



Persistent Memory Enablement Update





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Hewlett Packard Enterprise

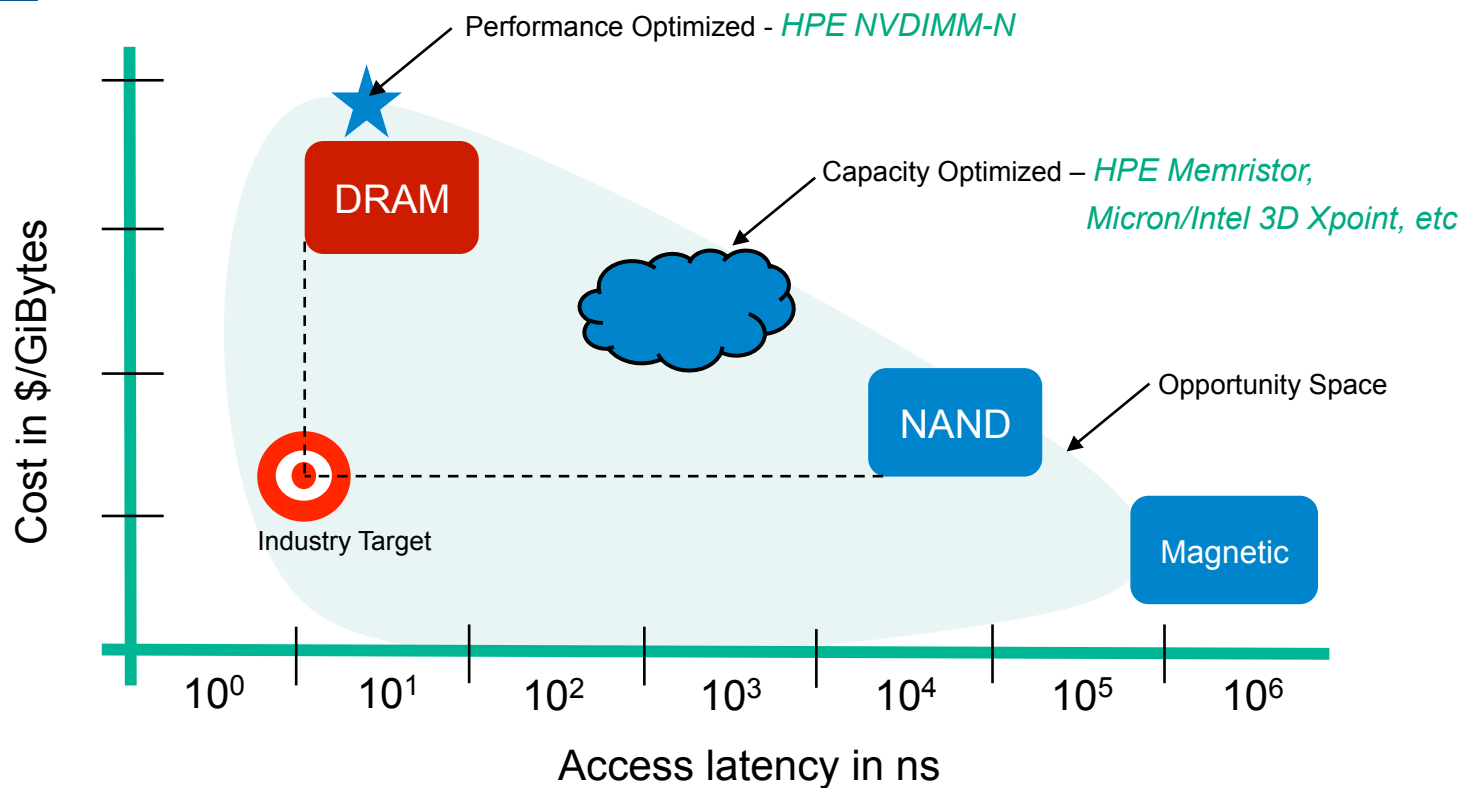
Section Manager – Persistent Memory Engineering



HPE Delivers Industry First Persistent Memory Enabled Servers

Industry Standard SW	Software Apps	Native Applications (Microsoft SQL Server and Exchange Server)	HPE Reference Architectures	Microsoft SQL Server 2016; Hortonworks Hadoop Spark Database
	Operating Systems	Microsoft Windows Server 2012 R2	HPE Collaboration on O/S Enablement	Microsoft Windows Server 2016, Leading Linux Distros (Linux SDK)
HPE Infrastructure	Persistent Memory	HPE 8GB NVDIMM 	HPE NVDIMM Micro Controller and Smart Storage Battery	Future Offerings with Increased Capacity and Performance
	Servers	HPE ProLiant DL 360/380 	HPE BIOS and HPE iLO Server Management	HPE BladeSystem, HPE Synergy, HPE ProLiant ML, HPE Apollo, HPE Integrity
April 2016 HPE Innovation			2016 +	

Types of Media





Yesterday's Storage & Memory

Devices built from RAM, Flash, and Magnetic Media

Memory



RAM
DIMM

All Memory

Block Storage



Flash
SSD, PCI,
NVMe

Fast Storage



Magnetic
HDD, Tape

Cheap/Dense Storage



2016 Storage & Memory

Introducing NVDIMM-N the New Leader in Fast Storage

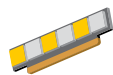
Memory



RAM
DIMM

All Memory

Block Storage



RAM + Flash
NVDIMM-N

Fastest Storage



Flash
SSD, PCI,
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Balanced Storage



Magnetic
HDD, Tape

Cheap/Dense Storage



2016 Storage & Memory Convergence Begins

What is storage and what is memory begins to blur

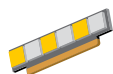
Memory



RAM
DIMM

Fast Memory

Byte Addressable Storage



RAM + Flash
NVDIMM-N

Fast Byte Addressable Storage

Block Storage



RAM + Flash
NVDIMM-N

Fastest Storage



Flash
SSD, PCI,
NVMe

Balanced Storage



Magnetic
HDD, Tape

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Comparing NVDIMM Performance to Flash

Performance Measurement	NVDIMM vs SAS SSD	NVDIMM vs PCIe Workload Accelerator
IOs Per Second (IOPs)	34x more IOPs	24x more IOPs
Bandwidth	16x greater Bandwidth	6x greater Bandwidth
Latency	81x lower Latency	73x lower Latency

HPE NVDIMM technology promises to unlock new levels of HPE ProLiant performance



Applications that will be impacted by Persistent Memory



Relational Database

MSFT SQL
MySQL
Maria DB
Oracle



Scale-out Storage

Vmware VSAN
MSFT Azure
Store Virtual



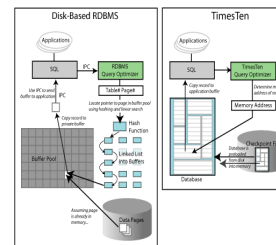
Virtual Desktop Infrastructure

Vmware VDI
Citrix HDI



Big Data

- Mongo DB
- Cloudera
- HortonWorks
- Hadoop
- Cassandra
- MSFT SQL Hadoop



In Memory Database

SAP HANA
MSFT SQL Hekaton
XAP Gigaspace

Middleware

Java
.NET

Optimizes and abstracts NVM devices

HPC and others ...

Storage

HP Storage



Microsoft SQL Server Transaction Log Performance

Hardware

- HPE ProLiant DL360 Gen9
- DB data on 6x 400GiB SSD

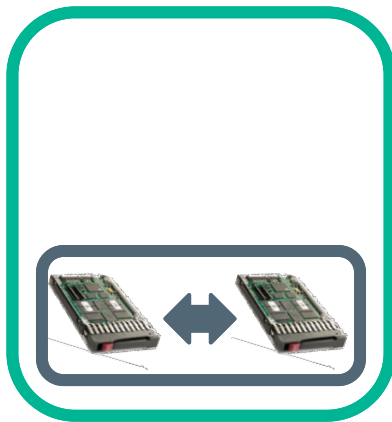


Software

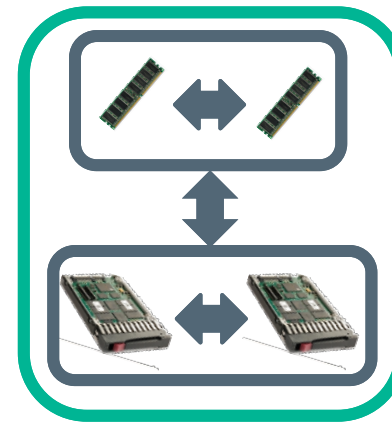
- MS WS2016 TP 5 inbox driver
- Microsoft SQL Server
- Microsoft Storage Spaces

Microsoft SQL Server transaction log performance comparison in 2 scenarios:

#1: Mirrored Pool of SSDs



#2: Pair of SW mirrored HPE 8GB NVDIMMs, front-ending mirrored Pool of SSDs (caching)





Microsoft SQL Server Transaction Log Performance

Hardware

- HPE ProLiant DL360 Gen9
- DB data on 6x 400GiB SSD

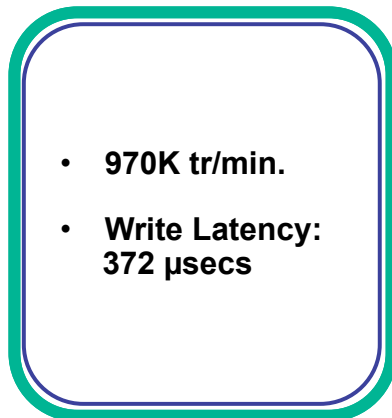


Software

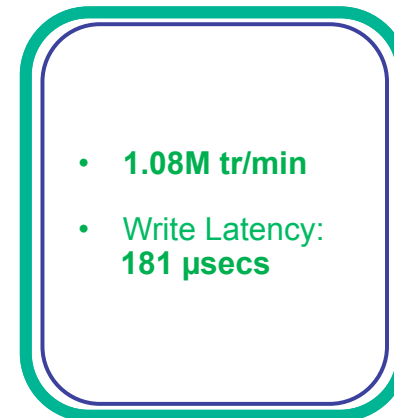
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Microsoft SQL Server transaction log performance comparison in 2 scenarios:

#1: Mirrored Pool of SSDs

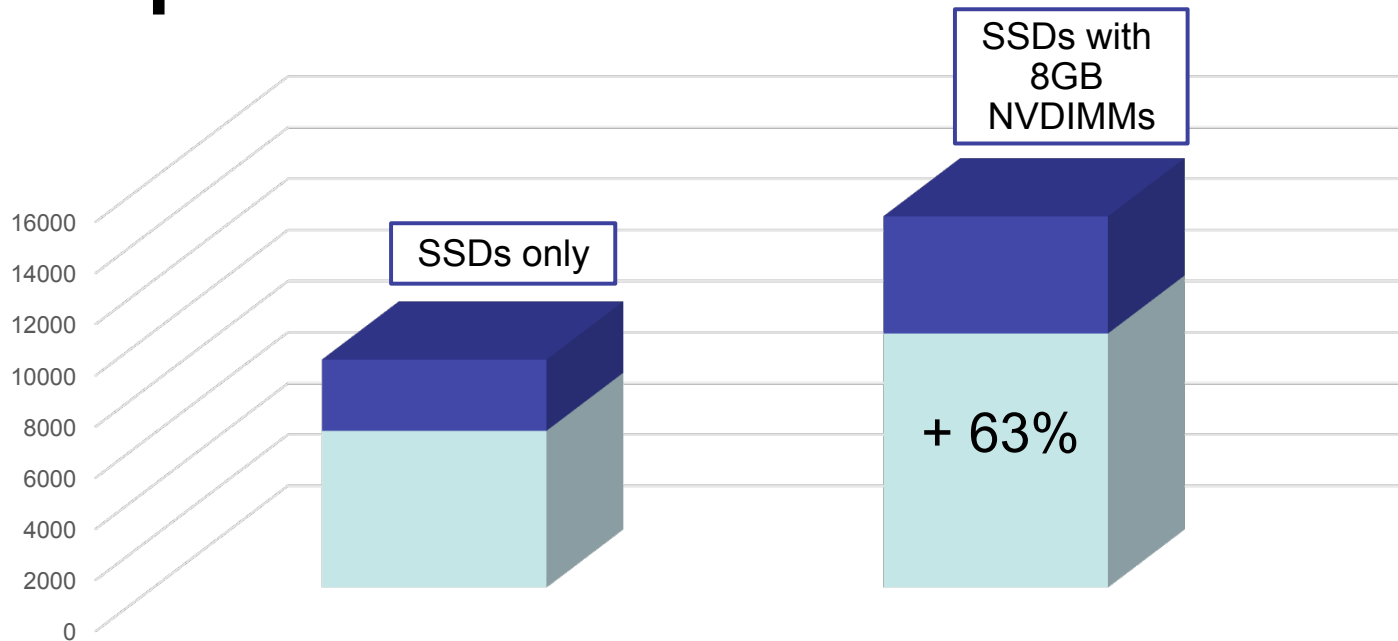


#2: Pair of SW mirrored HPE 8GB NVDIMMs, front-ending mirrored Pool of SSDs (caching)





HPE Persistent Memory Microsoft Exchange performance





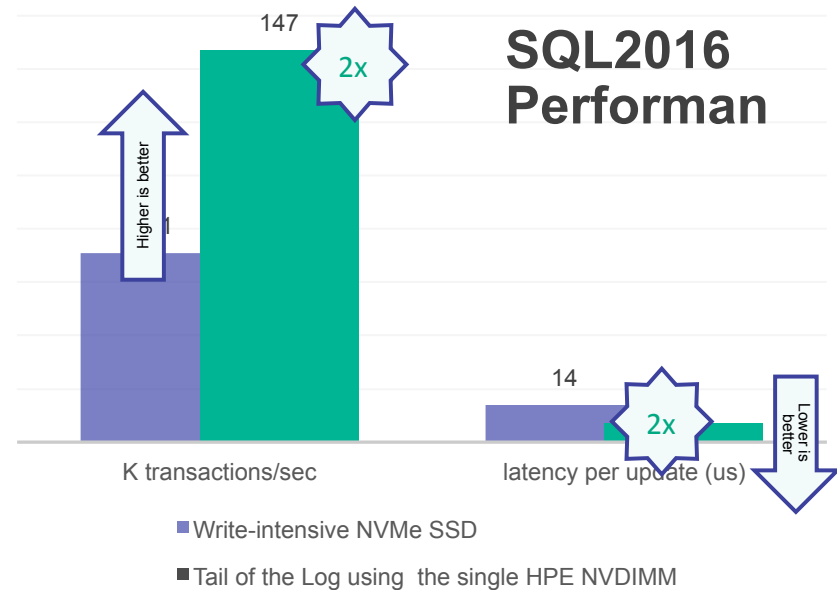
SQL2016 Tail of the Log

Server configuration:

- ✓1x HPE ProLiant DL380 Gen9 (both sockets populated)
- ✓1x NVDIMM-N (8GB) – for the tail of the log
- ✓2x SATA SSD (400GB) – as the store for Database files
- ✓1x NVMe SSD (400GB) – as the store for both logs
- ✓128GB Memory

Software:

- Windows Server 2016 TP5
- SQL Server 2016 RC3
 - SQL Tables are stored on 2x SATA SSDs that are striped (Simple Space)
 - SQL Tail of the Log enabled
 - Table Size configured to match Data and Log storage capacities
 - Threads: 1 per Windows logical processor
 - SQL queries: Create, Insert, Update
 - SQL PerfCollectors: None
 - Batch Size: 1
 - Row Size: 32B



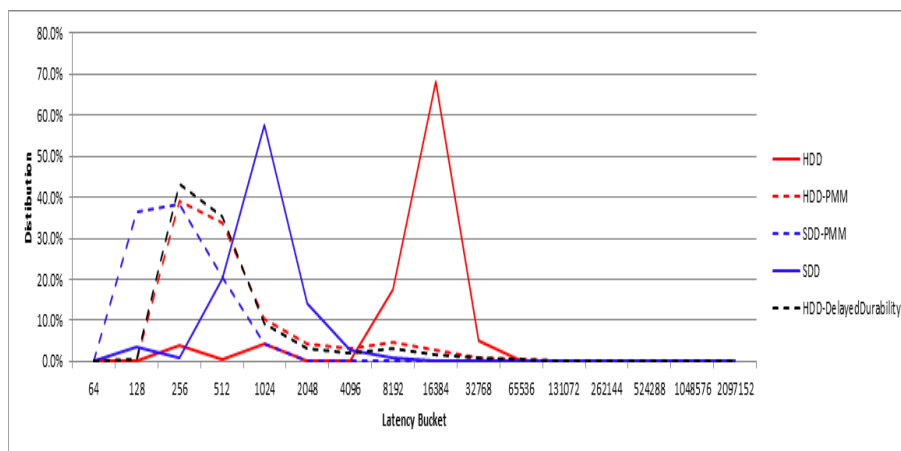
Executed Tests and results :

- 05/19/2016: 2x with a HPE write-intensive NVMe SSD
- 05/06/2016: 3x with a mixed (vs. write-intensive) type NVMe SSD



HPE Persistent Memory Log with SQL 2016

- Use byte-addressable log implementation
- Using Windows Server 2016 DirectAccess (DAX) filesystem capability
- Dramatic reduction in latency



	HDD	HDD-PM	SDD-PM	SDD	HDD-DelayedDurability
64 us]	0.0%	0.0%	0.0%	0.0%	0.0%
128 us]	0.0%	0.1%	36.3%	3.5%	0.7%
256 us]	3.9%	39.2%	38.3%	0.9%	43.1%
512 us]	0.4%	34.0%	20.7%	20.1%	35.5%
1024 us]	4.4%	10.4%	4.5%	57.6%	9.3%
2048 us]	0.0%	4.2%	0.1%	14.2%	3.3%
4096 us]	0.1%	3.0%	0.0%	2.6%	2.1%
8192 us]	17.6%	4.7%	0.0%	0.9%	3.2%
16384 us]	68.2%	2.6%	0.0%	0.2%	1.6%
32768 us]	5.0%	1.0%	0.0%	0.0%	0.7%
65536 us]	0.3%	0.6%	0.0%	0.0%	0.5%
131072 us]	0.1%	0.1%	0.0%	0.0%	0.1%
262144 us]	0.0%	0.0%	0.0%	0.0%	0.0%
524288 us]	0.0%	0.0%	0.0%	0.0%	0.0%
1048576 us]	0.0%	0.0%	0.0%	0.0%	0.0%
2097152 us]	0.0%	0.0%	0.0%	0.0%	0.0%

