ESG Lab Validation

FlexPod Datacenter with NetApp All-Flash FAS

Converged Infrastructure for High-performance Latency-sensitive Databases and Virtual Desktop Solutions

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Contents

ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about data center technology products for companies of all types and sizes. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments.

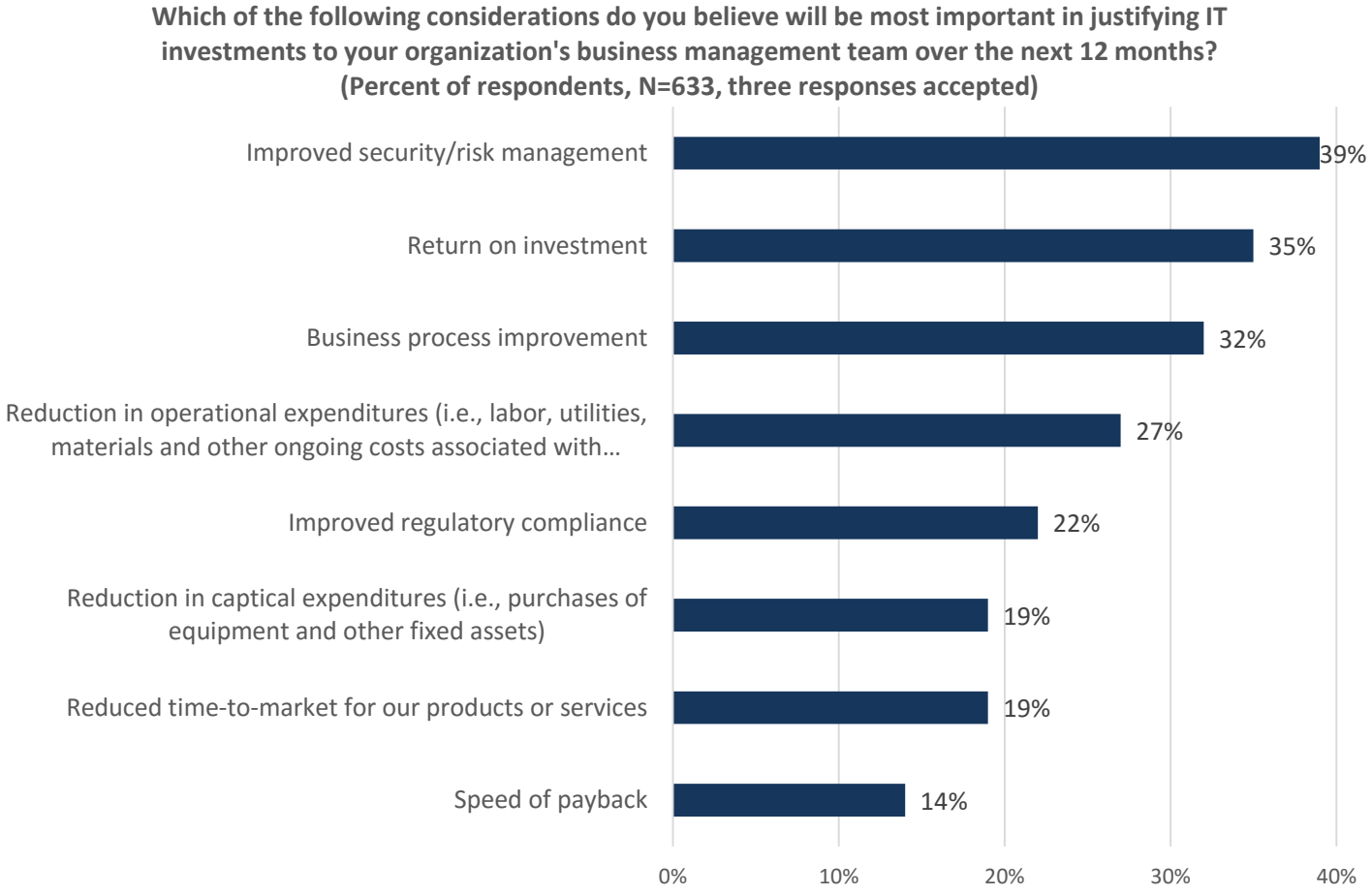
Introduction

This ESG Lab Report documents validation of the real world performance, ease of management, and agility of the FlexPod Datacenter with All Flash FAS in high-performance Oracle RAC and virtual desktop environments. A combination of hands on testing by ESG Lab and audited in-house performance testing executed by NetApp was used to create this report.

Background

As the number of internal and external applications grows, requiring investments in supporting infrastructure, IT is still hearing the mantra "do more with less." ESG's 2016 IT Spending Intentions Survey reveals that TCO considerations are among the most important investment criteria—return on investment (35%), business process improvement (32%), reduction in operating expenses (27%), and reduction in capital expenses (19%) make up four of the eight most important criteria for justifying IT investments to organizations' business management teams.[1]

Figure 1. Most Important Justifications for IT Investments



Source: Enterprise Strategy Group, 2016

Converged infrastructure (CI) platforms combine servers, storage, network connectivity, and (in some cases) software into a single solution. Thanks to the elimination of the system integration effort—countless hours of designing, configuring, and testing servers, networks, and storage subsystems—CIs provide guaranteed interoperability and functionality, along with ease of deployment and management, performance, agility, resiliency, and simplicity.

1. Source: ESG Research Report, *2016 IT Spending Intentions Survey*, February 2016.

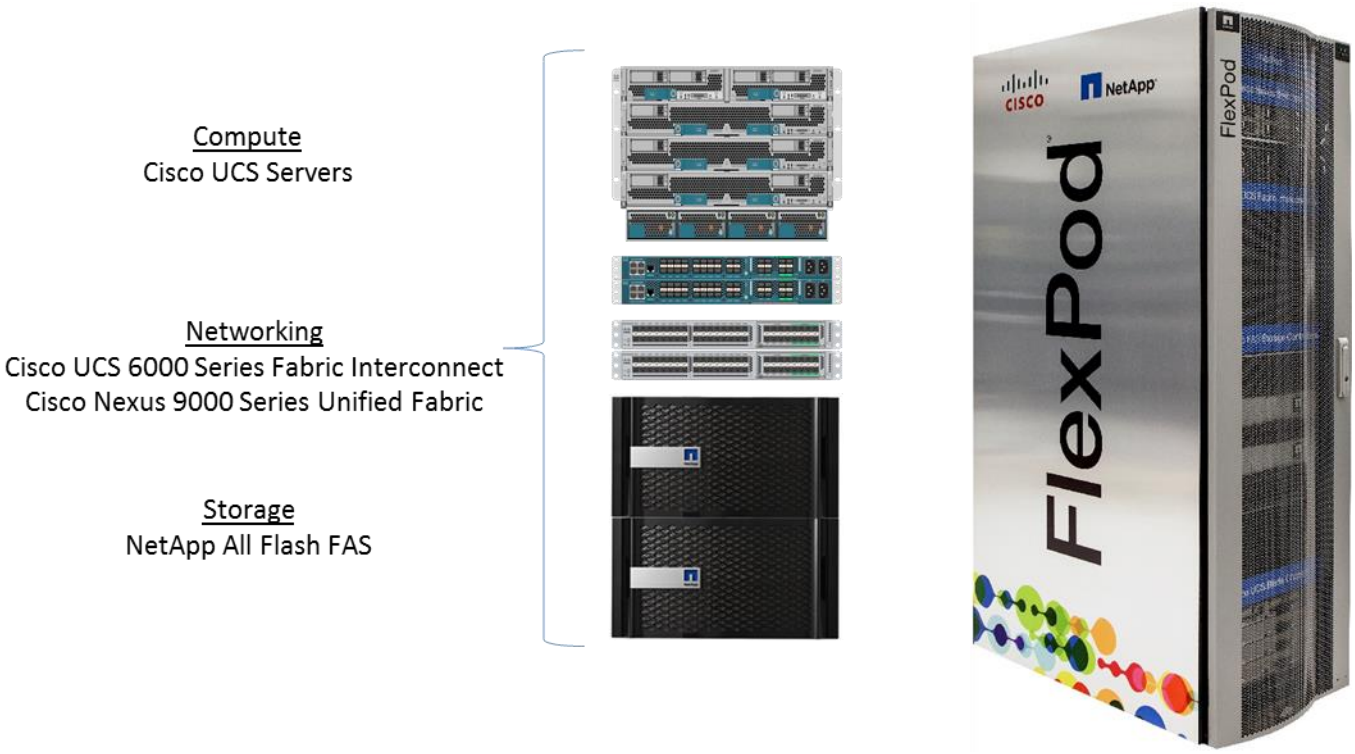
Converged infrastructures continue to gain mindshare and market traction, as they often have a more direct impact on TCO than the more traditional approach to infrastructure architecture. According to ESG research, 32% of surveyed organizations are currently using converged infrastructure technology, and an additional 56% are planning on using converged infrastructure in the future, which is an indicator that a majority of organizations believe that CIs can help to improve the TCO of their IT environments.[2]

FlexPod Datacenter

The FlexPod Datacenter with NetApp All Flash FAS system is a converged infrastructure platform that combines best-of-breed technologies from NetApp and Cisco into a powerful converged platform for enterprise applications. NetApp works closely with Oracle to support the most demanding transactional and response-time-sensitive databases required by today's businesses. Simultaneously, NetApp works with VMware to support the most demanding virtualization and desktop virtualization infrastructures.

Like all FlexPod Systems, the FlexPod Datacenter with NetApp All Flash FAS is comprised of compute (database, virtualization, application, and management servers from Cisco), network (three-layer network and SAN technologies from Cisco), and storage (NetApp All Flash FAS storage systems).

Figure 2. FlexPod Datacenter with All Flash FAS



Source: Enterprise Strategy Group, 2016

FlexPod Datacenter with NetApp All Flash FAS is designed to encompass all the benefits of FlexPod—including validated, preconfigured, pretested configurations; simplified management; high availability and resiliency; improved efficiency; and easy scaling—while providing the following business benefits for virtual desktop infrastructures and applications running on Oracle Database:

[2] Source: ESG Research Report: The Cloud Computing Spectrum, from Private to Hybrid, March 2016.

- Over 239,000 IOPS (for typical 75% read OLTP workloads)
- Consistent microsecond level response time
- The ability to scale the infrastructure granularly to fit any workload
- A balanced configuration across networking, servers, and storage
- Non-disruptive maintenance and upgrades: addition or replacement of Oracle RAC blades in minutes

Individually and in concert, the components of the FlexPod solution are designed to keep applications available. This converged infrastructure solution integrates high-availability and disaster recovery capabilities to enable customers to achieve "always on" performance with the agility to meet the rapidly changing demands of today's business environment.

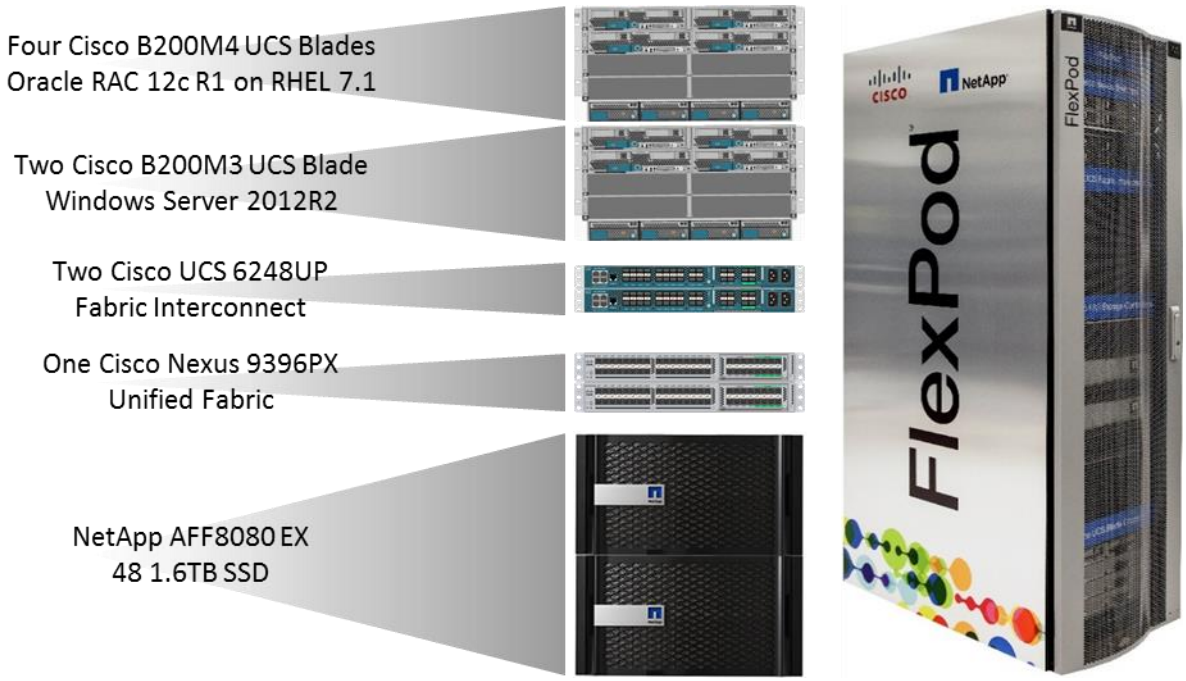
ESG Lab Validation

ESG Lab performed hands-on evaluation and testing of the FlexPod Datacenter with NetApp All Flash FAS at NetApp facilities in Sunnyvale, California and Research Triangle Park, North Carolina. Testing was designed to demonstrate the performance and low latency of the FlexPod Datacenter as infrastructure for Oracle databases and applications using industry-standard tools and methodologies. Additional testing was designed to demonstrate the performance and low latency of the FlexPod Datacenter as infrastructure for virtual desktop implementations. Also of interest were manageability, reliability, availability, and serviceability.

FlexPod Datacenter for Oracle Databases

ESG Lab validated the performance of the FlexPod Datacenter with All Flash FAS running a four-node Real Application Clusters (RAC) configuration of an Oracle Database 12c R1 running Red Hat Enterprise Linux 7.1 on Cisco UCS B200M4 compute blades. The FlexPod Datacenter was configured with a NetApp AFF8080 EX storage system containing 48 1.6TB SSDs. Connectivity was provided by Cisco UCS fabric interconnect switches and Cisco Nexus unified fabric switches.

Figure 3. The ESG Lab Test Bed for Oracle Databases



Source: Enterprise Strategy Group, 2016

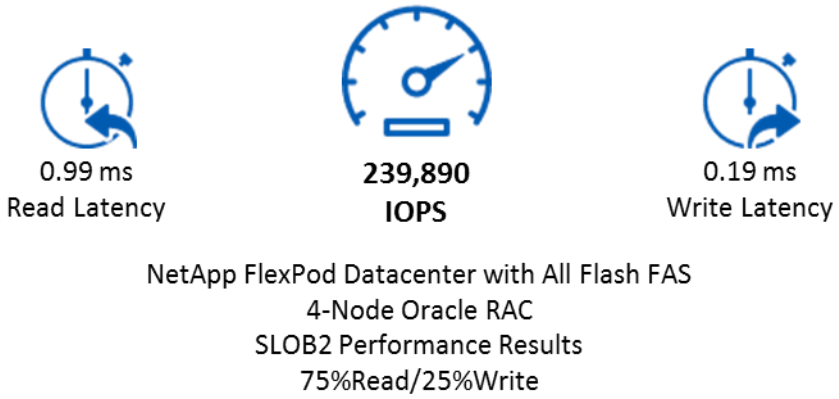
Oracle Performance

All performance testing was completed on a simulated real-world populated database. Testing focused on measuring the throughput and latency of Oracle SQL-driven random I/O. ESG Lab utilized the widely adopted and publicly available Silly Little Oracle Benchmark kit (SLOB2) version 2.3 to efficiently generate realistic system-wide, random, single block, application-independent SQL queries. The SLOB2 benchmark exercised all components of the FlexPod Datacenter by stressing the physical I/O layer of Oracle through SGA[3] buffered random I/O without being limited to a specific load-generating application.

[3] The system global area (SGA) is a group of shared memory structures that contain data and control information for one Oracle Database instance. The SGA is shared by all server and background processes.

ESG Lab evaluated the performance of the FlexPod Datacenter in a typical OLTP environment generating a 75% read/25% write mix of transactions. Figure 4 shows the results of testing. While delivering more than 239,000 IOPS, the application latency was measured at 0.99 milliseconds. This strongly suggests that the storage system is capable of delivering higher levels of IOPS than observed in these tests while still maintaining response times under the industry standard threshold of 1 millisecond.

Figure 4. Oracle SLOB2 Benchmark Results



Source: Enterprise Strategy Group, 2016

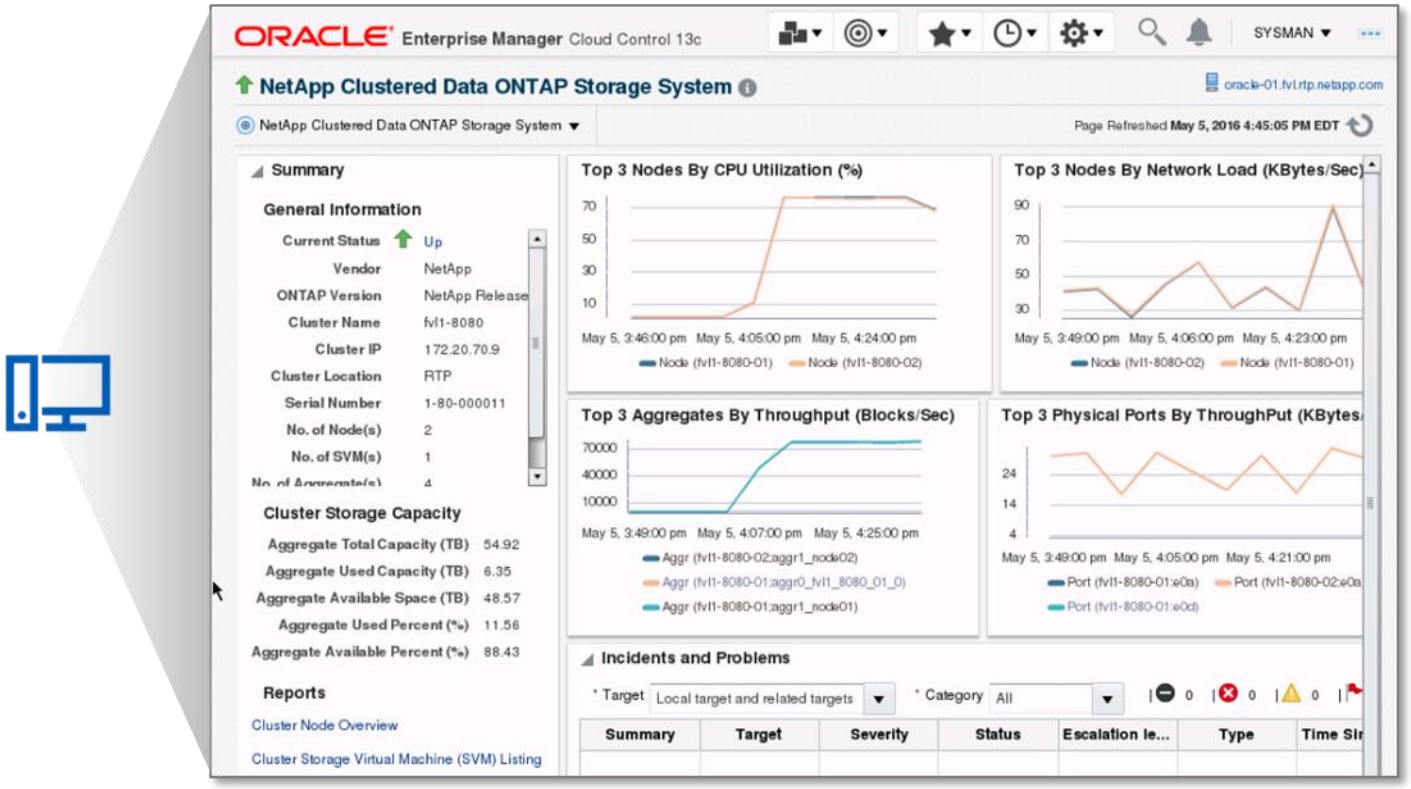
NetApp Storage System Plug-in for Oracle Enterprise Manager

To simplify management of FlexPod Datacenter with Oracle databases, NetApp has developed the NetApp Storage System Plug-in for Oracle Enterprise Manager. The plug-in integrates NetApp storage system monitoring into Oracle Enterprise Manager, providing a single interface for monitoring database and storage system, and includes a graphical representation of the database to storage topology. This helps administrators to understand the whole stack and to quickly identify and resolve issues.

The plug-in automates the process of collecting telemetry, enabling administrators to analyze current and historical availability, performance, and usage metrics. Built-in reports map database components like tablespaces and datafiles to storage components like aggregates and volumes. Additional reports enable administrators to consolidate database and storage performance data into a single view.

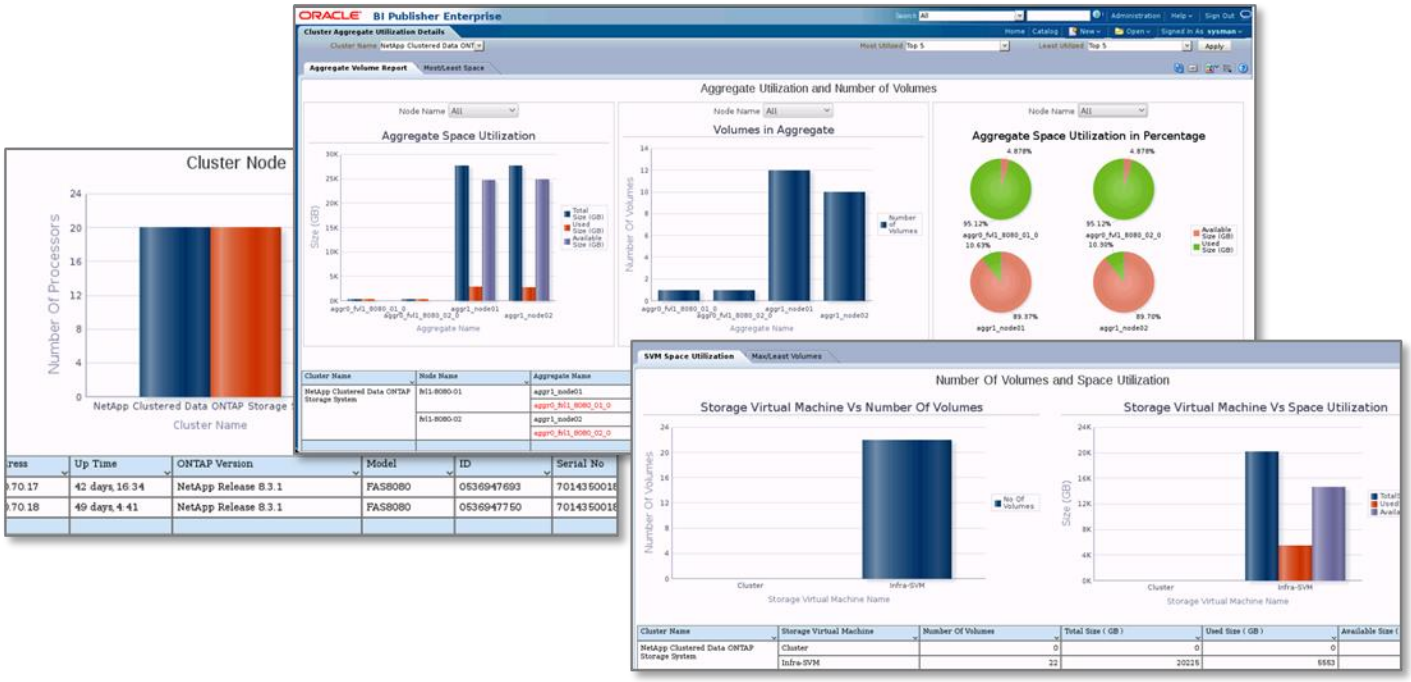
ESG Lab examined NetApp Storage System Plug-in for Oracle Enterprise Manager as a tool for consolidated management of the converged infrastructure when used with Oracle databases. The NetApp summary screen is shown in Figure 5. The left hand side of the screen contains current status and configuration information, including total, used, and available capacity. The main portion of the screen is devoted to four performance graphs, providing top-three resource consumers for CPU utilization, network throughput, storage aggregate throughput, and network port throughput. These at-a-glance graphs enable the administrator to quickly and easily determine if the FlexPod Datacenter is operating optimally. Below the graphs is a listing of all incidents and problems.

Figure 5. NetApp Storage System Plug-in for Oracle Enterprise Manager—Dashboard



Next, ESG Lab explored some of the many other screens providing additional details of the NetApp storage solution. As shown in Figure 6, the NetApp plug-in provides details of the storage aggregate space utilization and the number of volumes per aggregate. A second screen details the number of volumes per NetApp storage virtual machine (SVM), along with SVM space utilization. A third screen shows the status and details of the NetApp cluster nodes. Each of these screens enables administrators to monitor the NetApp storage system using Oracle Enterprise Manager, simplifying the work and engendering greater understanding of the current status, configuration, and performance of the FlexPod Datacenter.

Figure 6. NetApp Storage System Plug-in for Oracle Enterprise Manager—Details



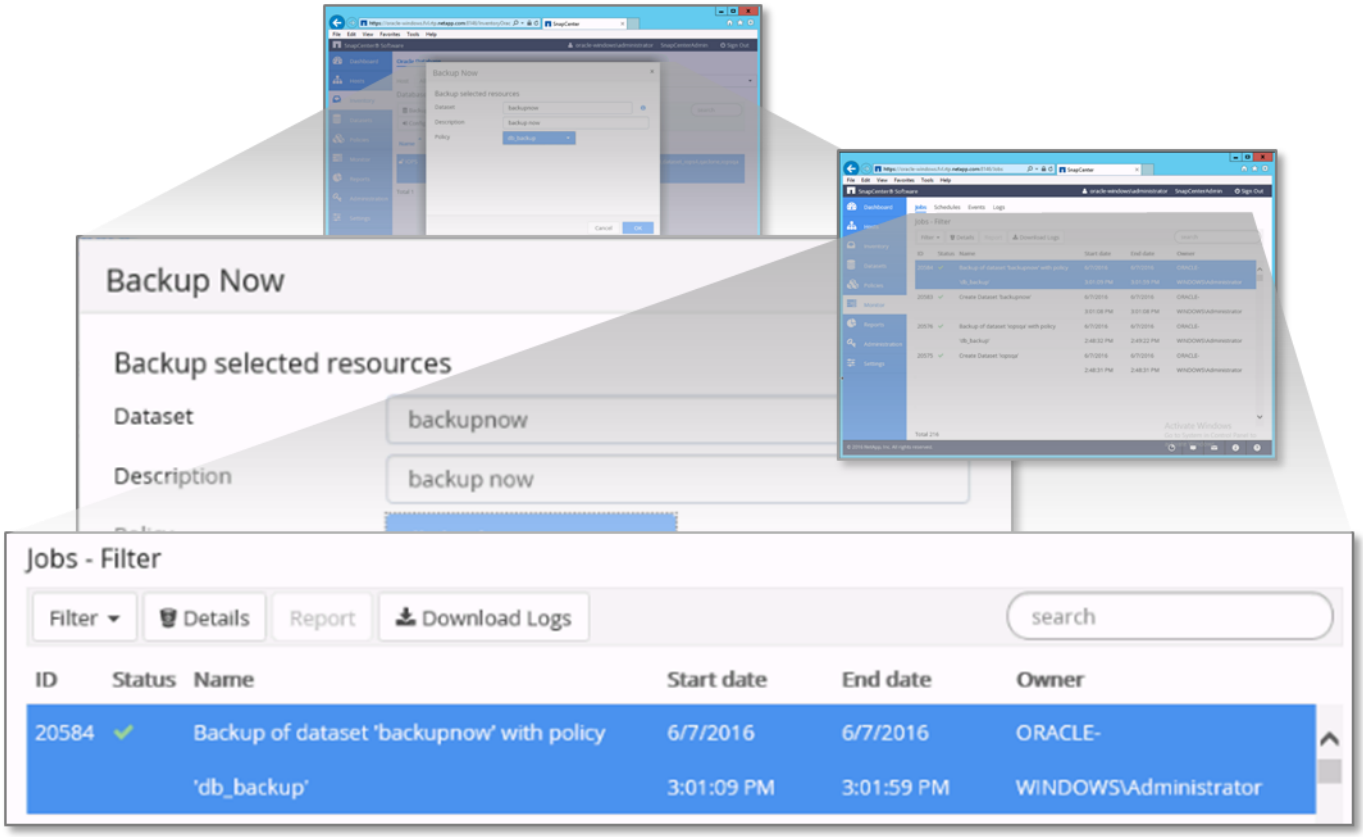
NetApp SnapCenter for Oracle Databases

NetApp SnapCenter is a software solution providing centralized data protection and clone management using a single GUI across all application environments. The GUI supports monitoring, notification, logging, reporting, and scheduling for all application and database plug-ins. Utilizing role-based access control (RBAC) for self-service, SnapCenter is scalable—additional SnapCenter servers can be added at any time for high availability and load balancing. Using SnapCenter with plug-ins, database administrators can schedule and perform self-service database backup, restore, and clone for both Microsoft SQL Server and Oracle databases.

ESG Lab examined NetApp SnapCenter for Oracle as a tool for performing routine database backup, restore, and clone. First, we created a backup job to back up an existing database. NetApp provides a simple interface, guiding the administrator through each step necessary to rapidly setup and execute backup jobs.

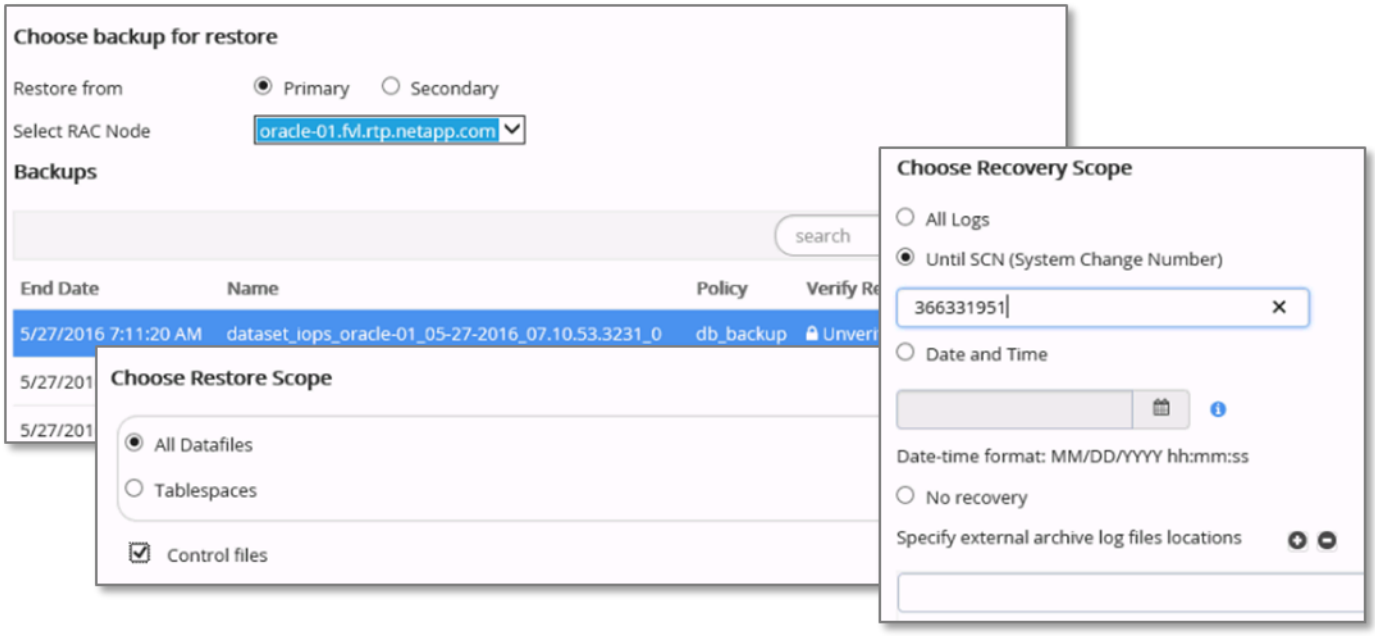
As shown in Figure 7, ESG Lab first entered ***backupnow*** for the name of the dataset, and ***backup now*** for the description. We chose the previously created policy ***db_backup*** for the backup policy, and then clicked ***OK*** to save the backup job. From the list of available backup jobs, we executed ***backupnow.*** SnapCenter notified us when the backup was complete, providing the job start and stop date and time.

Figure 7. Creating a Backup Job with NetApp SnapCenter for Oracle Databases



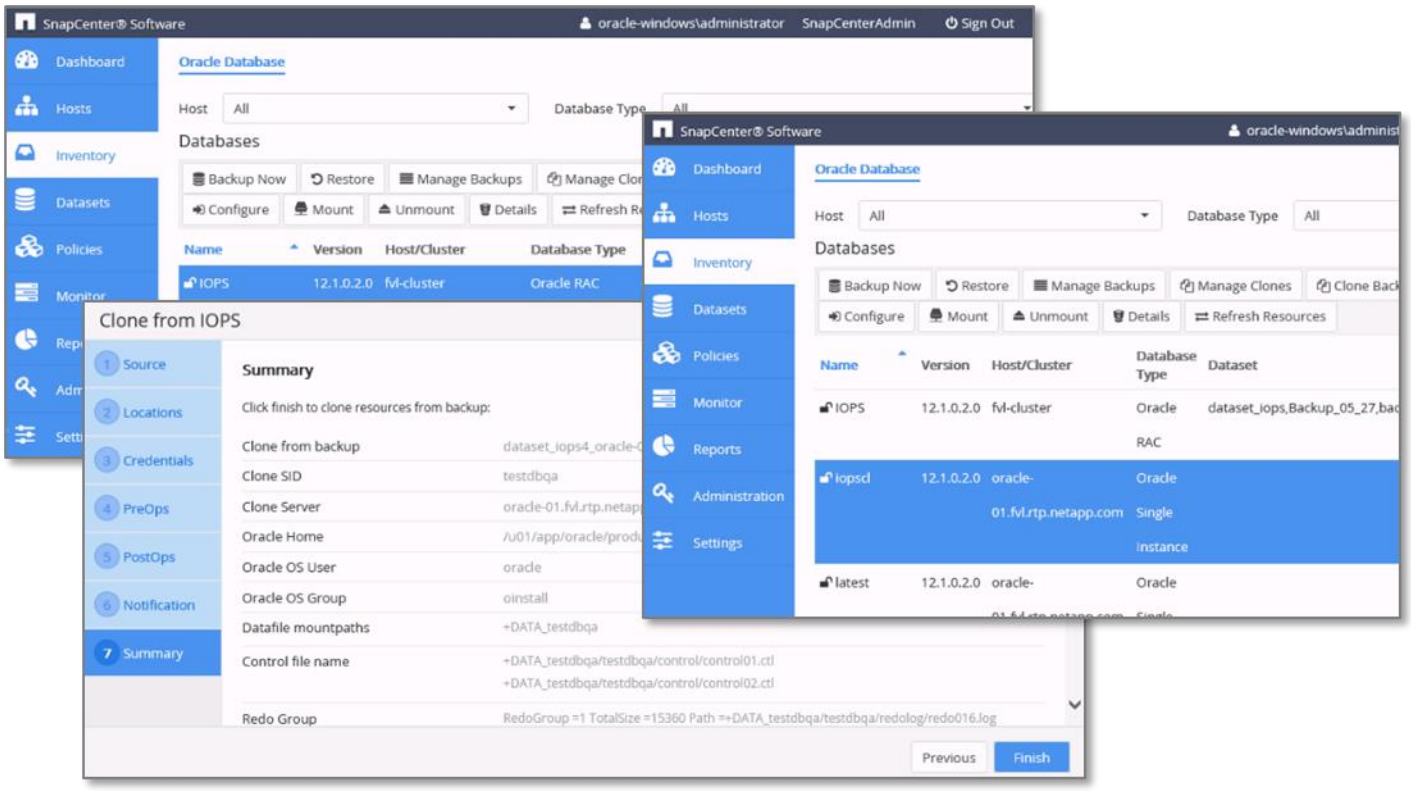
To verify that the backup job completed successfully, we used Oracle database tools to destroy the database. Next, as shown in Figure 8, using SnapCenter, we chose the backup, the RAC node for the restoration, and the scope of the restoration. SnapCenter notified us when it completed the database restoration, providing the start and stop date and time. We used Oracle database tools to verify that the restored database was accessible and contained the previously backed up data.

Figure 8. Restoring an Oracle Database using NetApp SnapCenter



Finally, we used SnapCenter to clone the database. As shown in Figure 9, we first selected the database to be cloned. Next, we chose the backup set and clone server, and then executed the clone operation. Once complete, the new clone appeared in the database inventory list.

Figure 9. Cloning an Oracle Database using NetApp SnapCenter



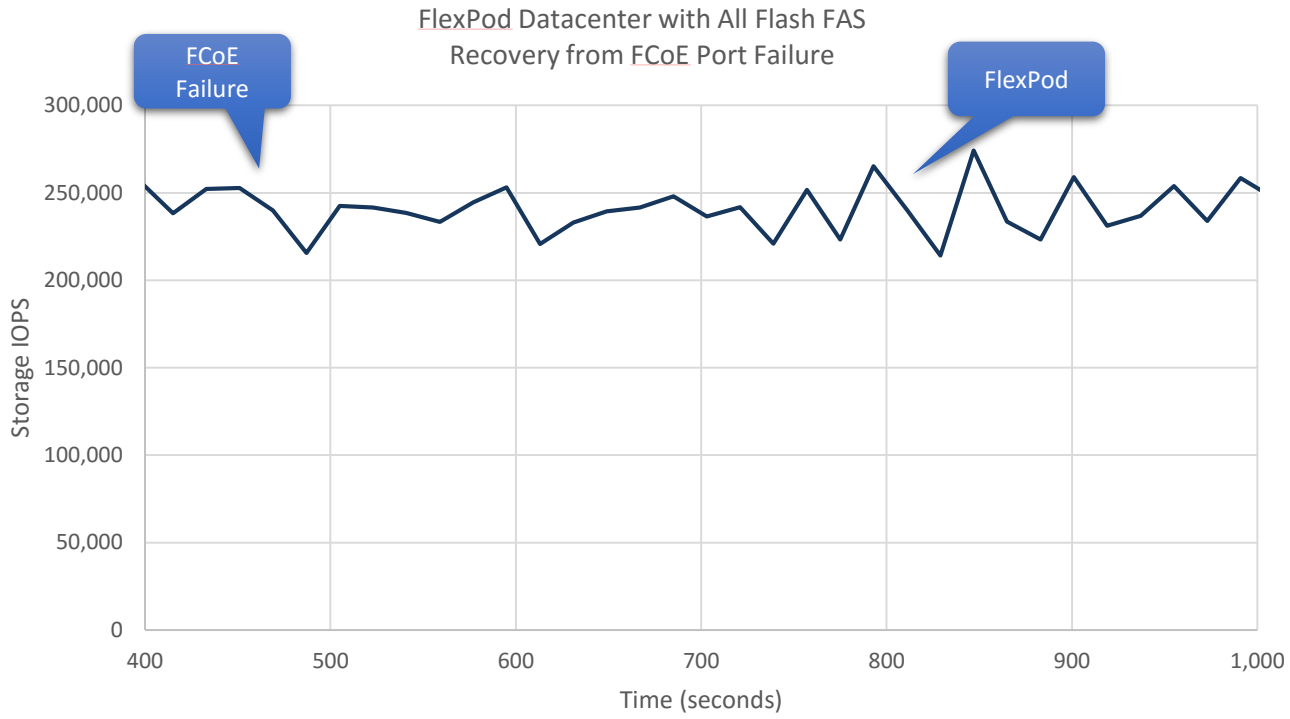
FlexPod Datacenter Resiliency

Data remains the lifeblood that oxygenates the entire body of enterprise IT. Many organizations depend on Oracle databases to capture, manage, and distribute data for organizations, including both online transaction processing (OLTP) and big data analytics applications. Resiliency is critical for databases—any failures can cause delays that will eventually be visible by users, and can ultimately result in data loss.

To evaluate the resiliency of the FlexPod Datacenter with All Flash FAS, ESG Lab used the SLOB benchmarking tool to apply a workload to the FlexPod. During testing, we used the NetApp ***sysstat*** utility to capture the NetApp FAS storage IOPS and storage system CPU utilization.

We first simulated a cable failure by artificially disabling one of the FCoE ports on the NetApp FAS storage system. This occurred at approximately 470 seconds into the test. As can be seen in Figure 10, there was a brief drop in transactional throughput, during which the FlexPod continued to operate without interruption. The drop lasted only a few seconds, and then the FlexPod returned to normal throughput. At approximately 810 seconds into the test, we re-enabled the failed FCoE port. Again there was a very brief and very small drop in throughput, and then the system resumed normal transactional throughput. The drops in throughput occurred as multipathing on the database servers switched over from the failed path to surviving paths, and then back to the affected path when the FCoE connection was restored.

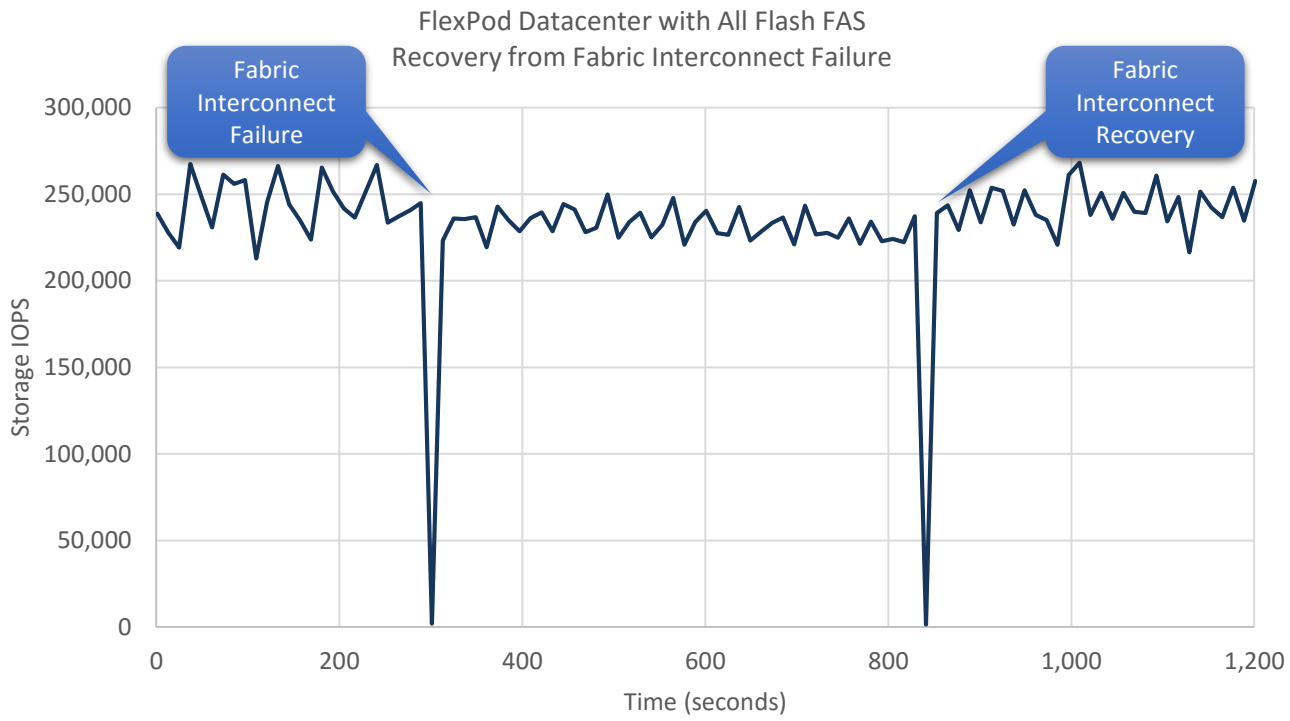
Figure 10. Recovery from FCoE Failure



Source: Enterprise Strategy Group, 2016

In the next test, we simulated a fabric interconnect failure by rebooting one of the Cisco fabric interconnect switches. This occurred at approximately 289 seconds into the test. As can be seen in Figure 11, there was a temporary interruption in data transfer while the second Fabric interconnect switch took over for the first switch, becoming the primary switch in the system. Within a few seconds, the system resumed normal operation utilizing only the second switch. When the first switch finished rebooting, simulating the recovery of the switch after failure, we observed another momentary interruption in data transfer. Then the system resumed steady state data transfer, with the first switch acting as a subordinate to the second switch.

Figure 11. Recovery from Fabric Interconnect Failure

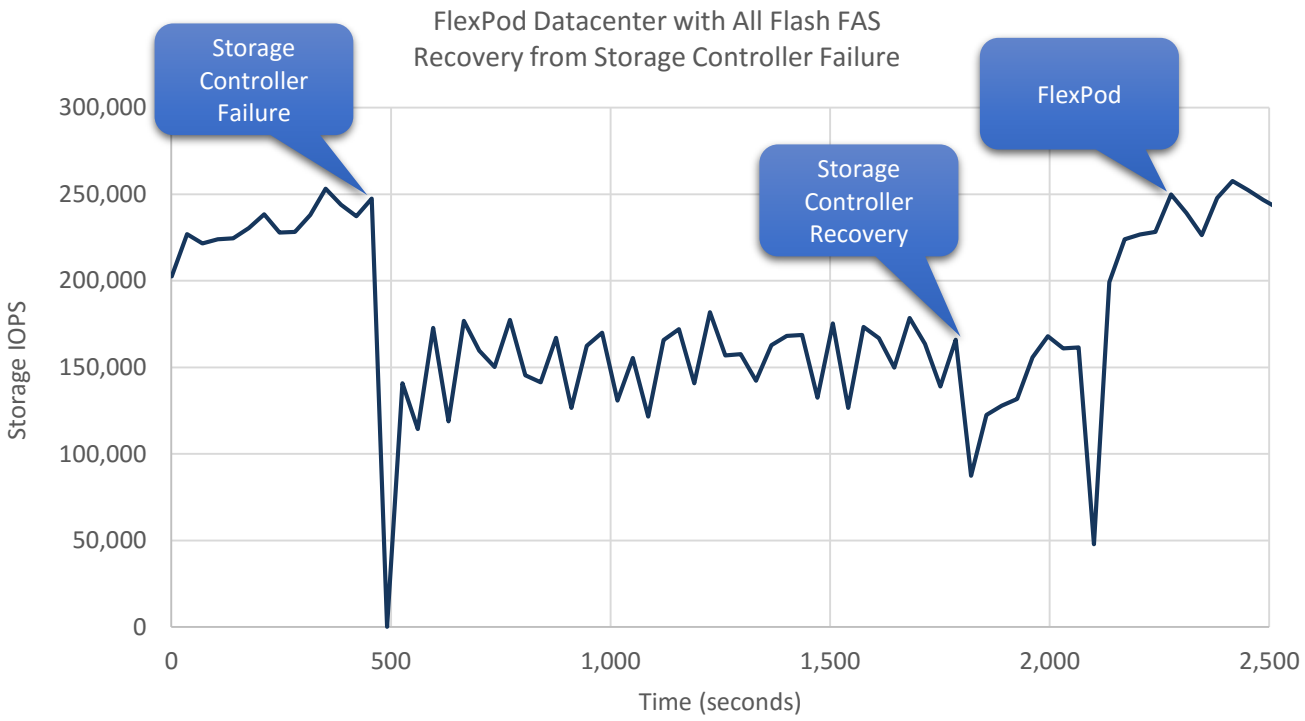


Source: Enterprise Strategy Group, 2016

In the final resiliency test, we simulated a storage controller failure by initiating a panic on one of the storage controllers on the All Flash FAS storage system. This occurred at approximately 460 seconds into the test. As can be seen in Figure 12, there was a momentary interruption in data transfer while the second controller was promoted to the active controller for the storage system. The system resumed steady state operation, averaging approximately 150,000 IOPS. The reduced transactional throughput, down from almost 250,000 IOPS, reflects that the single storage controller was processing all storage transactions for the entire system, rather than distributing the workload across both controllers.

At approximately 1,800 seconds, the first controller was restarted, resulting in recovery of the storage system after a storage controller failure. We observed two momentary interruptions in data throughput while the controllers negotiated to share the workload. Once the negotiation was complete, the controllers managed the multipathing to give back the load from the second controller to the first controller. When the giveback completed, the system resumed steady state operations, with the total workload being spread across both storage nodes, achieving the same transactional throughput observed prior to the controller failure.

Figure 12. Recovery from Storage Controller Failure



Source: Enterprise Strategy Group, 2016

Why This Matters

Performance degradation is among the most important challenges to managing database size and growth. The responsiveness of transactional databases and business-critical applications has a direct impact on productivity and revenue. Manageability, availability, reliability, and agility also factor into the challenges to cost-effectively meet service level agreements for business-critical applications.

ESG Lab confirmed that the FlexPod Datacenter with All Flash FAS was able to support 239,890 IOPS while running the SLOB2 benchmark, which simulated a real-world 75% read/25% write transactional database application. This performance was achieved while maintaining read response times of about 0.99ms, just below the 1ms standard threshold for performance degradation.

NetApp's plugin for Oracle Enterprise Manager enables database administrators to monitor and manage storage system capacity and performance, and make rapid adjustments to fine tune the system to meet rapidly changing business needs. Simultaneously, NetApp's support for Oracle in SnapCenter provides storage administrators the ability to quickly and easily back up, restore, and clone databases.

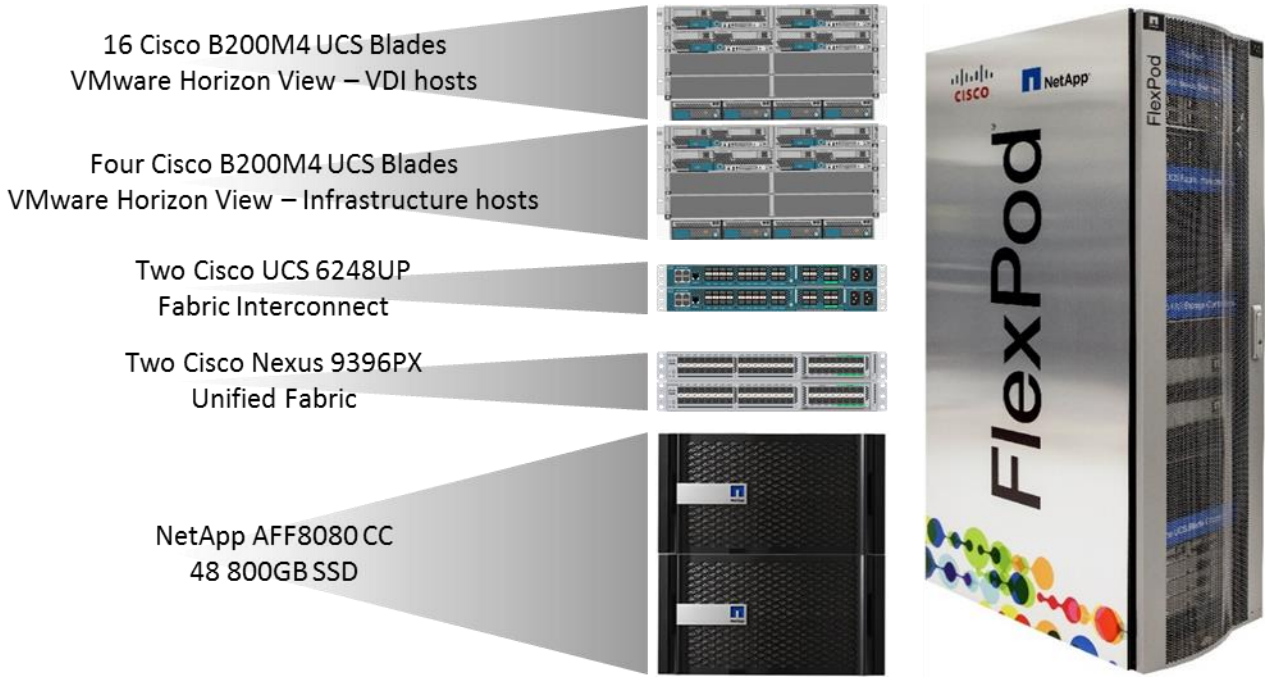
ESG Lab also confirmed that the FlexPod solution, with pre-configured high availability, was resilient and reliable. When faced with induced failures, the system quickly reverted to alternate communication paths, and distributed the workload across controllers, causing only momentary interruptions in service, and recovering without administrator intervention.

ESG Lab testing has validated that performance, reliability, availability, and agility of the FlexPod Datacenter solution can be used as the core converged infrastructure supporting the demanding performance requirements of real-world databases.

FlexPod Datacenter for Virtual Desktop Infrastructure

ESG Lab validated the performance of the FlexPod Datacenter with All Flash FAS in a virtual desktop infrastructure environment running VMware Horizon View. Sixteen Cisco UCS B200M4 compute blades were used as virtual desktop hosts, and four Cisco UCS B200M3 blades were used as infrastructure hosts. The FlexPod Datacenter was configured with a NetApp All Flash FAS AFF8080 CC storage system containing 48 800GB SSDs. Connectivity was provided by Cisco UCS fabric interconnect switches and Cisco Nexus unified fabric switches.

Figure 13. The ESG Lab Test Bed for VMware Horizon View VDI



Source: Enterprise Strategy Group, 2016

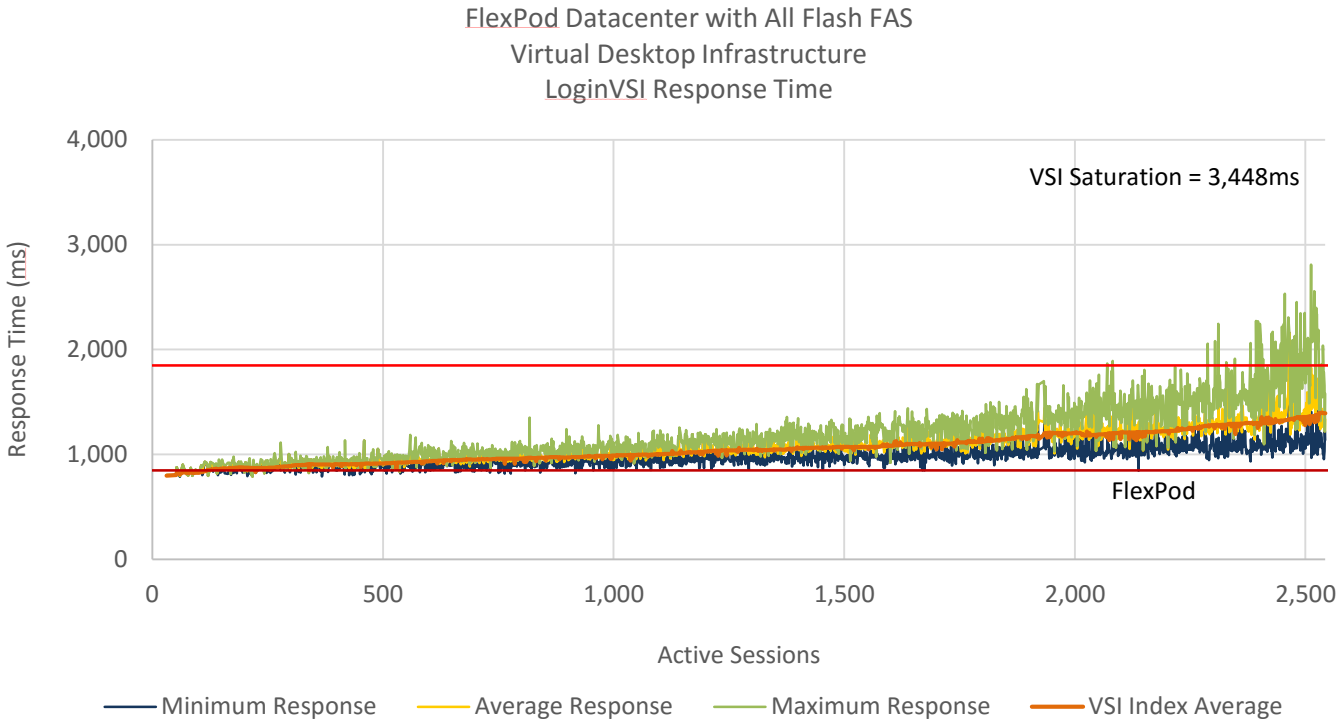
VDI Performance

ESG Lab used the industry standard VDI benchmarking tool Login VSI to validate the performance of the FlexPod Datacenter in a VDI environment. Login VSI validates application performance and response times for various predefined VDI workloads with an ultimate goal of showing desktop density potential for a given set of hardware and software components. Final results are presented using easily understandable Login VSI metrics that represent the number of concurrent sessions running when the VDI environment reaches a saturation point.

Login VSI v4.1 simulates the activity of an increasing number of initiated remote desktop sessions. The tool calculates the saturation response time as an average response time 2,600ms more than the baseline average response time. The number of desktop sessions running when this saturation response time is reached is the maximum number of virtual desktops that can be supported by the environment, and is known as VSImax.

The Login VSI results for this configuration of the Flexpod Datacenter with All Flash FAS are shown in the graph in Figure 14, which plots the response time in milliseconds (ms) against the number of active sessions. Login VSI measured an 848ms average baseline response time, and calculated a 3,448ms average response time for a saturated system. With 2,544 virtual desktop sessions running simultaneously, the average response time peaked below 1,500ms, demonstrating that the FlexPod had not yet reached the saturation point, and there was sufficient headroom to run more virtual desktops.

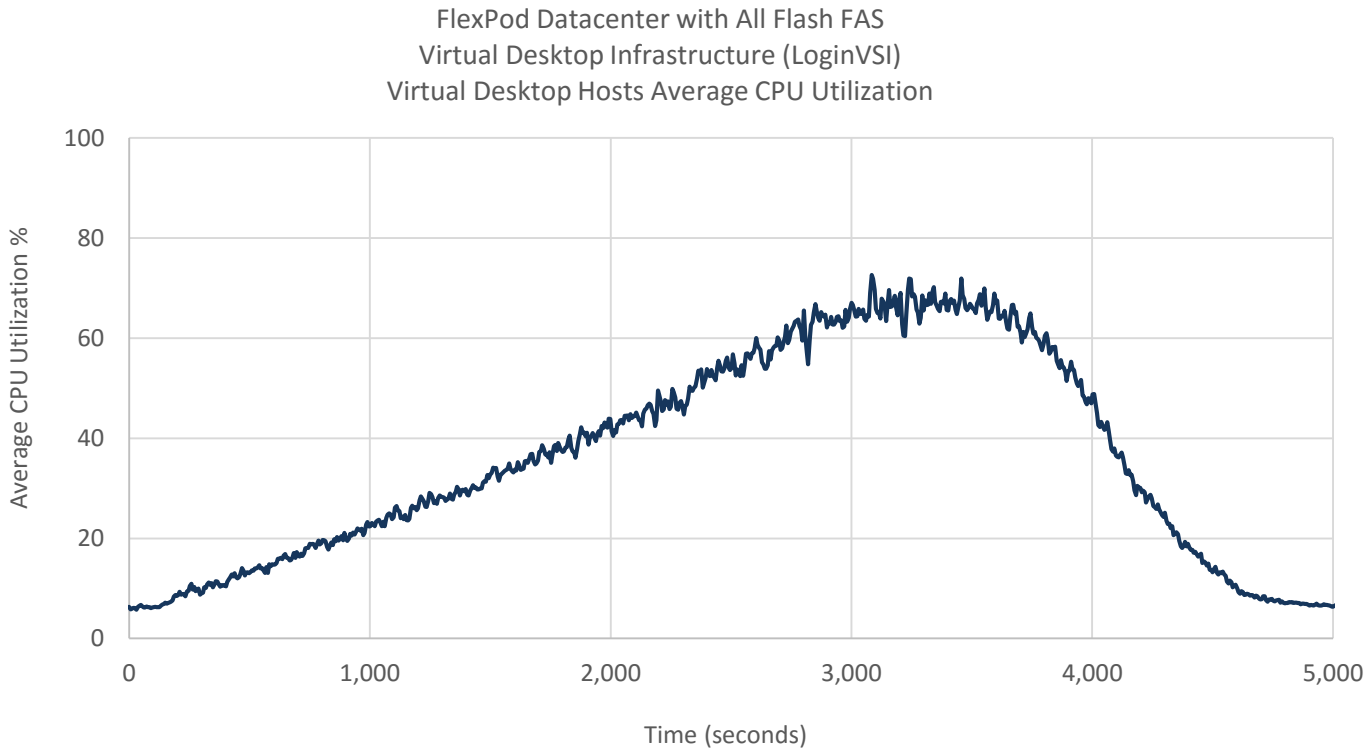
Figure 14. LoginVSI Results



Source: Enterprise Strategy Group, 2016

ESG Lab also used ESXtop, a VMware built in utility, to collect additional performance metrics, including the virtual desktop host CPU utilization. As can be seen in Figure 15, over the duration of the test, the average CPU utilization across all hosts peaked below 80%. As with the response times and saturation points, the CPU utilization demonstrates that there is excess compute power, and the infrastructure can support more than the 2,544 virtual desktops that ran during testing.

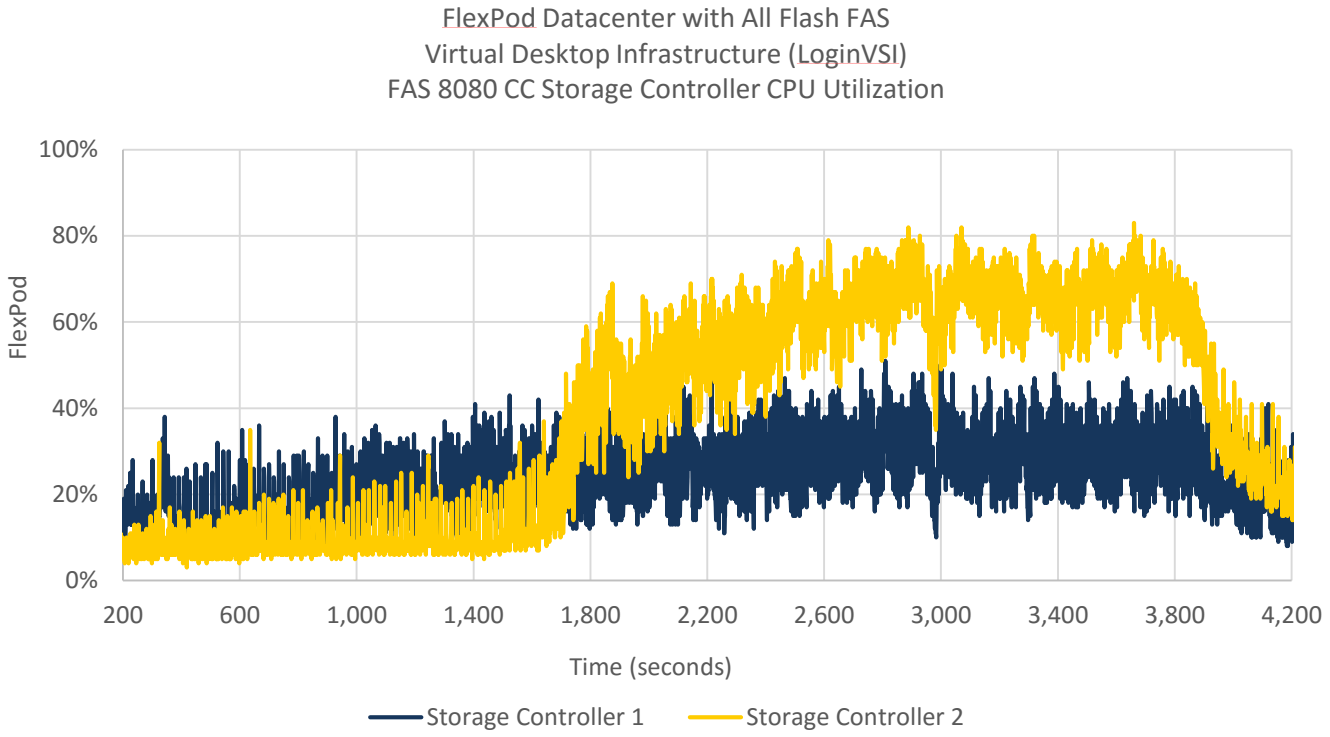
Figure 15. VDI Hosts Average CPU Utilization



Source: Enterprise Strategy Group, 2016

During Login VSI testing, ESG Lab also collected telemetry data from the NetApp FAS 8080 storage system. The storage system controller CPU utilization is shown in Figure 16. For the duration of the test, CPU utilization peaked below 80%. This, too, demonstrates that the FlexPod solution provides sufficient storage system compute power to support more than the 2,544 virtual desktops that ran during testing.

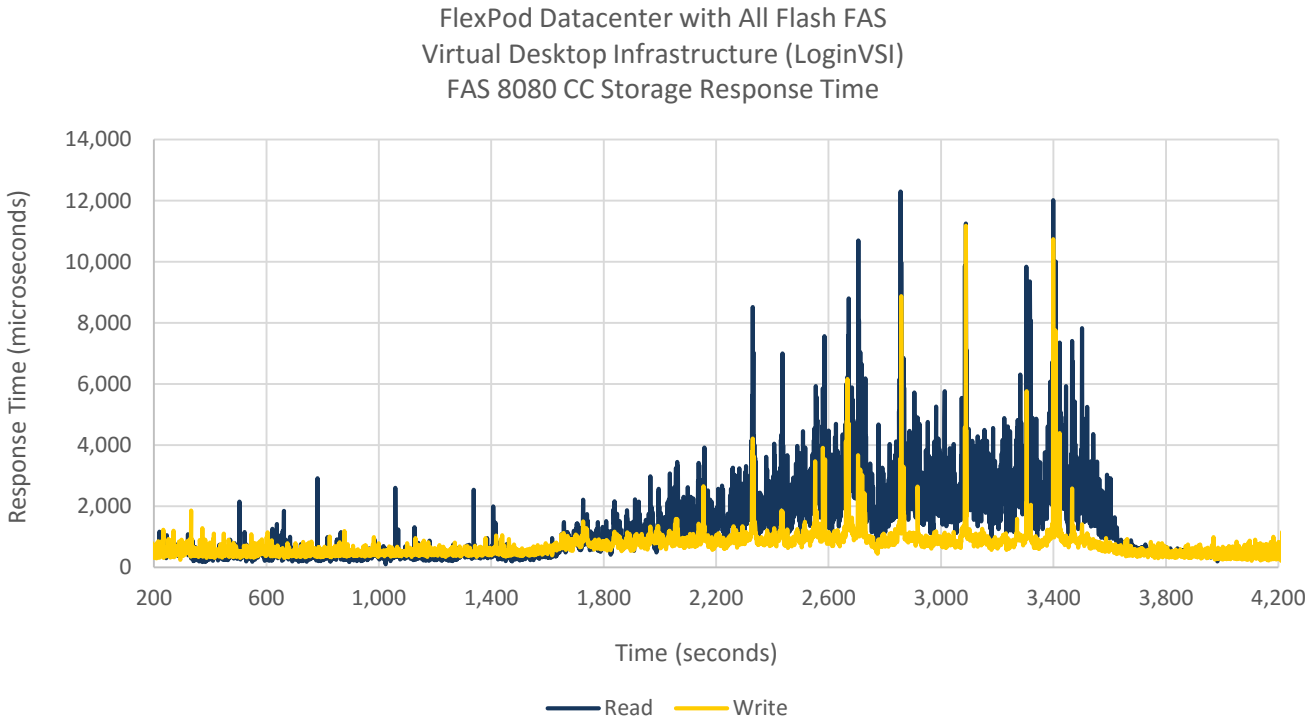
Figure 16. Storage Controller CPU Utilization



Source: Enterprise Strategy Group, 2016

The read and write response time as measured by the FAS 8080 storage system are shown in Figure 17. Over the duration of the test, the read response time peaked at 12.3ms and write response time peaked at 11.2ms. Average read response time was 1.3ms and average write response time was 0.73ms. The ability of the NetApp FAS 8080 to respond so quickly to requests, especially under a demanding VDI load, contributes to overall performance and the ability of the FlexPod to support more than 2,544 virtual desktops.

Figure 17. Storage System Response Time



Source: Enterprise Strategy Group, 2016

Why This Matters

Delivering the optimal user experience is an essential IT task, made more complicated by virtual desktop environments, which can hammer an infrastructure, since I/O is generally random, constantly shifting, and often write-intensive, and these characteristics are exacerbated as the environment scales.

ESG Lab validated that FlexPod Datacenter with All Flash FAS delivers a solid VDI platform. With a generator simulating virtual desktop workloads, we were able to instantiate and run more than 2,544 desktops while maintaining an optimal user experience. The virtual desktop processors never exceeded 80% CPU utilization. At the same time, the storage system controllers used less than 80% of their CPUs, and still returned average response times of just around 1ms. These results demonstrate that the FlexPod converged infrastructure provides an agile VDI platform, with plenty of headroom to run even more desktops, as well as a solution that can ensure IT can execute on its mission to deliver an optimal user experience.

ESG Lab Validation Highlights

- ☑ ESG Lab confirmed that a FlexPod Datacenter with All Flash FAS, configured with 48 1.6TB SSDs and a four node Oracle Real Application Clusters database, provides performance for OLTP environments, sustaining more than 239,000 IOPS with 75% reads and 25% writes.
- ☑ Response times when running the database workload were under the 1ms threshold considered standard for perceivable impacts in performance.
- ☑ The NetApp storage system plug-in for Oracle Enterprise Manager enabled database administrators to directly monitor storage capacity and performance, and enabled fine tuning for rapid agility to meet exacting demands.
- ☑ The NetApp SnapCenter for Oracle enabled storage administrators to quickly and easily back up, restore, and clone Oracle databases, simplifying the management burden.
- ☑ The FlexPod Datacenter proved resilient, reliable, and available, leveraging architecture redundancy and multipathing to minimize disruptions in operations from failures of network links, network switches, and storage controllers.
- ☑ ESG Lab also confirmed that a FlexPod Datacenter with All Flash FAS, configured with 48 800GB SSDs and 16 compute nodes, was able to support 2,544 virtual desktops in a VMware Horizon View VDI environment.

Issues to Consider

- ☑ Generally accepted best practices and predominantly default Oracle and NetApp All Flash FAS settings were used during the design of this test. As expected after any benchmark of this magnitude, deep analysis of the results indicates that tuning would probably yield slightly higher absolute results.
- ☑ The test results/data presented in this document are based on benchmarks deployed in a controlled environment. Due to the many variables in each production data center environment, it is still important to perform capacity planning and testing in your own environment to validate system configuration.
- ☑ While the FlexPod Datacenter is a converged infrastructure solution, and is designed to simultaneously support many different types of workloads, due to time and resource constraints, database and VDI tests were conducted independently. It is important to take into account your own specific combination of workloads when determining the capacity and configuration of your converged infrastructure environment.

The Bigger Truth

IT professionals are being tasked with justifying every new iteration of their infrastructure strategy. How can organizations keep pace with capacity that is doubling every two to four years while staying within budget? How will storage investments be protected now and in the future? How can more capacity be managed with better performance and service levels with existing staff? Will investments complement—or complicate—virtual server consolidation initiatives? How will IT create a winning strategy that works for both the team *and* the organization?

ESG research indicates that business intelligence/data analytics initiatives, managing data growth, and data integration are among the most cited IT priorities for the organizations surveyed by ESG.[4] Integrating the latest and greatest storage, networking, and server technologies into a flexible architecture for multiple enterprise workloads can be a significant challenge. Integrated, pre-built, pre-tested converged infrastructures hold the promise of taking the pain out of the equation, enabling organizations to deliver performance, reliability, availability, and an optimal user experience from a single solution.

NetApp and Cisco have teamed together to combine best-of-breed storage, networking, and server components into a single, flexible architecture for enterprise workloads. The result is the FlexPod Datacenter with All Flash FAS, a converged infrastructure solution which leverages the performance, reliability, and availability of NetApp All Flash FAS storage, Cisco UCS servers, and Cisco UCS and Nexus networking fabrics.

ESG Lab confirmed that NetApp has built upon the long history of performance and scalability of the FAS series. The FlexPod Datacenter with a four node Oracle Real Application Clusters database was able to sustain more than 239,000 IOPS in OLTP database testing with 75% reads and 25% writes. Managing the environment was simplified with NetApp's plugin for Oracle Enterprise Manager, which provides database administrators with the ability to monitor storage system capacity and performance. Likewise, storage system administrators, using NetApp SnapCenter, can quickly and easily back up, restore, and clone Oracle databases.

We also confirmed that NetApp and Cisco have delivered a platform well suited to the challenging task of delivering an optimal user experience for virtual desktop infrastructures running VMware Horizon View. We were able to run more than 2,544 virtual desktops on a FlexPod Datacenter configured with 16 UCS nodes and an All Flash FAS with 48 800GB SSDs. Peaking below 80% CPU utilization and 80% storage system controller CPU utilization, this configuration still had plenty of headroom to add more virtual desktops.

ESG Lab is pleased to report that the FlexPod Datacenter with All Flash FAS delivers simple, efficient, consistently high performance, along with advanced data management functionality and application integration. FlexPod is clearly well suited to support a mix of demanding real-world business applications running in a performance-critical Oracle database infrastructure, as well as virtual desktop infrastructures running VMware Horizon View. Organizations investigating converged infrastructures to support all of their database and VDI deployments would be smart to take a closer look at the FlexPod Datacenter with All Flash FAS solutions.

[4] Source: ESG Research Report, *2016 IT Spending Intentions Survey*, February 2016

Appendix

Table 1. ESG Lab Test Bed for Oracle Database

FlexPod Datacenter with All Flash FAS	
Storage	
NetApp All Flash FAS 8080EX	48x 1.6TB SSD total Data ONTAP 8.3.1
Compute	
Cisco UCS 5108 Chassis	Quantity: 2 (only 1 used during testing) Firmware: 2.2(5b)
Cisco B200M4 compute blade	Quantity: 4 2 x Intel Xeon E5-2630 processors, 128GB RAM
Cisco B200M3 compute blade	Quantity: 2 2 x Intel Xeon E5-2650 processors, 96GB RAM
Network	
Cisco UCS 6248UP Fabric Interconnect Switch	Quantity: 2
Cisco Nexus 9396PX Unified Fabric Switch	Quantity: 1
Software	
Cisco UCS Manager	2.2(5b)
Red Hat Enterprise Linux	7.1 Kernel version 3.10.0.-229.e17.x86_64
NetApp SnapCenter Server	1.1
NetApp SnapCenter Plug-in for Linux	1.1
Oracle Database	12c Enterprise Edition Release 12.1.0.2.0
NetApp OEM Plug-in for Oracle Enterprise Manager	12.1.0.3.1
SLOB	2.3.0.3-1

Table 2. ESG Lab Test Bed for Virtual Desktop Infrastructure

FlexPod Datacenter with All Flash FAS	
Storage	
NetApp All Flash FAS 8080CC	48x 800GB SSD total Data ONTAP 8.3.2
Compute	
Cisco UCS 5108 Chassis	Quantity: 3 Firmware: 3.1(1e)
Cisco B200M4 compute blade	Quantity: 16 (for VDI hosts) 2 x Intel Xeon E5-2690v3 processors, 384GB RAM
Cisco B200M3 compute blade	Quantity: 4 (for infrastructure hosts) 2 x Intel Xeon E5-2620v2 processors, 256GB RAM
Network	
Cisco UCS 6248UP Fabric Interconnect Switch	Quantity: 2
Cisco Nexus 9396PX Unified Fabric Switch	Quantity: 2
Software	
Cisco UCS Manager	3.1(1e)
Cisco NX-OS	7.0(3)I2(2a)
NetApp Virtual Storage Console (VSC)	6.2
VMware ESXi	6.0.0, 3380124
VMware vCenter Server	6.0.0, 3339084
VMware Horizon View Administrator	7.0.0, 3633490
VMware View Composer	7.0.0, 3613429
VMware Horizon View Client	4.0.1, 3698521
VMware Horizon View Agent	7.0.0, 3633490
Windows Desktop	Windows 10 Enterprise 32-bit
Microsoft Office	2016 Professional 32-bit
Microsoft SQL Server	2012 R2 (4-bit)
Microsoft SQL Server Native Client	11.0 (64-bit)
Login VSI	4.15

Enterprise Strategy Group is an IT analyst, research, validation, and strategy firm that provides market intelligence and actionable insight to the global IT community.

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