SDC
STORAGE DEVELOPER CONFERENCE
SNIA ■ SANTA CLARA, 2014

New Fundamental Data, Storage and Device Technologies

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SanDisk®

Forward-Looking Statements

During our meeting today we may make forward-looking statements.

Any statement that refers to expectations, projections or other characterizations of future events or circumstances is a forward-looking statement, including those relating to market position, market growth, product sales, industry trends, supply chain, future memory technology, production capacity, production costs, technology transitions and future products. This presentation contains information from third parties, which reflect their projections as of the date of issuance.

Actual results may differ materially from those expressed in these forward-looking statements due to factors detailed under the caption “Risk Factors” and elsewhere in the documents we file from time to time with the SEC, including our annual and quarterly reports.

We undertake no obligation to update these forward-looking statements, which speak only as of the date hereof.

NVDIMM Market Update

- NVDIMM-N is shipping in volume with DDR3
  - Memory mapped devices, DRAM and NAND (DRAM like capacity)
  - Use case: persistence via writes to NAND if/when power fails
- NVDIMM-F is shipping in volume with DDR3
  (e.g. ULLtraDIMM™ SSD)
  - Block storage alternative to PCIe/SAS
  - Use case: High capacity, low latency SSD block storage through aggregate devices residing on memory bus
- Future considerations captured by JEDEC/SNIA
  - NVDIMM-N2 – same as NVDIMM-N but with user accessible NAND
  - Next generation of STT MRAM and RRAM

ULLtraDIMM™ SSD – Executive Summary

- First enterprise-class SSD that utilizes the memory bus
- ULLtraDIMM SSD takes advantage of the ultra-fast memory bus lanes
- Lowest write latency SSD in the market for latency sensitive workloads
- Parallel architecture allows high IOPS and bandwidth performance
- Guardian™ Technology Platform for enterprise endurance
- Partners in the ecosystem are working on taking advantage of this new architecture: Atlantis for VDI, Percona for No SQL, VMware VSAN …

ULLtraDIMM™ SSD – Features

Guardian Technology™ Platform

- ❑ Enterprise level endurance with MLC
- ❑ 10 drive writes per day
- ❑ 5 year warranty

Ultra Low Latency, High Performance

- ❑ Low write latency (less than 5 usec)
- ❑ Scalable performance by adding additional ULLtraDIMM SSDs

Enterprise Class Reliability

- ❑ Back up power circuitry
- ❑ Full data path protection
- ❑ Enterprise class MTBF

Scalable, Cost Effective Media

- ❑ 200, 400 GB
- ❑ Scalable architecture
- ❑ 19nm flash technology (MLC)

Memory Channel Interface

- ❑ DDR3 protocol
- ❑ Configured as block device (through device driver)

ULLtraDIMM™ SSD Series

ULLtraDIMM SSDs	
Usage Model	Ultra low latency + scalable IOPS
Part numbers	400GB: SDLOOCFM-400G-6KB1 200GB: SDLOODFM-200G-6KB1
Form Factor	DDR3 RDIMM
Endurance (Random)	10 DWPD
MTBF	2M Hours
Warranty	5 years

Block Storage Software Drivers			
Linux RedHat	Linux SuSe	Microsoft Windows	VMware ESX
6.4	SLES 11 SP2	2012	5.1U2
6.5	SLES 11 SP3	2012 R2	5.5

Benefits to Applications

Financial Services

- Block device
- Low, predictable latency
- Fast Interactive Data Analysis

Database

- Block device/ memory extension*
- Increase Transactions per Second

Virtualization

- Block device
- Increased VMs per Node
- Faster response times per VM

Blade Server

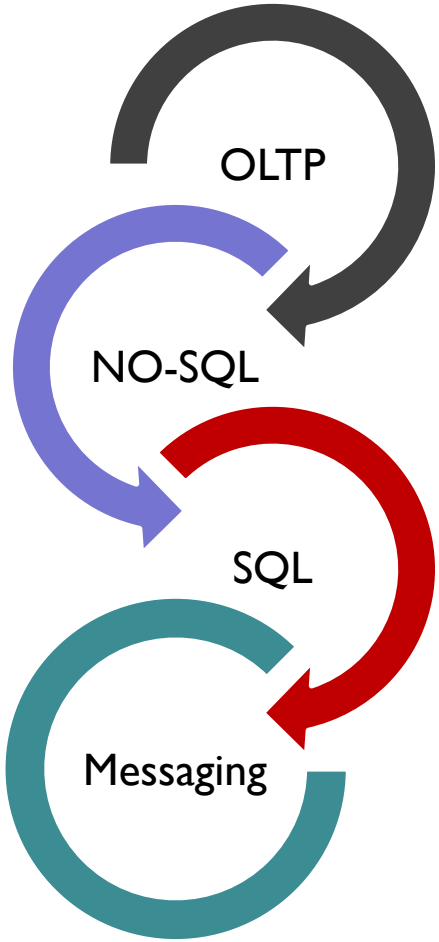
- Block device
- Utilizes empty DIMM slots
- Enables high density storage blades

In Memory Compute*

- Memory extension
- Reduce response times for analytics queries
- * Future roadmap

Call for Proof of Concepts!

- SanDisk invites enterprise and Cloud application partners think take advantage of the unique value that ULLtraDIMM™ SSDs can bring to the applications
- Can your application take advantage of lower write latency – as low as 5us?



Customer Validation – IBM

Performance: Near Linear Scaling

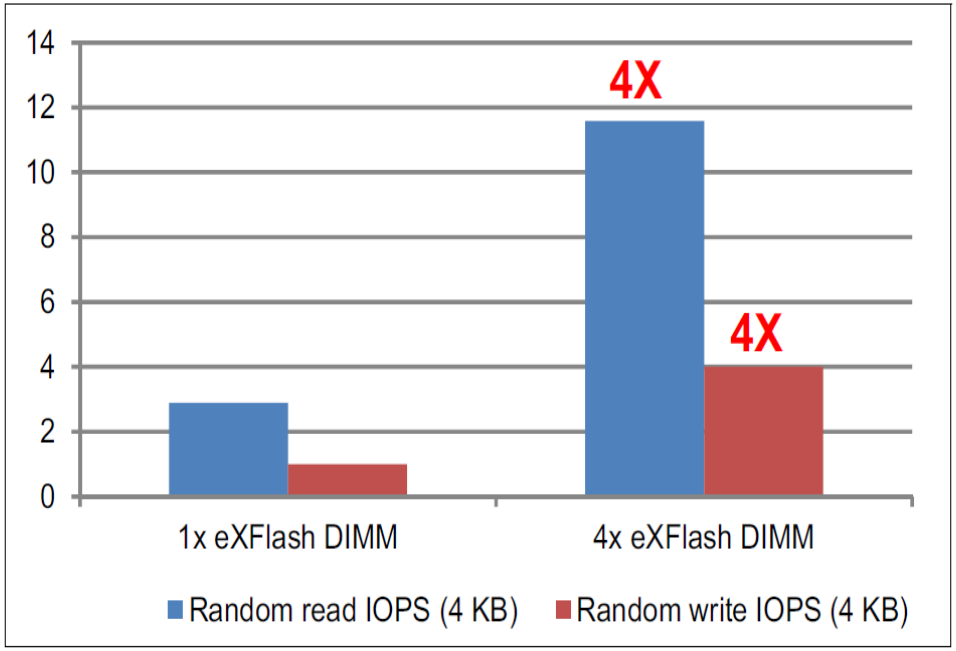


Figure 12 eXFlash DIMM scalability

As shown in Figure 12, eXFlash DIMMs provides near linear performance scalability by adding more eXFlash DIMMs to the system.

Source: IBM Redpaper ' Benefits of IBM eXFlash Memory Channel Storage in Enterprise Solutions'; Author: Ilya Krutov; February 24, 2014; IBM form# REDP-5089-00

Customer Validation – IBM

Write Latency: Lower is Better

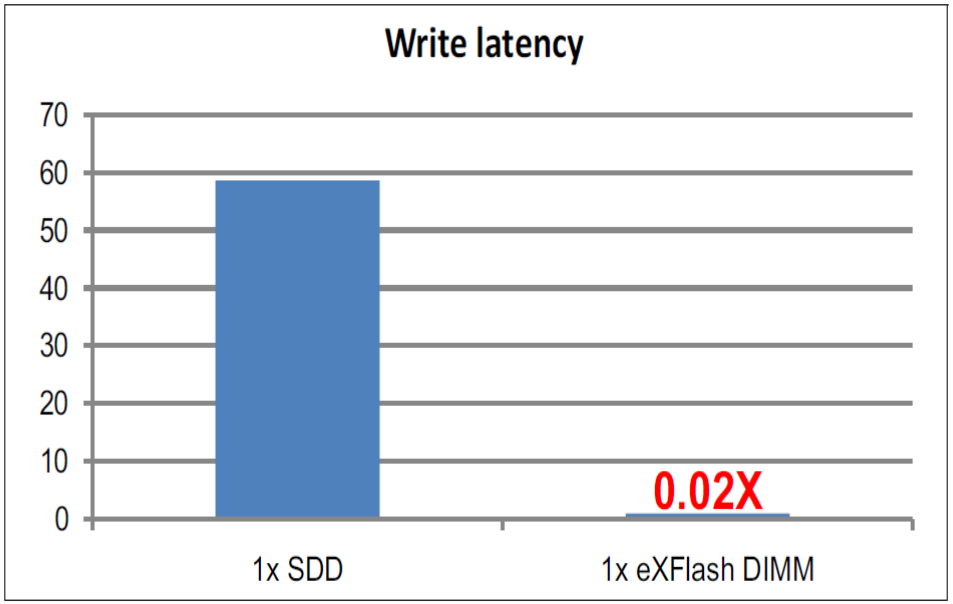
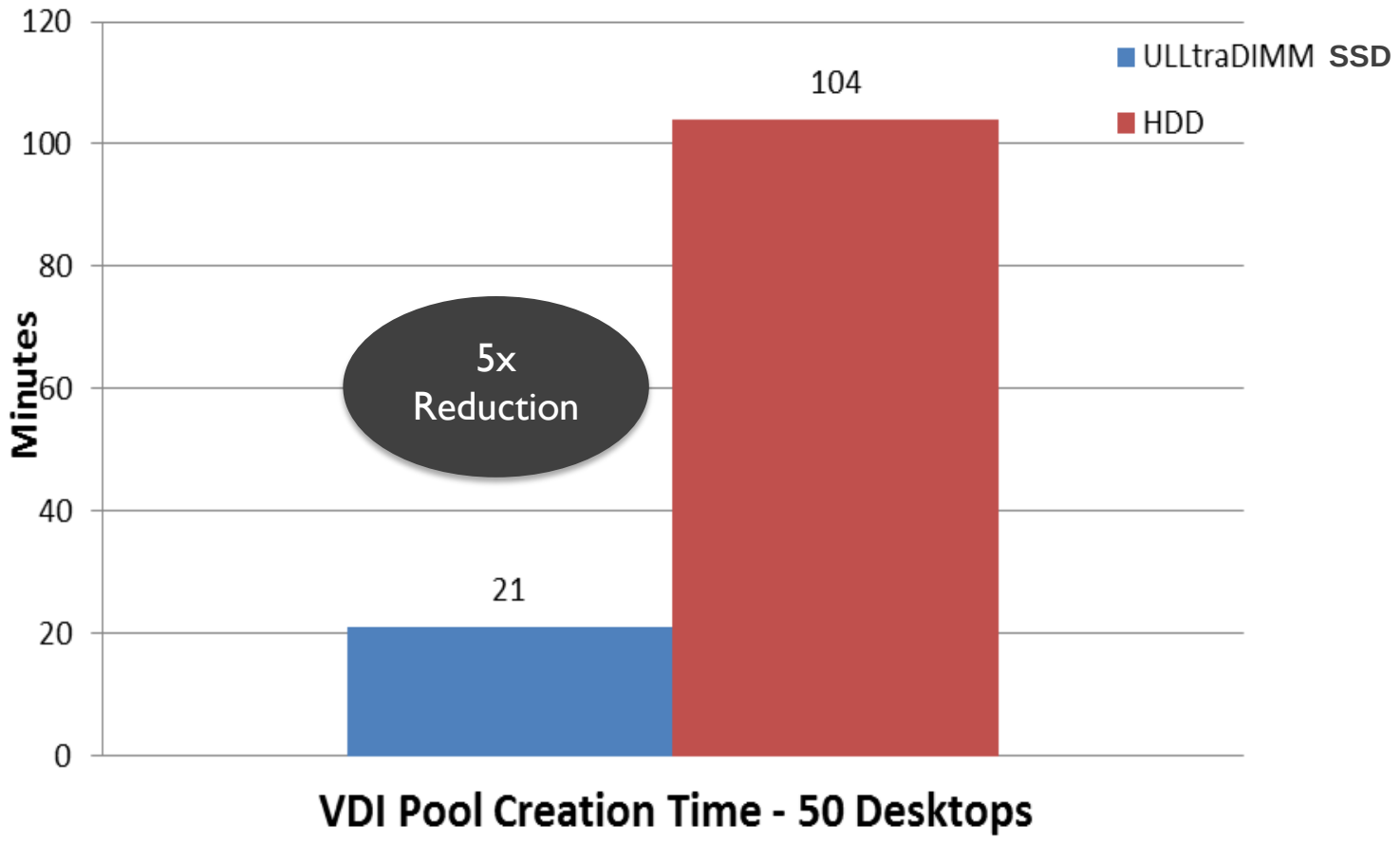


Figure 15 eXFlash DIMM versus SSD: write latency

With a queue depth of 1, the eXFlash DIMM provides more than 50 times improvement in write access latency compared to an SSD.

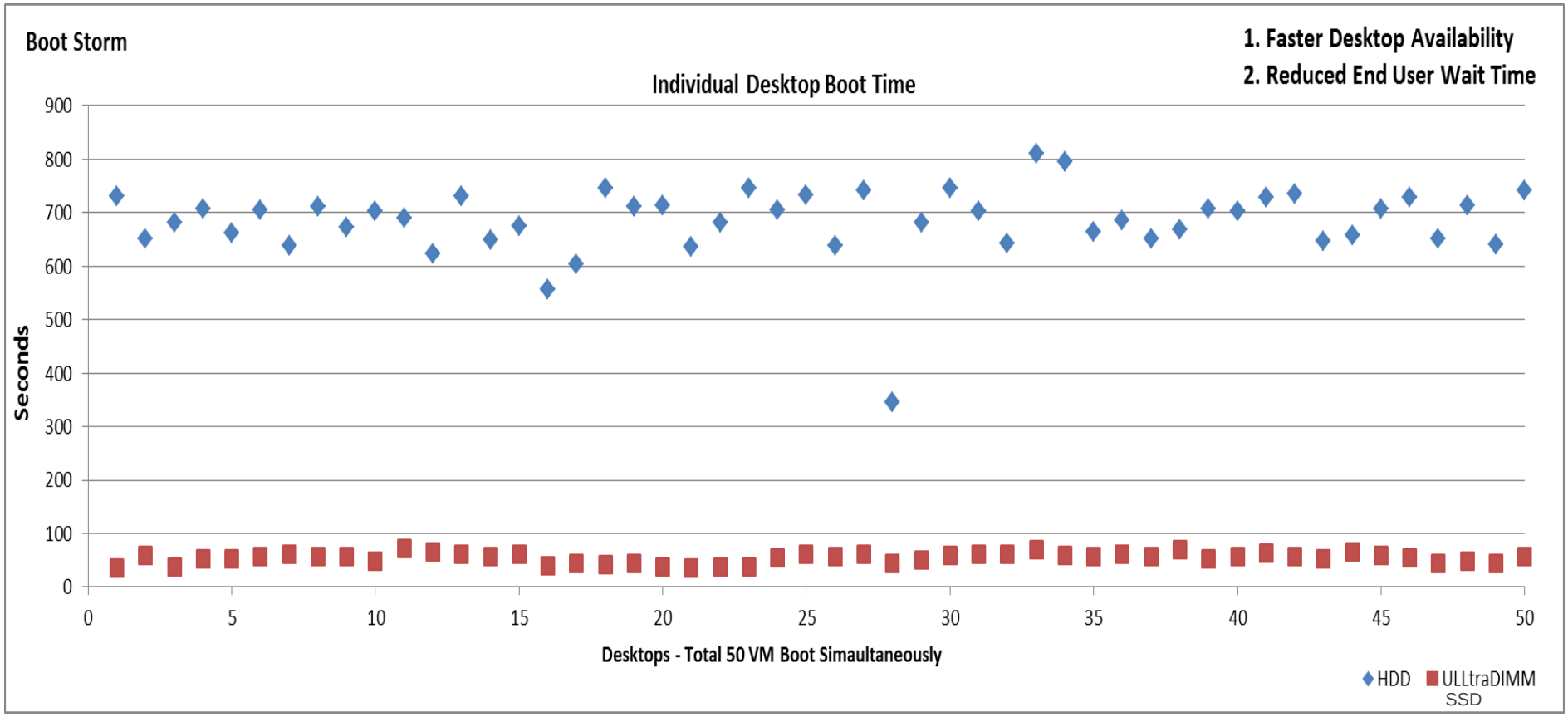
Source: IBM Redpaper ' Benefits of IBM eXFlash Memory Channel Storage in Enterprise Solutions'; Author: Ilya Krutov; February 24, 2014; IBM form# REDP-5089-00

VDI Desktop Creation is Faster with SanDisk ULLtraDIMM™ SSDs



Source: SanDisk internal testing

VDI 'Boot Storm' Impact Reduced by Using SanDisk Flash Storage



Source: SanDisk internal testing

SanDisk SSDs + VMware Virtual SAN™

Performance

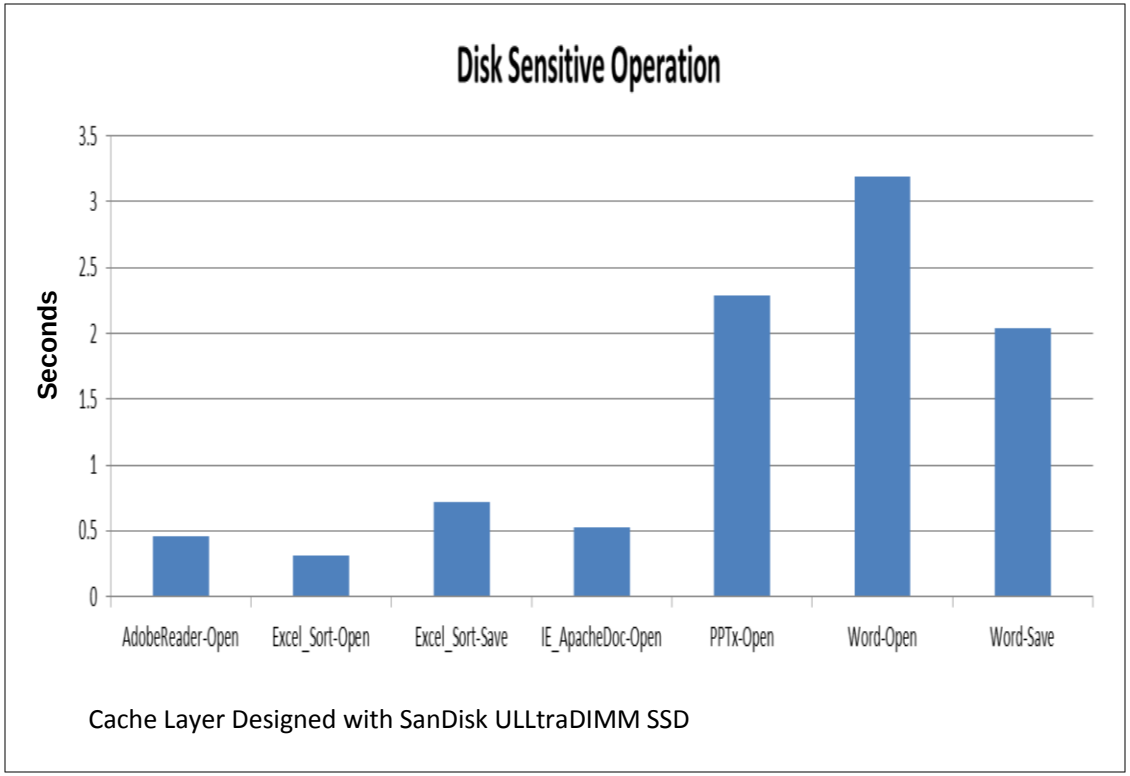
Availability

Capacity

Reliability

VDI Application Response Time on 8-Node VMware Virtual SAN™

ULLtraDIMM™ SSD + VMware Virtual SAN: For VDI Application Response Time



Source: SanDisk internal testing

All-Flash Converged Storage

IBM and Atlantis have introduced the world's first All-Flash Converged solution that integrates the proven IBM System x server platform, the innovative Atlantis USX software defined storage platform and unique IBM eXFlash memory channel storage.

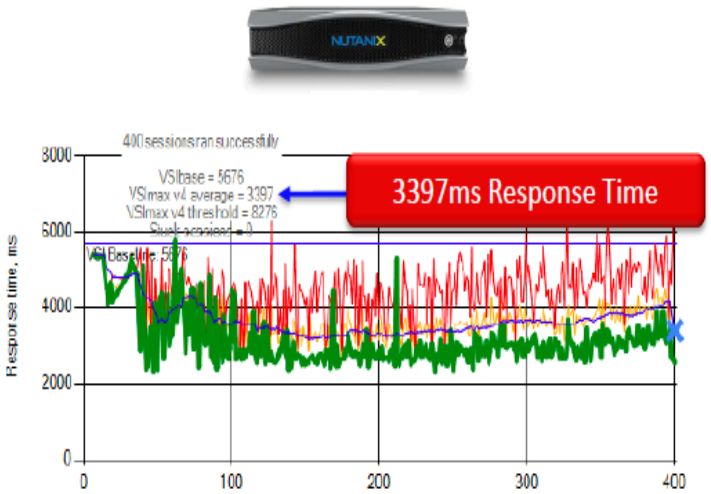
KEY BENEFITS

Cost Reduction

- ❑ 80% lower cost per GB than all-flash array
- ❑ 90% lower cost per IOPS than SAN
- ❑ No OPEX for data center storage

Source: Atlantis

VDI Performance Comparison – Atlantis

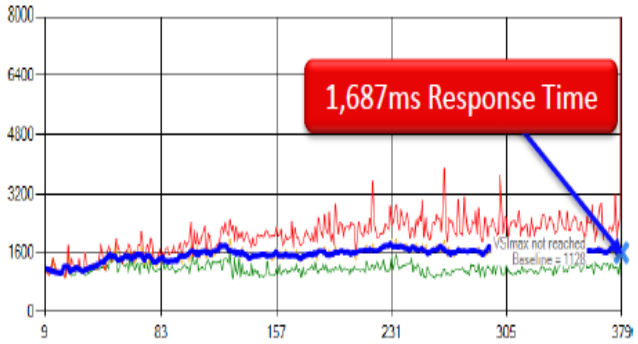


- $360-576 per desktop (task vs. power user)
- 100 desktops per server
- 3397ms response time

Source: Nutanix Citrix XenDesktop on Microsoft Hyper-V Reference Architecture

Atlantis USX

3 X IBM x3650 M4

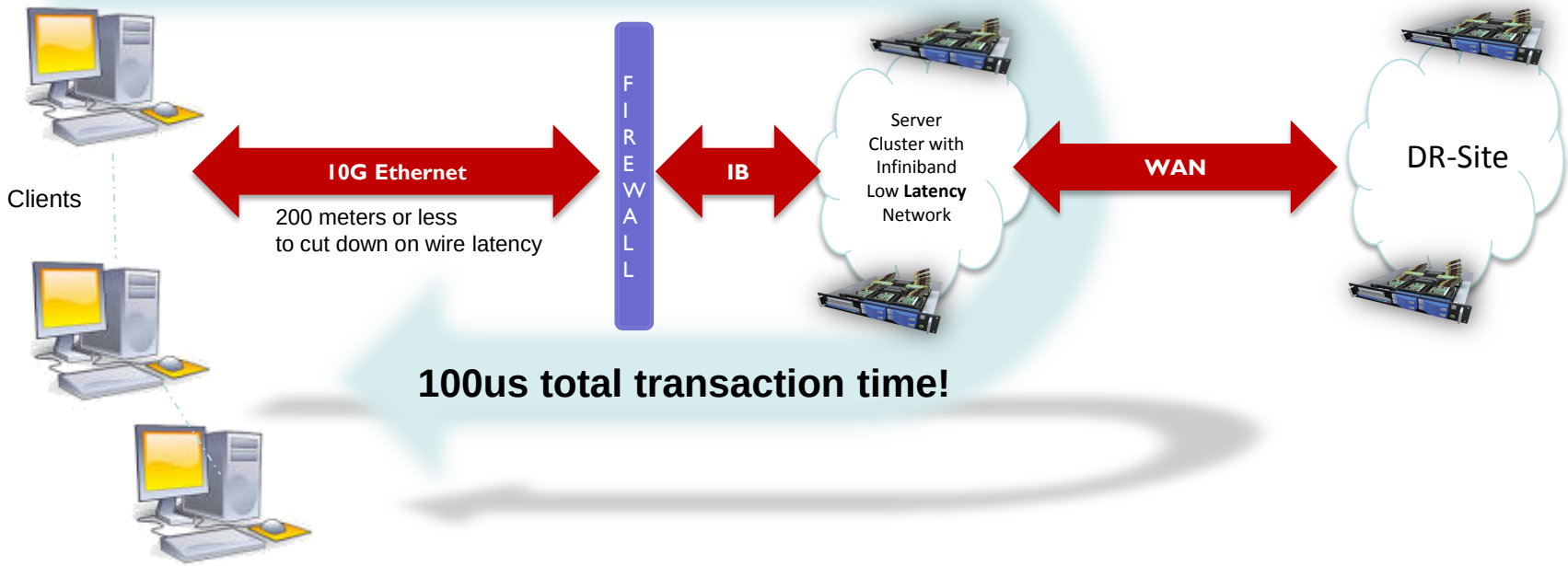


- $225 per desktop (38-61% cheaper)
- 126 desktops per servers (26% more)
- 1,687ms response time (50% Faster)

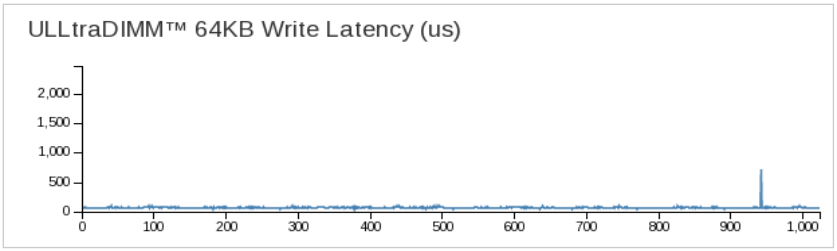
Source: Atlantis

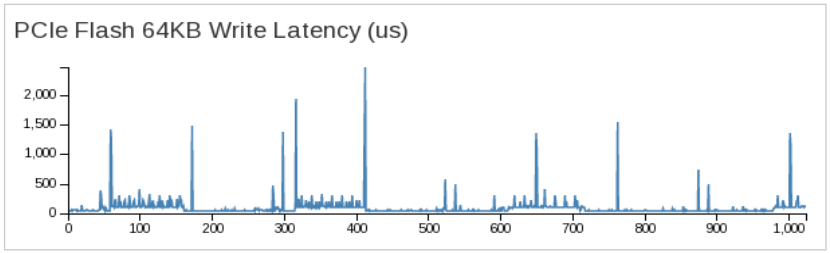
High Frequency Trading Example

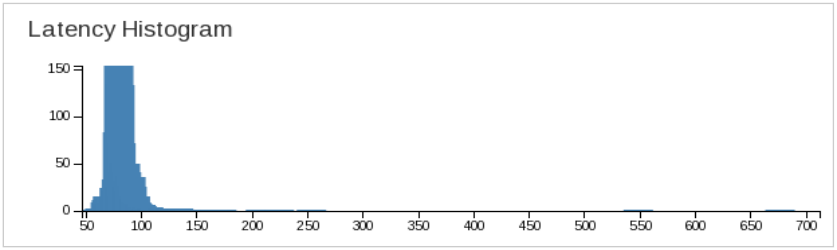
- A leading Stock Exchange is capable of completing a trade transaction in 100us!
  - ULLtraDIMM™ SSDs have the potential to reduce it even further

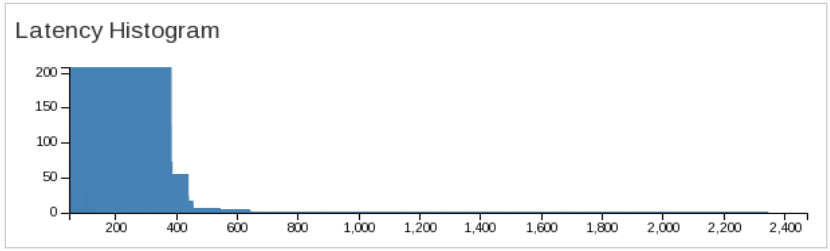


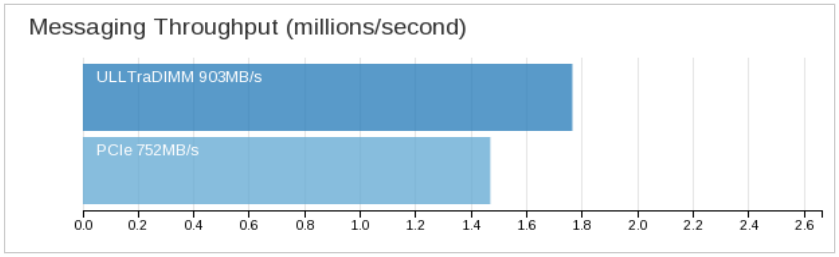
ULLtraDIMM™ SSDs vs PCIe SSDs

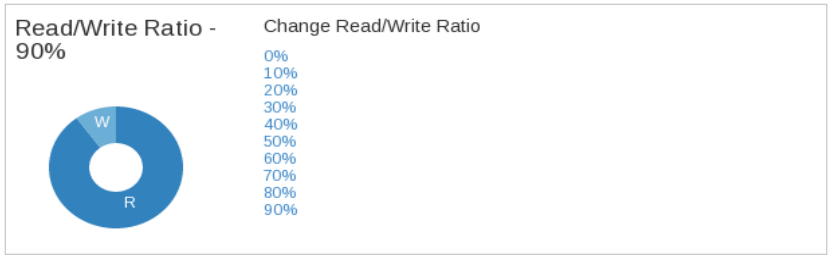












Source: SanDisk internal testing running 60East software

Call to Action

- New and exciting era of persistent memory on the ultra-fast memory bus is here
- SanDisk offers the lowest write latency SSD in the market for latency sensitive workloads
- Guardian™ Technology Platform for enterprise endurance
- Parallel architecture allows high IOPS and bandwidth performance
- SanDisk calls on ecosystems partners for Proof of Concepts to take application performance to new levels!

Thank you!

Any Questions?