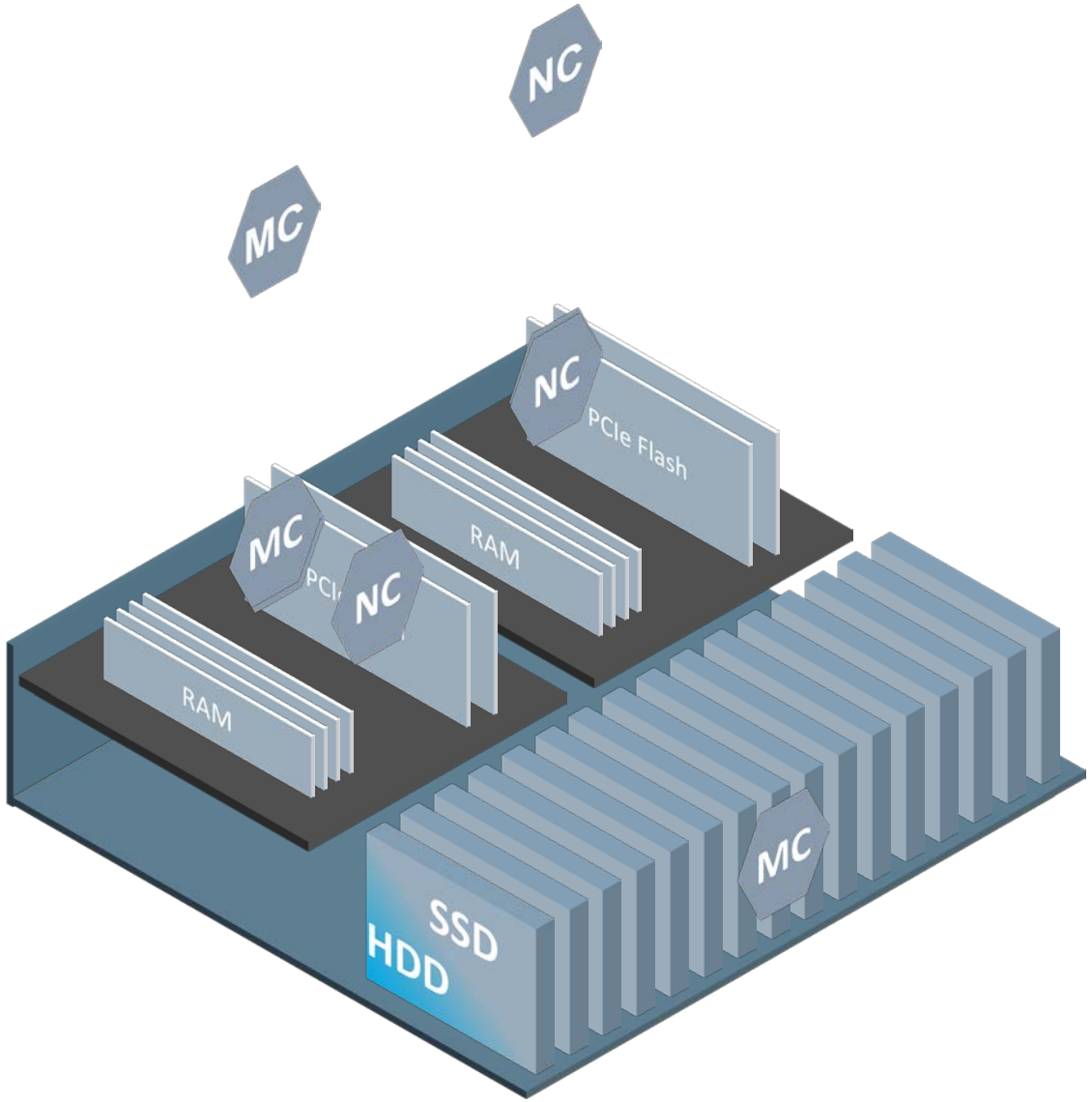
Consolidated Virtualization

- QoS allows consolidation of dissimilar workloads
  - VDI
  - Database
  - Virtual servers
  - Business decision apps
- Eliminates the “I/O blender” effect of mixed workloads

QoS Optimizes Each Workload's Datapath



Prioritized Active Cache

- Protected Read/Write Area
  - All writes occur in PCIe flash
  - Writes are mirrored for HA
  - QoS determines destage to disk
- Prioritized Read Cache
  - Determines *if* and *when* and *where*
  - Data is cached to RAM and/or PCIe flash

Policy	Caching Priority	Read Threshold*
MC: Policy 1	Most Aggressive	1 I/O hit
BC: Policy 2	Aggressive	4 I/O hits
BC: Policy 3	Less Aggressive	16 I/O hits
NC: Policies 4 & 5	None	Data is never cached

*Per 1 MB Page

Benefits of Pivot3 Data Reduction Technologies

IO Reduction for Performance	2.5X	2.5X acceleration* 50% lower latency Reduced IO vs. PCIe Flash IO
IO Consolidation for Endurance	4X	4X SSD life extension 7:1 consolidation ratio** from PCIe Flash writes to SSD writes
Data Reduction for Capacity	2:1	50% average capacity reduction 2:1 data reduction ratio*** No performance impact

** 2.5X acceleration based on v3.5 software benchmarks; ** 7:1 consolidation ratio based on Pivot3 customer measured metrics; *** 2:1 capacity reduction based on Pivot3 customer measured metrics*

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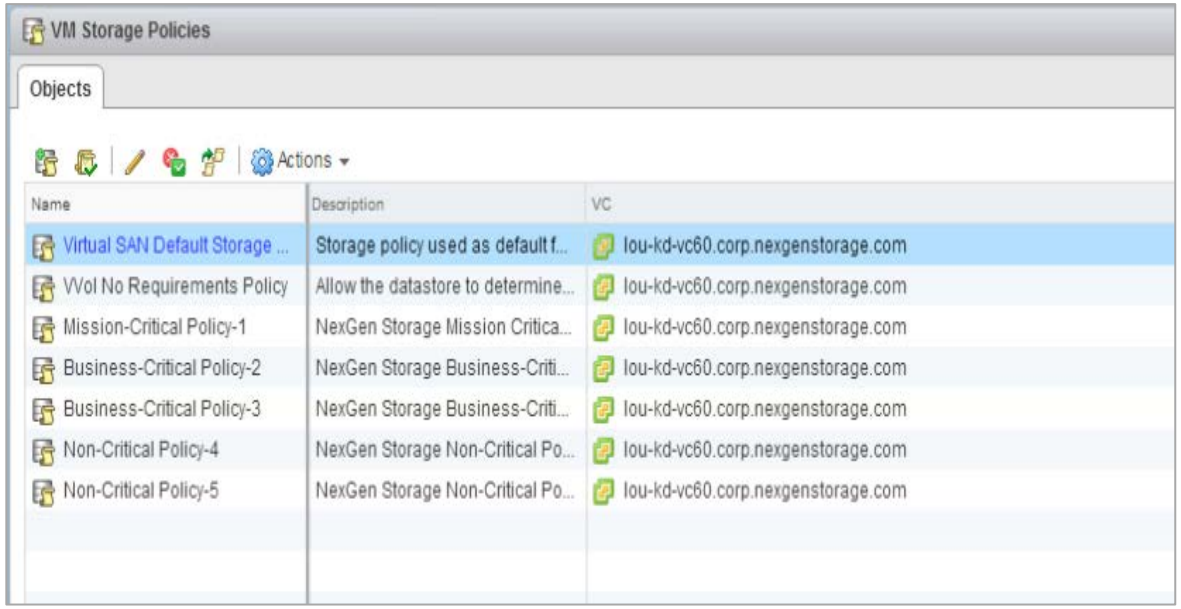
Storage QoS Per VM

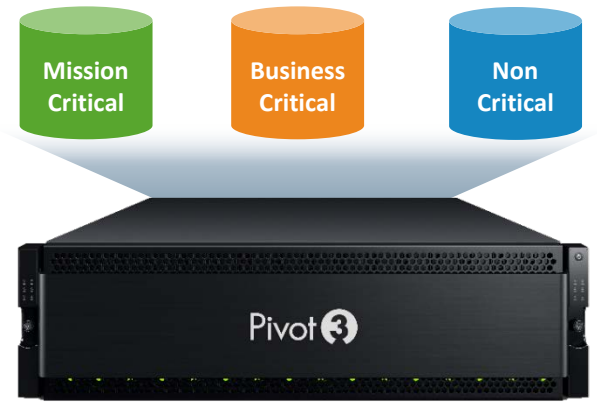
- VMware VVol integration with Pivot3 QoS
  - Natively surfaces Pivot3 performance QoS and service levels in vCenter
  - Tied to VM-level granularity = manage storage SLAs per VM
- Simplify Management
  - Gives administrators granular control over Pivot3 storage management tasks (provisioning, snap, rep, clone, QoS, performance, etc.) per VM
  - Integrates VM level performance QoS/SLAs with Pivot3 performance QoS/SLAs



VMware VVOL integration with Pivot3 QoS

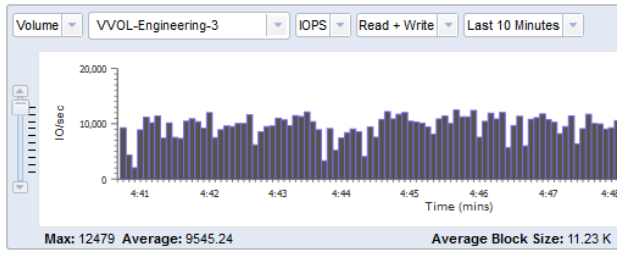
Managing Performance at a VM-level

Storage Silo Consolidation



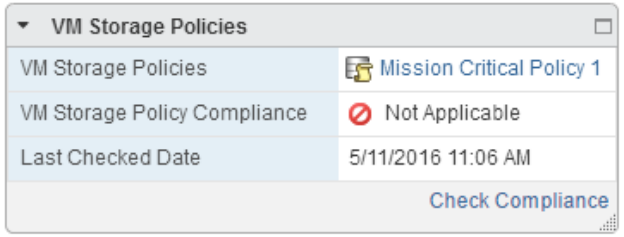
Host multiple VM Storage QoS policies on a single storage array; no separate silos

Predictable VM Performance



Per VM Storage QoS policies enable granular assignment of storage performance

Simple Policy Management



Pre-defined Storage QoS Policies applied to the VM removes management complexity

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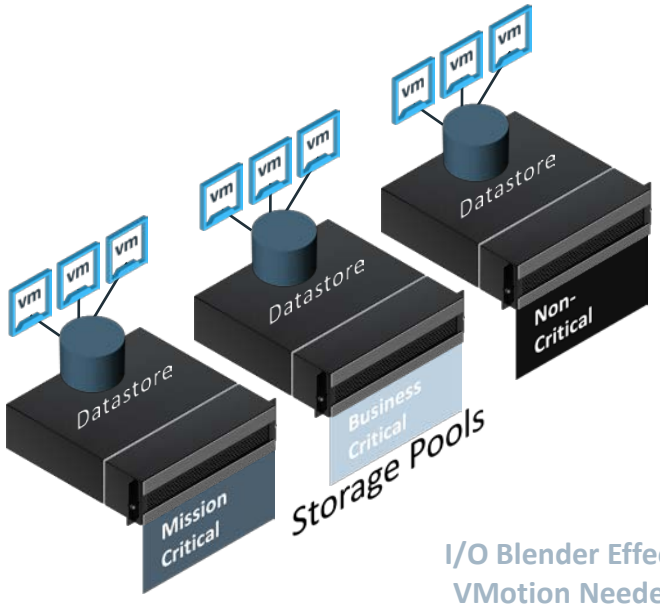
Storage QoS Takes VVOLs to the Next Level

Pre-vSphere 6 VVOLs



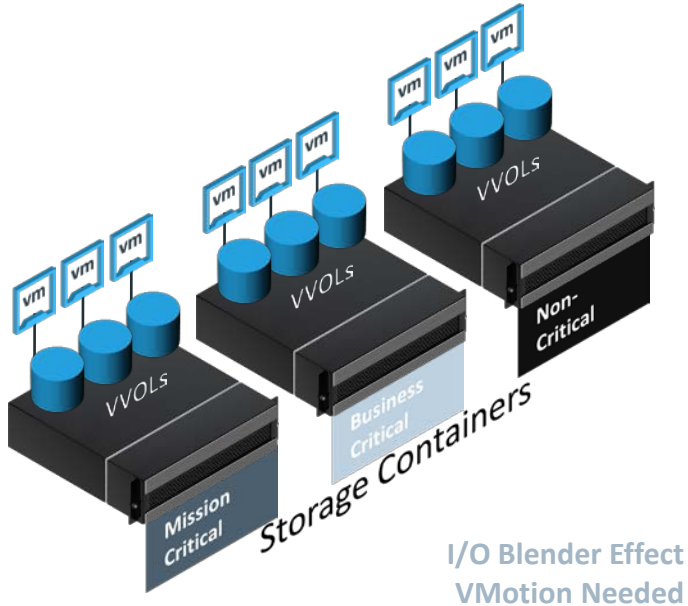
I/O Blender Effect
VMotion Needed

Storage Pool Consolidation

VM Workload Management

VM Aware Storage

vSphere 6 VVOL Integration



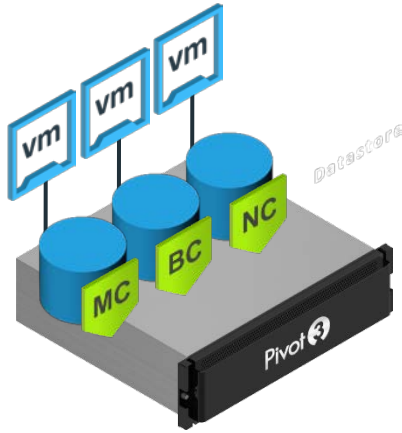
I/O Blender Effect
VMotion Needed

Storage Pool Consolidation

VM Workload Management

VM Aware Storage

Pivot3 QoS + VVOL



No I/O Blender Effect
No VMotion Required

Storage Pool Consolidation

VM Workload Management

VM Aware Storage

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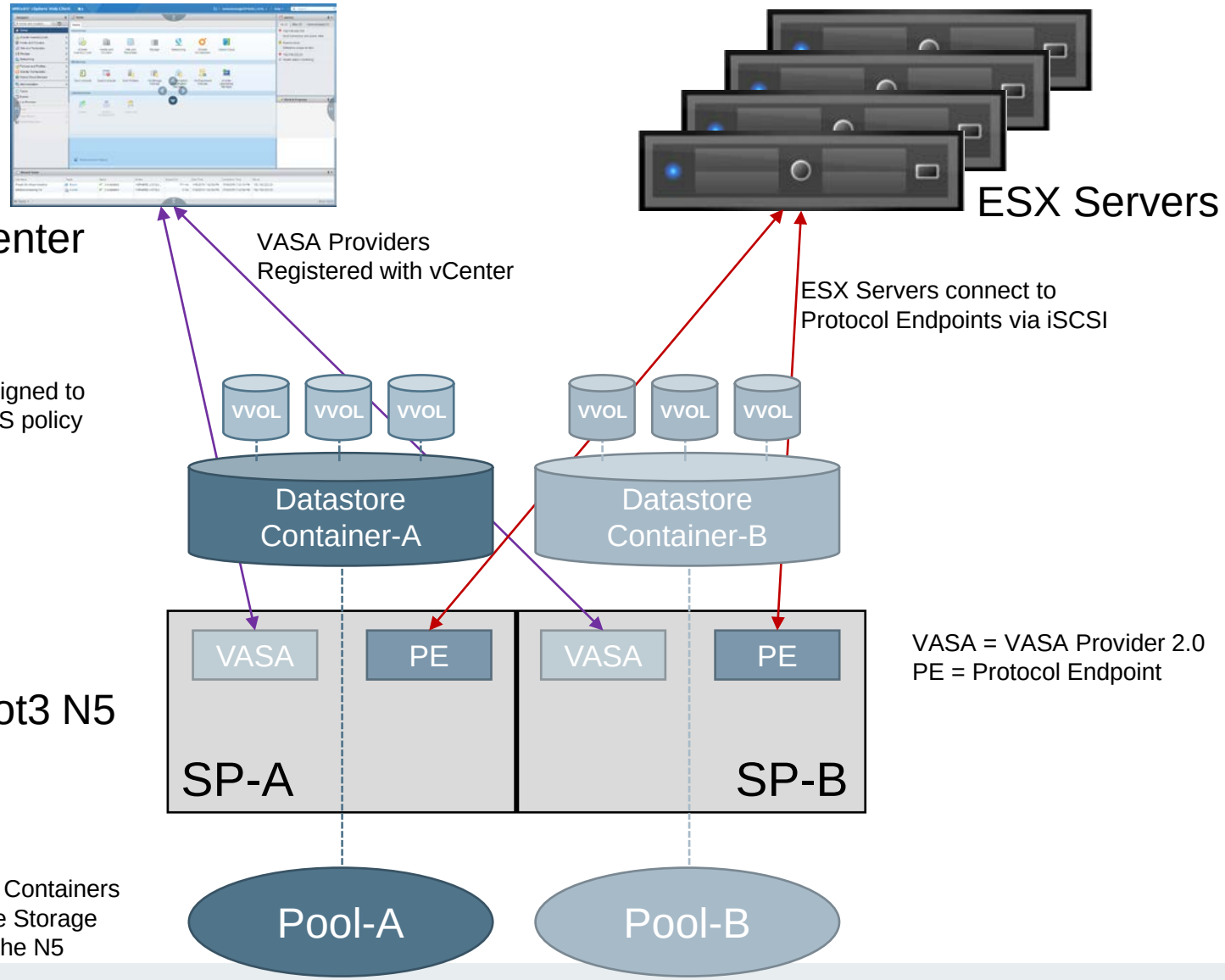
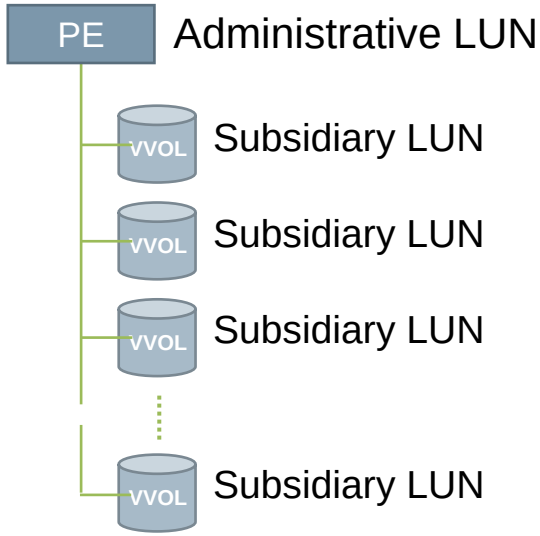
Pivot3 VVol Architecture



Pivot3 VVOL Features:

- QoS mapped to Storage Policy
- Software Defined Performance
- On-the-Fly QoS Change
- Automated VVOL Provisioning
- Thin Snapshot / Clone
- Equivalent Performance

VVOL Addressing:



Simple, Actionable Performance Information

Performance Info at a Glance

- Proactive monitoring
- Real-time performance information
- Performance by workload type and tier

Actionable Performance Statistics

- Granular performance information
  - Volume, tier, service level, system wide
  - By IOPS, TP, latency
  - Up to one year, and exportable

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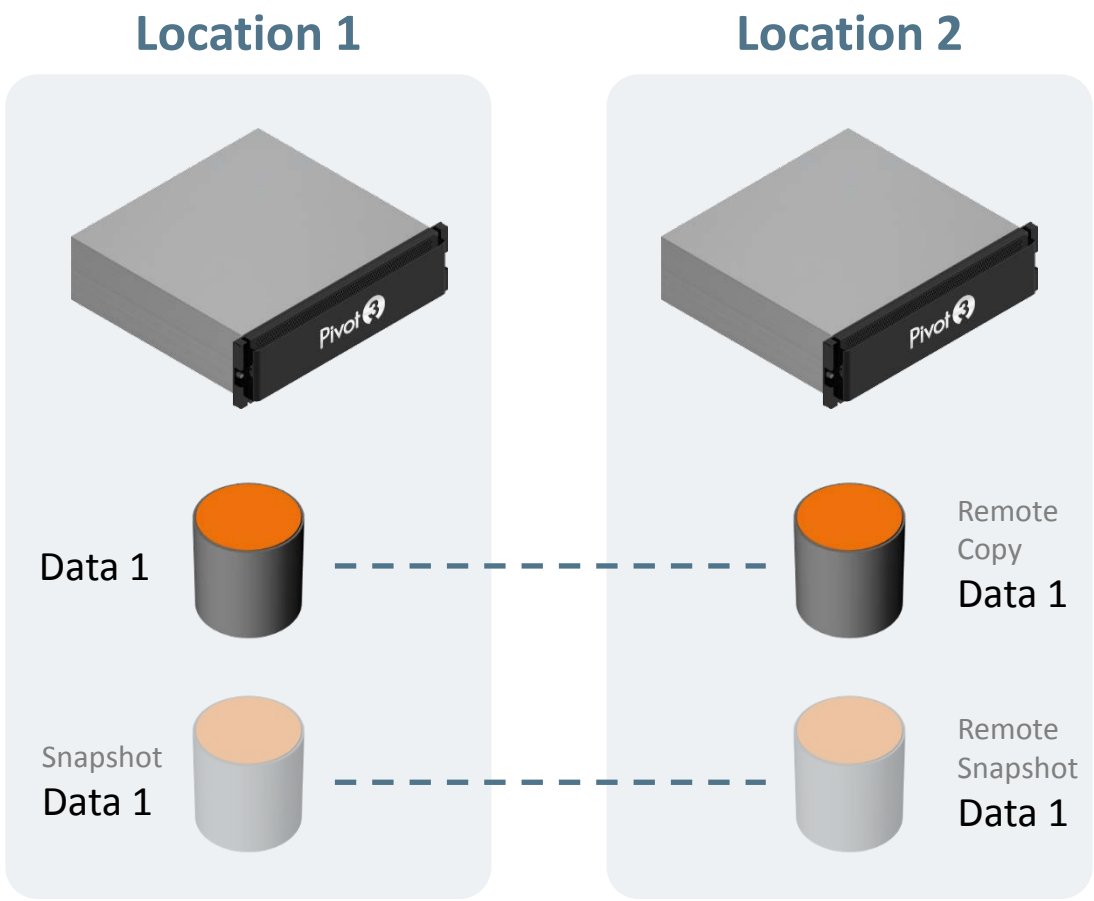
Simple to Manage Data Protection

- Snapshots
- Space efficient
- Scheduled
- Replication for DR
- Scheduled
- Asynchronous
- Between Different N5 Models
- VSS Provider for Microsoft
- Clones



VEEAM Zerto

Pivot3 Flash Storage Use Cases

Virtualize Critical Apps

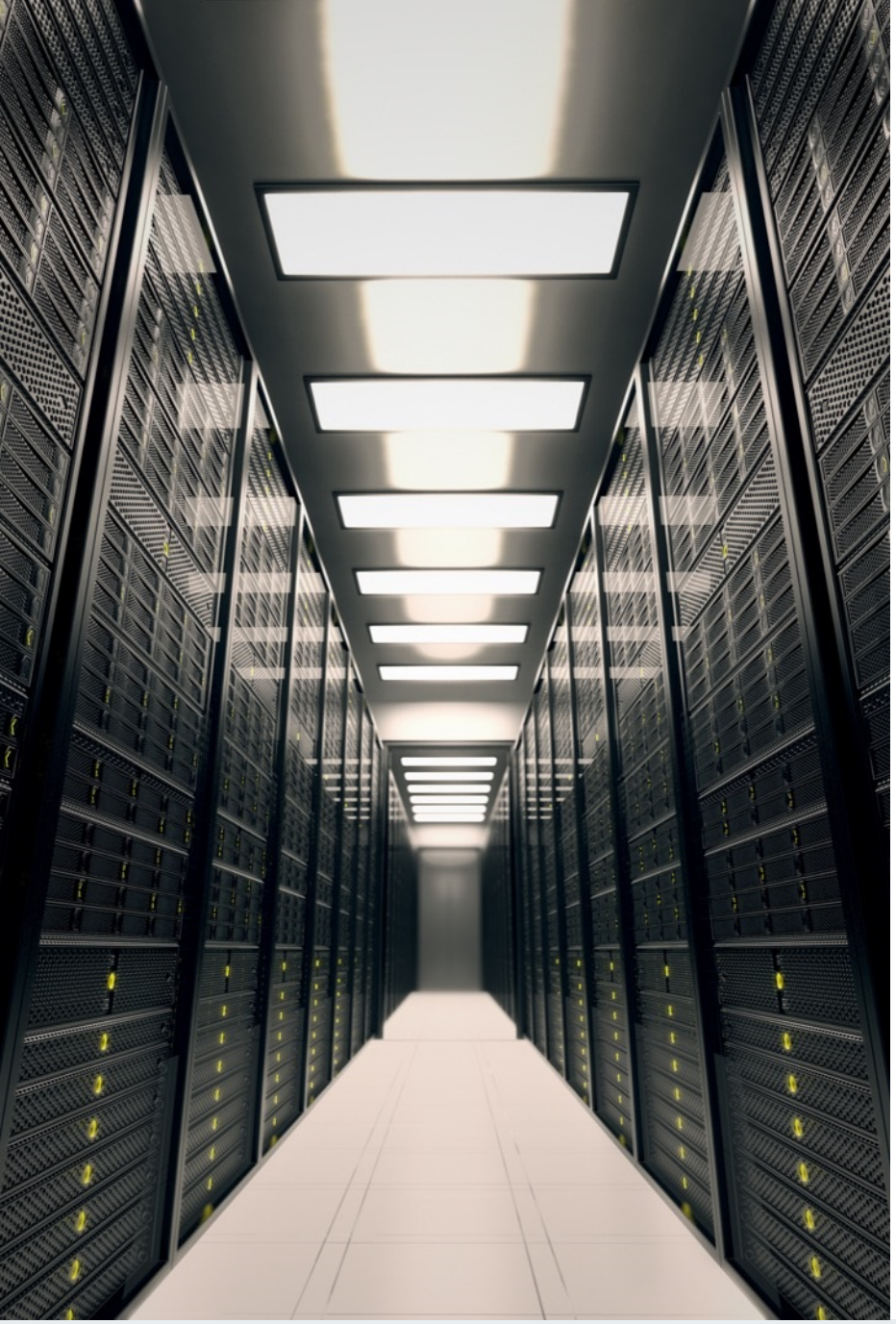
Server Virtualization

VDI

Deploy alongside other workloads

Database

Meet Mission Critical App SLAs



Server Virtualization: Confidently Virtualize Critical Applications

- Considerations
  - Meet mission critical application SLAs
  - Ease of management
- Why Pivot3?
  - Quickly apply QoS directly to VMs
  - Ensure mission critical VMs meet SLAs
  - Manage storage entirely within VMware vCenter

vmware READY

Microsoft Hyper-V

CITRIX ready

2-3X LOWER LATENCY AND PERFORMANCE WITH PCIE FLASH

40% MORE VM WORKLOADS WITH PIVOT3 QOS

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VDI: Deploy Alongside Other Workloads

- Considerations
  - High volume logins (boot storms)
  - Meet mission critical VM SLAs
- Why Pivot3?
  - Ultra-low latency cache for disk images
  - Consolidating multiple workloads with QoS
  - Ensure boot storms don't impact other apps

vmware READY END-USER COMPUTING

unidesk

CITRIX ready

6X FASTER BOOT TIMES
LA Metro

77% REDUCTION IN VDI RECOMPOSE PROCESS
C&S Companies

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Database: Meet Critical Application SLAs

- Considerations
  - Meeting low latency database requirements
  - Meet end-user experience expectations
- Why Pivot3?
  - Low-latency PCIe flash performance
  - Mission critical apps get resource priority in both sunny day and degraded mode operation

500%

INCREASE IN MONTHLY TRANSACTIONS
Bridgepay

157%

LOWER READ LATENCY
Kolcraft

Pivot3 N5 PCI-e Flash Arrays

- All-Flash and Hybrid
- Multi-tier Flash
- All-inclusive Feature Set
  - Quality of Service
  - Data Reduction Technologies
  - Data Protection
  - Deep VMware Integration
  - Online Scalability

nvm EXPRESS™ Adopter Member

vmware READY

Windows Server 2012 Certified

CITRIX ready

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Technical Specifications

Item	N5-200	N5-300	N5-500	N5-1000	N5-1500	N5-3000
Array Type	Hybrid	Hybrid	Hybrid	Hybrid	All-Flash	All-Flash
PCIe Flash Capacity	2.0 TB flash (base) 7.2 TB flash (max)	2.6 TB flash (base) 7.8 TB flash (max)	5.2 TB flash (base) 10.4 TB flash (max)	10.4 TB flash (base) 15.6 TB flash (max)	2.6 TB flash	2.6 TB flash
SSD Flash Capacity					15.0 TB raw (base) 60.0 TB raw (max)	30.0 TB raw (base) 60.0 TB raw (max)
HDD Capacity	32.0 TB raw (base) 128 TB raw (max)	64.0 TB raw (base) 256 TB raw (max)	64.0 TB raw (base) 256 TB raw (max)	64.0 TB raw (base) 256 TB raw (max)		
Performance Rating	150,000 IOPS * 2.0 GB/sec **	200,000 IOPS * 2.4 GB/sec **	225,000 IOPS * 2.7 GB/sec **	250,000 IOPS * 3.0 GB/sec **	450,000 IOPS * 6.0 GB/sec **	450,000 IOPS * 6.0 GB/sec **
PCIe Flash Scalability	5.2 TB flash Perf Pack	5.2 TB flash Perf Pack	5.2 TB flash Perf Pack	5.2 TB flash Perf Pack		
SSD Flash Scalability					15.0 TB SSD Shelf	15.0 TB SSD Shelf
HDD Scalability	32 TB Shelf HDD	32/48/64 TB HDD Shelf	32/48/64 TB HDD Shelf	32/48/64 TB HDD Shelf		
RAM	96GB	192GB	192GB	192GB	96GB	96GB
CPU	4x 6-core Intel Xeon E5645 2.4GHz (2x CPU per storage processor), 24x physical cores / 48 cores with hyper-threading					
Storage Processors	Dual Active/Active Storage Processors					
Network Interfaces	Data: (4) 1/10GbE SFP+ or (4) 1/10GBT RJ45, iSCSI / Management: (4) 1GbE RJ45, http, https					
All-Inclusive Feature-set	Quality of Service | Service Levels | Dynamic Data Path | Prioritized Active Cache | Data Reduction | Data Protection (Snapshot and Replication)					
VMware Integration	VAAI - vCenter Plug-in - MPIO ALUA - Virtual Volumes - Horizon View Proven Storage – vSphere Virtual Volumes					
Hardware Availability	Redundant storage processors | Redundant fans | Redundant, hot swap power supplies | Redundant network connections | Dual port SAS SSD drives | RAID, hot swap SSD drives					

** 4K random reads; ** 256K sequential reads*

Services and Support

Professional Services

- Design, configure and implement
  - Advanced architectural design
  - Business continuity planning & implementation
  - Application deployment
  - VDI implementation
  - Hardware and software upgrades
- System analysis
  - Performance optimization
  - Best practices for success
- Training and certification
  - Live remote or onsite
  - Online

Technical Support

- Support Offerings
  - 7 day x 24 hour phone | onsite/same day parts
  - 7 day x 24 hour phone | NBD parts
  - 5 day x 9 hour phone | NBD Parts
- Proactive Monitoring
  - Actionable alerts and notifications
  - Integrated phone-home telemetry
- Expertise to complement your IT team
  - Storage
  - Virtualization

Thank You