Fusion ioControl Hybrid Storage with XenDesktop
Executive Summary

Fusion-io teamed with Citrix to validate a VDI solution that emulates a day in the life of a 750 user Citrix deployment. The combination of Citrix XenDesktop using the FlexCast approach along with ioControl Hybrid Storage, 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

Virtualizing and centralizing computer desktops enables end-user computing environments consisting of various endpoint devices such as desktops, laptops, tablets, and cell phones to be controlled and managed from a central point. This allows IT to deliver a more secure, cost-effective, manageable, flexible and mature end-user computing model. Decoupling applications, data and the operating system from the endpoint and by moving these components into the datacenter, results in a more streamlined and secure way to manage users while providing agile, on-demand desktop services.

Storage has proven to be critical to both the operational and financial success of virtual desktop infrastructures (VDI). The challenge is to provide a computing and storage environment that delivers a high-quality, predictable, and productive user experience yet do it cost-effectively. Storage considerations that must be acknowledged prior to selecting storage for VDI are:

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

2. **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 storm, virus scans, and other updates. If virtual desktops are hosted on the same storage system as other applications, resource contention must not affect user experience.

3. **Cost**: Flash storage can solve the performance requirements of VDI, but cost can put the project out of reach. Hybrid flash arrays can be an affordable alternative. Many hybrids promise high capacity and performance, but sacrifice capacity for performance by consuming HDD trays with SSDs. A better solution would provide both guaranteed performance and maximum capacity.

4. **Flexible Scalability**: Confidence that your storage system can scale to meet VDI demands is reassuring. Being able to scale performance and capacity independently allows your storage system to grow in the dimension needed without having to incur unnecessary costs. Furthermore, the ability to scale performance without swapping out controllers or needing to add flash as capacity makes scaling less cumbersome and less costly.
5. **Storage Sprawl**: While not an obvious consideration, the ability to run VDI alongside other applications would be a desirable capability for most companies, especially mid-sized or small-to medium enterprises, since it reduces the costs and management complexity associated with storage sprawl across the organization.

6. **Validated with Your VDI platform of choice**: Having documentation that the storage is validated with your VDI platform of choice and what results should be expected take risks and unknowns out of the VDI deployment.

**Overview: Citrix VDI Capacity Program for Storage Partners**

In Q1 2014, Citrix launched a new program designed specifically to address the storage needs of customers who are implementing XenDesktop using the VDI FlexCast approach. VDI presents multiple types of data, each with its own unique requirements, to the storage infrastructure tier. Storage in turn responds to these requirements using a variety of HW and SW based approaches, some of which can by combined in hybrid solutions. The variety of choices, and the differences between them, has led to some confusion for customers and partners. To resolve this, Citrix constructed a turnkey “VDI Capacity” test rig in their Santa Clara Solutions Lab. This rig contained the necessary server capacity to generate 750 users of a reference XenDesktop workload. The VDI farm was complete and fully operational with the exception of storage. Citrix storage partners were invited to connect their storage to the VDI farm and participate in a “VDI Capacity” test that simulated of “a day in the life” of a 750 user Citrix farm.

**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. Using a simple, binary pass/fail methodology, if a partner’s provided storage solution can successfully support “a day’s” run to the defined user capacity, while sustaining required performance metrics, the partner passes and the test ends. Once passed, Citrix will describe the storage partner as “750 User Verified” for XenDesktop. Login VSI, a highly regarded and respected tool for standardized VDI performance and capacity testing, was used to generate VDI workloads and to measure performance. 750 desktops were created, launched, and executed a 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 “VSI Max”. More about Login VSI can be found here.

**Partner Overview**

Fusion-io delivers the world’s data faster. The Fusion ioMemory platform accelerates databases, virtualization, cloud computing, big data, and the applications that drive our economy and our daily lives. The Fusion ioControl Hybrid Storage Appliance makes performance affordable. By combining Fusion ioMemory-attached flash and disk, ioControl unlocks the performance potential of flash while maximizing economical storage capacity. As the key to a successful hybrid deployment is the ability to control what application data leverages the flash tier for acceleration, the Fusion ioControl QoS software uniquely allows customers to provision, prioritize, and control application performance based on their business objectives. The result is the perfect balance of leading performance and capacity that delivers 5x lower $/GB than disk drives and 10x lower $/IOPS than SSD-based storage arrays.
Partner Solution

Fusion-io has multiple flash solutions to power Citrix XenDesktop deployments depending on customers’ needs and situations. All Fusion-io solutions are based on Fusion ioMemory PCIe-based flash memory technology and software.

<table>
<thead>
<tr>
<th>VDI Requirement</th>
<th>Storage Requirement</th>
<th>Fusion-io Storage Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent Desktops:</td>
<td>New storage infrastructure required for VDI</td>
<td>ioControl Hybrid Storage</td>
</tr>
<tr>
<td>from 300 to 2000+</td>
<td>Share storage with other applications</td>
<td></td>
</tr>
<tr>
<td>Stateless Desktops</td>
<td>Host-based</td>
<td>ioDrive(s) + OEM Server</td>
</tr>
</tbody>
</table>

Table 1: Fusion-io VDI solution options

Based on the Citrix design requirements, our solution utilized an ioControl n5-100 Hybrid Storage Appliance connected into the Citrix infrastructure as shown in Figure 1:

Figure 1: n5-100 array connected into the Citrix infrastructure
The Citrix testing methodology entailed two distinct test scenarios, with the results being a pass/fail designation:

- **Test 1:** All 750 user VMs will be started simultaneously, total time from start of boot until all VMs have registered with the broker must be less than 10 minutes. This allows for 75 VMs per minute.
- **Test 2:** A 750-user LoginVSI test will be run. VSImax SHOULD NOT be achieved and average users responses time should be less than 4 seconds.

In order to support the Citrix capacity requirements and the LoginVSI IOPS medium workload, Fusion-io provisioned eleven thin LUNs (one per BL460c G7 server) with an effective capacity of 2.3TB per LUN plus a thin write cache LUN with an effective capacity of 7TB. The 32TB thick capacity requirement was based on Citrix VDI environment requirements (see addendum for details). All LUNs were assigned a Mission Critical ioControl QoS policy (75,000 IOPS floor, 750MB/sec floor and 10ms not-to-exceed latency per LUN). Fusion ioControl provides the ability to provision and prioritize storage resources with performance Quality of Service (QoS) policies. QoS policies are assigned to each volume independently, and define IOPS, throughput performance minimums and not-to-exceed latency targets for each application.

Both of the tests passed with the results being well within the pre-defined test result output parameters; “Test 1” received a Pass designation, “Test 2” also received a Pass designation along with additional response time details which were provided as well. In Figure 2, we see that the ioControl overall average response time was sub 1.5 seconds (well below the 4 second cut-off), VSImax Baseline was calculated as 1198 and VSImax was not reached. Figures 3 and 4 provide even more discrete data around overall and application specific response times, with ioControl being well below response time cut-off values. All of these ioControl performance metrics translate to a high quality, predictable user experience.

![Figure 2: VSImax](citrix.com/ready)
Solution Components / Architecture Design

Fusion-io has a full series of hybrid storage appliances, which can optimally support from 300 to 2000+ virtual desktops per appliance. Based on the Citrix XenDesktop capacity design requirements, Fusion-io provided an n5-100 Hybrid Storage Appliance, the specifics of which are:

- ioControl model n5-100 with 1.57TB ioMemory flash capacity and 32TB raw disk capacity
- All-inclusive software including Performance QoS, Dynamic Data Placement, Phased Data Reduction, Snapshot, and Replication
- Can optimally support 750+ virtual machines, with that number being even higher depending on VDI desktop profiles and performance policy settings
- Example end-user cost per desktop based on ioControl n5-100 standard system and Citrix test requirements = $105/desktop
### ioControl n5 Series

<table>
<thead>
<tr>
<th>Model</th>
<th>n5-50</th>
<th>n5-100</th>
<th>n5-150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Capacity</td>
<td>730 GB to 1,460 GB</td>
<td>1,570 GB to 3,140 GB</td>
<td>2,400 GB to 4,800 GB</td>
</tr>
<tr>
<td>Disk Capacity (RAID 6)</td>
<td>16 TB to 160 TB</td>
<td>32 TB to 176 TB</td>
<td>48 TB to 192 TB</td>
</tr>
<tr>
<td>Performance Rating (IOPS)</td>
<td>50,000 to 100,000</td>
<td>100,000 to 200,000</td>
<td>150,000 to 300,000</td>
</tr>
<tr>
<td>RAM</td>
<td>48 GB</td>
<td>96 GB</td>
<td></td>
</tr>
<tr>
<td>Storage Processors</td>
<td>Dual Active - Active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network Interfaces</td>
<td>Data: (4) 10GbE iSCSI + (8) 1 GbE iSCSI</td>
<td>Management: (4) 1 GbE HTTP</td>
<td></td>
</tr>
<tr>
<td>Hardware Availability</td>
<td>Redundant Storage Processors</td>
<td>Redundant Network Connections</td>
<td>Redundant Fans</td>
</tr>
</tbody>
</table>

**Table 2: ioControl n5 Series configuration options**

**Figure 5: ioControl n5 Series front view**

**Figure 6: ioControl n5 Series rear view**
Fusion ioControl Hybrid Storage provides the performance, control and consolidation that XenDesktop deployments require, making it an excellent component of a XenDesktop VDI solution. Fusion ioControl advantages and benefits for VDI include:

1. **Flash-first Hybrid Architecture**: VDI workloads can be very write-heavy. Most hybrid arrays use flash for read cache, but write requests are serviced by disk (disk-first hybrids). ioControl utilizes a flash-first data path, where every write request is serviced by flash resulting in faster response times for desktop users.

2. **Predictable Performance with QoS**: Unlike other hybrids, ioControl allows you to provision and manage flash performance with Quality of Service (QoS). ioControl QoS is a policy based management mechanism that allows you to prioritize workloads by business importance.

3. **More Performance, Less Waste**: ioControl Hybrid Storage was 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. Fusion ioMemory flash consumes zero drive bays; no capacity is sacrificed for performance.

4. **Grow On Your Terms**: ioControl allows you to scale performance online by adding Fusion ioMemory 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 ioControl hybrid. Additionally, ioControl allows you to scale performance to the host, via Fusion-io server-side read cache, to address ultra-low latency requirements.

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### Additional solution Information

Fusion ioControl Hybrid Storage provides the performance, control and consolidation that XenDesktop deployments require, making it an excellent component of a XenDesktop VDI solution. Fusion ioControl advantages and benefits for VDI include:

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5. **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, ioControl allows 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.

6. **Validated with Citrix XenDesktop**: ioControl has been validated with Citrix XenDesktop in the Citrix Lab and is validated with VMware Horizon View and part of the VMware Horizon View Fast Track Program. Customer case studies of ioControl deployed to support VDI are also available.

Additionally, ioControl has an easy to use, yet powerful, user interface that simplifies administration of the VDI storage environment. Advanced monitoring and reporting tools such as the main dashboard which provides a simple and intuitive view into the state of the appliance resources is shown in Figure 7, and an advanced monitoring and reporting interface providing the administrator insight into performance metrics at all levels as shown in Figure 8.
Conclusion and Additional Resources

i. In this whitepaper, we validated that Fusion ioControl Hybrid Storage passed the 750 user Citrix VDI Capacity Program test requirements, validating ioControl as an effective storage solution for XenDesktop deployments. As a Citrix Ready storage partner, Fusion-io achieved a “750 user verified” certification status as a result of passing the rigorous Citrix testing methodology. Furthermore, the testing demonstrated that the ioControl Hybrid Storage Appliance has significant headroom beyond the 750-user VDI load, allowing for even additional VDI and mixed workloads.

ii. Quick links/reference guides

Addendum

Minimum storage requirements as determined by Citrix for 750 concurrent VDI desktop users:

- **Write Cache Files:**
  - 6 GB Write cache file per user
  - 4.5 TB minimum required
  - Additional 2.5 TB added to LUN for overhead
- **User Data:**
  - 30 GB allowed for each user
  - 750 * 30 = 22 TB of required space
  - 3 TB added for overhead
- **Total storage capacity required:**
  - 7 TB for write cache + 25 TB for user data = 32 TB required
Citrix Provided Server Configuration

- A single HP C7000 enclosure is used hold the servers
- The enclosure is in a separate isolated environment
- Servers are BL460c G7 with 2 Procs and 192 GB of memory
  - 1 server contains the necessary infrastructure VMs
  - 4 servers contain client VMs necessary to drive work load
- A separate Login VSI 3.74.0 license was obtained to further provide isolation
- VM Configuration - 32-bit Win7 1.5GB memory, 1 vCPU
  - 11 servers contain XD7 desktops
- VM Configuration – 64-bit Win7 1.5 GB memory, 1 vCPU
  - Servers are Windows 2012 Hyper-V

Figure 9: Server Layout
Citrix Provided Configuration

Network Configuration

- FlexFabric configured to allow for either Ethernet or Fibre connectivity from the blades. These are connected to a 4gb Brocade switch
- Four networks were created:
  - Network 1 – internal to HP Virtual Connect for PXE boot of VMs, 5 gb
  - Network 2 – Connection to lab storage and management, 1gb
  - Network 3 – Production network for connection between clients and XD VMs, 5 gb
  - Network 4 will be either:
    - Connection to vendor storage for using iSCSI, 9 gb OR
    - Fibre connection to SAN for vendor storage
- There was no HA or redundancy across the NICs

XenDesktop Configuration

- XenDesktop 7 used
- Provisioning was done with PVS version 7.0.0.46. Due to MCS working best with file based storage and not all vendors supporting file based storage (NFS), PVS will be used to provision the desktop VMs. This will create a write-intensive environment.
- One each broker (DDC) and PVS VM was created to support the Infrastructure
Storage Configuration

- Fusion ioControl model n5-100 with 1.57TB ioMemory flash capacity and 32TB raw disk capacity, dual active processors, four 10GbE iSCSI data connections and four 1GbE management connections
- Storage presented: eleven thin provisioned LUN's (one per BL460c G7 server) with an effective capacity of 2.3TB each plus a thin provisioned write cache LUN with an effective capacity of 7TB.
- All LUNs were assigned a Mission Critical policy: 75,000 IOPS floor, 750MB/sec floor & 10ms not-to-exceed latency per LUN.

Definitions

VM definitions
- Infrastructure VMs:
  - All will be 64-Bit Windows 2012
  - AD VM – 4GB memory, 1 vCPU
  - DDC VM – 8 GB memory, 2 vCPU – locally configured SQL
  - PVS VM – 4 GB memory, 2 vCPU – locally configured SQL
- Client VMs
  - 32-bit Win7, 1.5 GB memory, 1 vCPU
- XD VMs
  - 64-bit Win8, 1.5 GB memory, 1 vCPU

LoginVSI
- LoginVSI 3.7 will be used
  - VSIShare will be inside the chassis
  - IOPs medium work load will be used

About Citrix Ready

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