Citrix Ready VDI Capacity Program

Pivot3 PCIe Flash Array With Citrix XenDesktop

A performance test demonstrating the Pivot3 solution successfully supporting a complex Citrix XenDesktop workload designed to simulate a 1,500-user VDI environment at normal load.
While virtual desktop infrastructure (VDI) has become more common in recent years, storage-related challenges like performance and cost have inhibited broader adoption and impacted return on investment and user satisfaction.

Many strategies exist for solving the storage challenges associated with VDI. These strategies encompass a range of work-around solutions that address the symptoms instead of the underlying deficiencies. Some companies even go to the extreme of intentionally limiting desktops in an attempt to artificially induce a reduction of I/O requests.

Fortunately, storage solutions exist to resolve these issues and deliver better VDI performance and user experience. With a proper storage solution, VDI can deliver on its promised flexibility while maximizing cost effectiveness and deployment success.

This white paper summarizes a performance test Pivot3 conducted with Citrix to validate a VDI solution that emulates a day in the life of a 1,500-user XenDesktop deployment. It will outline the parameters of the validation test and discuss why Pivot3 PCIe Flash Arrays are suitable storage solution for XenDesktop deployments.

The paper also discusses additional benefits of Pivot3 PCIe Flash Arrays, including improved performance management and reduced costs. Ultimately, the combination of Citrix XenDesktop and Pivot3 PCIe Flash Arrays was proven to provide a cost-effective solution that meets the performance, capacity and scalability requirements of organizations wanting to deploy VDI.

The Business Challenge

However, storage has proven to be critical to both the operational and financial success of VDI. The challenge is to provide a computing and storage environment that delivers a cost-effective, high-quality, predictable and productive user experience.

Considerations to be Acknowledged Prior to Selecting Storage for VDI

**Performance:** High I/O performance and low latency are keys to a successful VDI user experience. Nothing stalls VDI adoption faster than user frustration caused by slow boot-ups and application response times. It is important to note that VDI is generally characterized as write-heavy. While this is less a concern with all-flash storage arrays, since all reads and writes go to flash, it can be problematic for most hybrid arrays, which do not use flash for writes.

**Cost:** Traditional all-flash storage can solve the performance requirements of VDI, but cost can put the project out of reach. Many hybrids promise high capacity and performance, but sacrifice capacity by consuming HDD trays with SSDs. A better solution would provide both guaranteed performance and maximum capacity.
Storage Sprawl: The ability to run VDI alongside other applications would reduce the cost and management complexity associated with storage sprawl across the organization. This is especially important for small and midsize companies, for which sprawl is a major consideration due to the additional cost in system administration, support and maintenance on top of initial acquisition costs.

Top Features to Consider in a VDI Storage Solution

- **Predictable User Experience**: Virtual desktop users will expect the same, if not better, user experience as they have with their physical desktops. For a storage system, this means performance must remain consistent, even during boot storms, virus scans and updates. If virtual desktops are hosted on the same storage system as other applications, resource contention must not affect user experience. The effects of latency spikes that occur, even in all-flash arrays, must be mitigated as well or they will impact the user experience.

- **Flexible Scalability**: Confidence that your storage system can scale to meet VDI demands is not only reassuring, but helps in planning. Being able to scale performance and capacity independently allows your storage system to grow in the dimension needed without incurring unnecessary costs. Furthermore, the ability to scale performance without swapping out controllers or needing to add flash makes scaling less cumbersome and less costly.

- **Prioritize Performance and Data Protection**: Having the ability to easily prioritize what desktops and applications are more important than others will allow the system to automatically allocate storage system resources to the desktops and applications that matter most to your business. This will ensure consistent performance to users who matter most and enable the storage system to support multiple, mixed application workloads to reduce overall storage costs and sprawl.

- **Validated With Your VDI Platform of Choice**: Having documentation that the storage solution is validated with your VDI platform of choice takes risks and unknowns out of the VDI deployment. This shows you what results you should expect.

Citrix VDI Capacity Program for Storage Partners

Citrix Ready launched the VDI Capacity Program with many existing storage partners. The goal is to address the storage needs of customers who already have implemented or are considering implementing Citrix XenDesktop. VDI presents multiple types of data — each with its own unique requirements — to the storage infrastructure tier. Storage in turn can cope with these requirements using various hardware- and software-based approaches, some of which can be combined into hybrid solutions. As the number of storage options for VDI has steadily increased over the last several years, confusion has arisen for some customers who are still unsure as to which approach is right for them.

To address this confusion, Citrix started this program — Citrix Ready VDI Capacity Program for Storage Partners Phase II — with storage partners representing several different VDI workloads with their storage solutions. To participate in the program, the partner was required to set up a test environment with the compute resources needed to simulate a 1,500, 3,000 or 5,000 user XenDesktop workload.

As opposed to a traditional “benchmark,” whereby different achievement scores are possible, this VDI Capacity program is a simulation of “a day in the life” of a XenDesktop site supporting a certain number of users. If a partner’s chosen storage solution can successfully support “a day’s” run to the defined user capacity while sustaining required performance metrics, the partner passes and the validation test is concluded.

**Test Methodology**

The focus of the VDI Capacity Program for Storage Partners is on provisioning the appropriate amount of storage performance and capacity with a cost-efficient design. If a partner passes, Citrix will describe the storage partner as verified for XenDesktop for the requisite number of users.

LoginVSI, a highly regarded and respected tool for standardized VDI performance and capacity testing, was used to generate VDI workloads and to measure performance. In this test, 1,500 desktops were created and launched; Pivot3 executed a knowledge worker workload program that simulates a typical workday. Pass/fail was determined by whether or not the storage system used could successfully handle the storage demands placed on it without reaching a latency limit called “VSImax.”

The Citrix test methodology entailed two test scenarios, both with a binary pass/fail designation:

- All 1,500 user virtual machines (Vms) must start simultaneously. Total time taken from start of boot until all Vms have registered with the broker must be noted (Test-1).
- A 1,500 user LoginVSI knowledge worker workload test must be run. VSImax should not be achieved (Test-2).
- Total IOPS, read IOPS and write IOPS must be monitored throughout and noted.
- The storage cost and infrastructure cost per user, yielding storage cost per desktop, must be noted.

The Pivot3 N5-500 Hybrid Flash Array used in this validation is part of the Pivot3 PCIe Flash Array product family and comes with 5.2 terabytes of PCIe flash and 64 terabytes raw disk capacity. The N5-500 is specified for 225,000 IOPS and 2.7 gigabytes/second throughput. The N5 array and server environment used in the test was configured as follows:

### VDI Hosts

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Quantity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server model</td>
<td>SuperMicro 2028GR-TRHT</td>
<td>15</td>
<td>15 servers</td>
</tr>
<tr>
<td>Processor(s)</td>
<td>Intel Xeon Processor E5-2650 v3 10-Cores (25M Cache, 2.3GHz)</td>
<td>2</td>
<td>2 processors per server (20 cores)</td>
</tr>
<tr>
<td>Memory</td>
<td>Samsung 32GB DDR4-2133 CL15 ECC Registered</td>
<td>8</td>
<td>256 GB per server</td>
</tr>
<tr>
<td>Server Disk(s)</td>
<td>SanDisk X300 SSD 128GB, RNL, 7MM 2.5&quot;, 4x4D 64GbM (bootdisk)</td>
<td>2</td>
<td>2 disks per server</td>
</tr>
<tr>
<td>Server model</td>
<td>Onboard Dual 10GB Base-T</td>
<td>1</td>
<td>1 adapter per server</td>
</tr>
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</table>

### VM Launcher Host

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Quantity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server model</td>
<td>SuperMicro SYS-8026B-6RF</td>
<td>1</td>
<td>1 server</td>
</tr>
<tr>
<td>Processor(s)</td>
<td>Intel® Xeon® Processor E5-4620 (16M Cache, 2.20 GHz)</td>
<td>4</td>
<td>4 processors per server (32 cores)</td>
</tr>
<tr>
<td>Memory</td>
<td>16GB RDIMM DDR3 Memory</td>
<td>32</td>
<td>512 GB RAM per server</td>
</tr>
<tr>
<td>Server Disk(s)</td>
<td>Intel® SSD 320 Series (80GB, 2.5in SATA 3Gb/s, 25nm, MLC) (bootdisk)</td>
<td>2</td>
<td>160 GB per server</td>
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<tr>
<td>Network Adapter</td>
<td>AOC-STGN-I2S Dual 10GB Addon Card</td>
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<td>1 adapter per server</td>
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</table>
### Infrastructure Host

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Quantity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server model</td>
<td>1U Supermicro SYS-1028R-WC1R</td>
<td>1</td>
<td>1 server</td>
</tr>
<tr>
<td>Processor(s)</td>
<td>Intel Xeon E5-2640 v3 2.60 GHz (8-Cores)</td>
<td>2</td>
<td>2 processors per server (16 cores)</td>
</tr>
<tr>
<td>Memory</td>
<td>144GiB</td>
<td>1</td>
<td>144 GB RAM per server</td>
</tr>
<tr>
<td>Server Disk(s)</td>
<td>Samsung Solid-State Drive 128 GB (bootdisk)</td>
<td>2</td>
<td>256 GB per server</td>
</tr>
<tr>
<td>Network Adapter</td>
<td>Onboard 10GB Base-T + I350T2BLK</td>
<td>1</td>
<td>1 adapter per server</td>
</tr>
<tr>
<td>Network Adapter</td>
<td>SanDisk Fusion ioMemory 1.6TB</td>
<td>1</td>
<td>1.6 TB per server</td>
</tr>
</tbody>
</table>

### Overview of Pivot3

Pivot3 delivers smarter infrastructure solutions. Hyperconverged Infrastructure (HCI) and Flash Storage Arrays that maximize resource utilization, deliver high availability and performance, and lets you prioritize what matters most. Pivot3’s innovations — including scalar erasure coding, distributed scale-out hyperconvergence, and multi-tier flash arrays leveraging PCIe flash and storage Quality of Service (QoS) — help IT organizations address their most pressing challenges. Pivot3 has more than 2,000 customers in 53 countries and has successfully deployed more than 16,000 mission- and business-critical infrastructures in multiple industries such as financial services, healthcare, government, transportation, education, video surveillance, gaming, entertainment and retail.

### Pivot3 Unique Offerings

Pivot3 N5 PCIe Flash Arrays offer both productivity-boosting performance and simplified management for production workloads. Pivot3 N5 arrays come in all-flash and hybrid models and deliver the predictable application performance end users require, along with industry-leading flash utilization. This test was done with a hybrid model. With the vSTAC SLX solution, Pivot3 flash arrays can also be combined under a common management interface with Pivot3 hyperconverged appliances to provide the simplicity and economics of hyperconverged with the predictable performance of flash storage and Dynamic QoS.

Pivot3 N5 Hybrid Flash Arrays provide the performance, simplified management and consolidation that XenDesktop deployments require, making it an excellent component of a XenDesktop VDI solution. Advantages and benefits for VDI include:

- **Flash-First Hybrid Architecture:** VDI workloads can be write-heavy. Most hybrid arrays use flash for read cache, but write requests are serviced by disk (disk-first hybrids). Pivot3 utilizes a flash-first data path, where every write request is serviced by PCIe flash, resulting in faster response times for desktop users.
Predictable Performance: Pivot3’s hybrid model allows you to provision and manage flash performance and data protection with Quality of Service (QoS). Pivot3 QoS is a policy-based management mechanism that lets you prioritize workloads by business importance. The performance policy specifies target IOPS and throughput as well as highest latency allowed. Data protection policies specify snapshot, replication and retention. Everything within the N5 array is automatically managed to ensure the performance policies that users set are achieved. For example, you may have different classes of VDI users. The most important users can be assigned the lowest possible response time/latency. If a less critical application spikes at a given moment, assigned users get the highest performance available.
• **More Performance, Less Waste:** Pivot3 N5 arrays were architected to maximize both performance and capacity at a reasonable cost. Flash is integrated into the CPU bus via PCIe; it runs at microsecond speeds with no need to traverse a RAID controller like other hybrids. Pivot3 PCIe flash consumes zero drive bays. No capacity is sacrificed for performance.

• **Grow on Your Terms:** Pivot3 N5 arrays allow you to scale performance online by adding PCIe flash into the system, doubling system performance without consuming drive bays. If capacity is required, up to three disk shelves can be added to every Pivot3 array.

• **More Consolidation, Less Footprint:** Storage arrays are often a dedicated resource for VDI workloads to prevent resource contention with other applications. With flash-first performance and QoS policies, Pivot3 N5 arrays allow you to confidently support multiple applications while isolating VDI workloads from other applications. This eliminates contention while reducing storage sprawl and administration and maintenance costs.

• **Validated by Citrix XenDesktop:** Pivot3 N5 arrays have been validated with Citrix XenDesktop. Customer case studies of Pivot3 N5 arrays deployed to support VDI are also available. Additionally, Pivot3 has an easy-to-use and powerful user interface that simplifies administration of the VDI storage environment. Advanced monitoring and reporting tools such as the main dashboard provide a simple and intuitive view into the state of the appliance resources.

**Overview of Test Results and Data**

In order to support the Citrix capacity requirements and the LoginVSI IOPS knowledge worker workload, Pivot3 provisioned 10 thin LUNs with an effective capacity of 6.4 terabytes per LUN. The 64 terabytes thick capacity requirement was based on Citrix VDI environment requirements (see appendix for details).

QoS policies were assigned to each volume independently and define both IOPS and throughput performance minimums along with not-to-exceed latency targets for each application. All LUNs were assigned a Mission Critical Pivot3 QoS policy:

- 100,000 IOPS target
- 750 megabytes/second target
- 5 milliseconds not-to-exceed latency target

Both of the tests passed with the results being well within the Citrix VDI Capacity Program output parameters. For Test-1 the time taken between the first brokered VM and last brokered VM was 24 minutes total or 63 desktops per minute. Test-2 also received a pass designation, with an average user response time of 0.689 milliseconds. The VSImax of 1,689 milliseconds was not reached.

VSImax overview and total IOPS generated during the test run are shown below:
Based on the 1,500 user XenDesktop VDI Capacity Phase II requirements, the Pivot3 N5-500 Hybrid Flash Array showed:

- Optimal support for 1,500+ virtual machines. That number can be even higher depending on VDI desktop profiles and performance policy settings.
- End user cost per desktop based on typical N5-500 pricing and Citrix VDI Capacity Program Phase II test requirements:
  - $60/desktop storage cost
  - $80/desktop server and network infrastructure cost

### Pivot3 PCIe Flash Array Lineup

#### ALL-FLASH ARRAYS

<table>
<thead>
<tr>
<th>N5-1500</th>
<th>N5-6000</th>
</tr>
</thead>
<tbody>
<tr>
<td>450,000 IOPS*</td>
<td>60 GB/s*</td>
</tr>
<tr>
<td>RAM</td>
<td>96 GB</td>
</tr>
<tr>
<td>PCIe Flash</td>
<td>2.6 TB</td>
</tr>
<tr>
<td>SSD Capacity</td>
<td>15 TB (60 TB Max)</td>
</tr>
<tr>
<td>Network Interfaces</td>
<td>Data: (8) 1/10GbE SFP+ or (8) 1/10GbE RJ45, iSCSI</td>
</tr>
</tbody>
</table>

#### HYBRID ARRAYS

<table>
<thead>
<tr>
<th>N5-200</th>
<th>N5-300</th>
<th>N5-500</th>
<th>N5-1000</th>
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</thead>
<tbody>
<tr>
<td>150,000 IOPS*</td>
<td>200,000 IOPS*</td>
<td>225,000 IOPS*</td>
<td>250,000 IOPS*</td>
</tr>
<tr>
<td>2.0 GB/s*</td>
<td>2.4 GB/s*</td>
<td>2.7 GB/s*</td>
<td>3.0 GB/s*</td>
</tr>
<tr>
<td>RAM</td>
<td>96 GB</td>
<td>192 GB</td>
<td></td>
</tr>
<tr>
<td>PCIe Flash</td>
<td>2.6 TB (7.2 TB Max)</td>
<td>5.2 TB (10.4 TB Max)</td>
<td>10.4 TB (15.6 TB Max)</td>
</tr>
<tr>
<td>HDD Capacity</td>
<td>32 TB (128 TB Max)</td>
<td>64 TB (448 TB Max)</td>
<td>64 TB (448 TB Max) / 128 TB (512 TB Max)</td>
</tr>
<tr>
<td>Network Interfaces</td>
<td>Data: (4) 1/10GbE SFP+ or (4) 1/10GbE RJ45, iSCSI</td>
<td>Management: (4) 1GbE RJ45, http, https</td>
<td></td>
</tr>
</tbody>
</table>
Test Results Prove an Ideal Combination

Citrix XenDesktop delivers full Windows VDI capabilities in addition to virtual apps, meeting the demands of any use case. XenDesktop enables users to access their apps, desktops and data without the limitations of a traditional solution. On the unified FlexCast Management Architecture (FMA) platform, XenDesktop is the only solution that is FIPS-compliant and Common Criteria-certified to meet the highest security standards of regulated industries.

End users will enjoy the simple virtual desktop interface, while IT will appreciate the superior performance of HDX technology, even when deployed over challenging, high-latency networks.

In this white paper, we validated a Pivot3 Hybrid Flash Array, which passed the 1,500 user Citrix VDI Capacity Program Phase II test requirements. This shows Pivot3 PCIe Flash Arrays are an effective storage solution for XenDesktop deployments. As a Citrix Ready storage partner, Pivot3 achieved “1,500 user verified” certification status as a result of passing this rigorous Citrix testing methodology. Furthermore, the testing demonstrated that the Pivot3 PCIe Flash Hybrid Storage array has significant headroom beyond the 1,500-user VDI load, allowing for additional VDI and mixed workloads.

It should be noted, however, that Login VSI only tests a small subset of the factors that are key to a successful VDI deployment. Two primary influential factors are user experience and administrative/management complexity. Any VDI solution that improves user experience while reducing operational overhead will result in a superior deployment and will bolster enhanced user and administrator acceptance. A byproduct of the Citrix VDI Capacity Program benchmark test was a clear demonstration that Pivot3 PCIe can simplify management requirements and deliver an unparalleled user experience.

As demonstrated with Login VSI test results, Pivot3 PCIe Flash Storage exceeds the benchmark set for the Citrix VDI Capacity Program. The test also confirmed that PCIe provides extremely high performance and capacity savings when deployed with XenDesktop VMs.
Appendix

Storage:

• Write Cache Files:
  – 6 GB Write cache file per user
  – 1,500 * 6 = 9TB of required space
  – 3 TB added to LUN for overhead
  – 12TB Total

• User Data:
  – 30 GB allowed for each user
  – 1,500 * 30 = 44 TB of required space
  – 8 TB added for overhead
  – 52TB Total

• Total Storage Capacity Required:
  – 12 TB for write cache + 52 TB for user data = 64 TB required

Network Configuration:

• Two networks will be created:
  – Network 1 – PXE boot of VMs, 10 GB and Production network for connection between clients (LoginVSI launchers) and XD VMs,
  – Network 2 - Connection to vendor storage using iSCSI, 10 GB

Software:

• Microsoft:
  – Windows OS 8.1 64 bit – Standard Edition
  – Windows OS Server 2012 STD R2
  – Microsoft Office 2013

• Citrix:
  – Provisioning Services 7.6 (Write cache on device HD)
  – XenDesktop 7.6

• LoginVSI:
  – LoginVSI target Setup for VDAs (Make sure PDF Reader, Flash Player, Java are selected)
  – LoginVSI Dataserver Setup (pre-requisite - LoginVSI File share)
About Citrix Ready

Citrix Ready identifies recommended solutions that are trusted to enhance the Citrix Delivery Center infrastructure. All products featured in Citrix Ready have completed verification testing, thereby providing confidence in joint solution compatibility. Leveraging its industry-leading alliances and partner ecosystem, Citrix Ready showcases select trusted solutions designed to meet a variety of business needs. Through the online catalog and Citrix Ready branding program, you can easily find and build a trusted infrastructure. Citrix Ready not only demonstrates current mutual product compatibility, but through continued industry relationships also ensures future interoperability. Learn more at citrixready.citrix.com.

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About Pivot3

Pivot3 is the world’s leading provider of dynamic hyperconverged solutions. Pivot3’s patented solutions dramatically improve data center simplicity and economics by increasing scale-out performance, driving down complexity and cost, saving an extraordinary amount of disk and physical space, and ensuring fault tolerance. With Pivot3’s unique Quality of Service capabilities, customers are able to prioritize data and application performance based on business value. Today, Pivot3 has more than 2,000 customers around the world deploying more than 16,000 hyperconverged infrastructure and flash storage arrays in multiple industries such as financial services, healthcare, government, transportation, video surveillance, entertainment, education, gaming and retail. The company has won numerous awards and was most recently featured by CRN in their Top 50 Virtualization list. Join us on LinkedIn, follow us on Facebook or Twitter (@Pivot3Inc) or visit us at http://pivot3.com.