NetApp Verified Architecture

FlexPod Select for High-Performance Oracle RAC

NVA Design

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1 Executive Summary

Data-driven companies need technology solutions that provide high availability, offer ease of management, and, perhaps most importantly, meet critical performance objectives. Oracle® databases are the choice of countless enterprises to deliver critical functionality to the business or its customers. NetApp has long delivered technologies that enable the capabilities of the Oracle product suite while taking into account an organization's operational cost guidelines.

The decision to deploy an infrastructure capable of supporting demanding applications has implications for a variety of facets within an IT organization. Decisions about such things as acquisition, deployment methodology, best practices, life-cycle, growth, and so forth must be taken into account to serve the demands of users and for the company to remain competitive both now and in the future. Database teams need an adequately responsive infrastructure in which no component can inhibit database performance. Careful consideration should be given to the compute network and storage layers of such an infrastructure. This is especially important when service-level agreements or objectives must be met for applications running on Oracle databases.

The NetApp® FlexPod® data center platform delivers key products including Cisco® Unified Computing System™ (Cisco UCS®) servers, Cisco Nexus® networking, and industry-leading storage from NetApp, all configured and validated according to industry best practices. As an industry-proven platform, FlexPod can be tailored to meet the needs of a variety of applications and use cases.

The product portfolios of Cisco and NetApp offer a wide array of choices when it comes to selecting the appropriate platform for Oracle databases. NetApp E-Series storage solutions, Cisco UCS, and Cisco Nexus components provide the foundation for a FlexPod environment capable of delivering high performance for Oracle databases. The FlexPod Select for High-Performance Oracle RAC solution accomplishes this by enabling fast transactions for end users and applications, providing a balanced architecture that provides extreme performance, and enabling businesses to react quickly to new business needs or competitive threats.

2 Program Summary

2.1 NetApp Validated Architecture Program

The NetApp Verified Architecture (NVA) program offers customers a validated architecture for NetApp solutions. NVAs provide customers with NetApp solution architecture that:

- Is thoroughly tested
- Is prescriptive in nature
- Minimizes customer deployment risks
- Accelerates customer time to market

This document is intended for NetApp and partner solution engineers and customer strategic decision makers. It describes the architecture design considerations used to determine the specific equipment, cabling, and configuration required in a particular environment. This document provides guidance about how to estimate workload characteristics and how to manage solution lifecycle events such as replacing equipment, updating firmware, and upgrading software. Additional considerations discussed in this document include:

- Resiliency
- Fault tolerance
- Degree of high availability
- Performance expectations

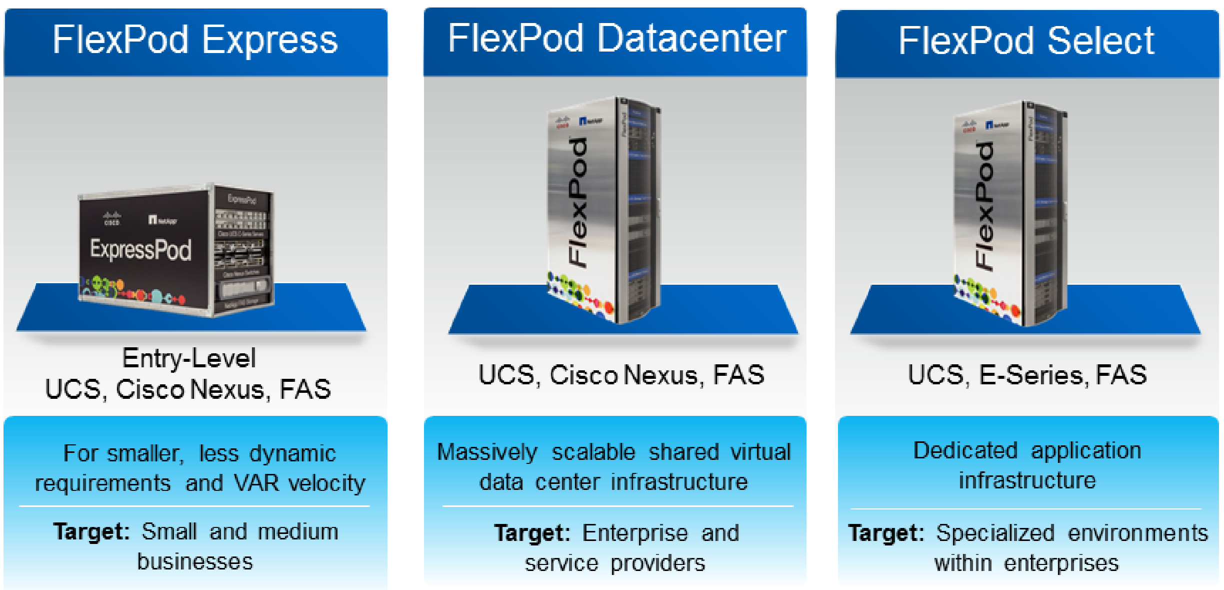
2.2 FlexPod Converged Infrastructure Program

FlexPod delivers key technologies from Cisco and NetApp. FlexPod reference architectures are often delivered in the form of Cisco Validated Designs (CVDs) or NVAs. Deviations based on customer requirements from a given CVD or NVA are encouraged, provided those variations do not result in the deployment of unsupported configurations.

All FlexPod solutions share key configuration principles in common, such as using converged Ethernet or SAN networks and maximizing hardware-level resiliency. As shown in Figure 1, the FlexPod program consists of three solutions: FlexPod Express, FlexPod Datacenter, and FlexPod Select.

- **FlexPod Express** offers customers an entry-level solution consisting of technologies from Cisco and NetApp.
- **FlexPod Datacenter** delivers a perfect multipurpose foundation for a variety of workloads and applications.
- **FlexPod Select** takes the best aspects of FlexPod Datacenter and tailors the infrastructure for a given application.

Figure 1) FlexPod portfolio.



The solution discussed in this design guide is part of the FlexPod Select family. Optimizing Oracle databases can include changes in the compute, network, and storage layers. As such, the design outlined in this document primarily pertains to architecture beholden to specific performance criteria.

3 Solution Overview

This NVA validates that the NetApp FlexPod Select solution can run Oracle databases in a highly resilient architecture while remaining competitive in both price and performance. This document addresses the scenarios that customers experience in their production Oracle databases.

The solution outlined in this NVA design guide was architected to deliver over 1 million input/output operations per second (IOPS) at submillisecond average latency with a workload that is 100% random reads using an 8K request size. Additionally, NetApp also validated that this solution delivers consistent performance using a variety of other mixed online transaction processing (OLTP) type workloads, such as:

- 90% reads, 10% writes, 100% random I/O using an 8K request size
- 80% reads, 20% writes, 100% random I/O using an 8K request size

3.1 Solution Technology

FlexPod Select uses technologies from Cisco and NetApp that are configured according to the companies' best practices. This section discusses the products and technologies leveraged in the solution.

NetApp EF550 Flash Array

The NetApp EF550 flash array is designed for performance-driven applications with submillisecond latency requirements.

This solution uses the NetApp EF550 flash array as the underlying storage technology, which is built on storage architecture with more than 20 years of storage development experience and more than 750,000 systems in the field. Each EF550 flash array can deliver extreme performance with submillisecond response times, enabling business-critical applications to deliver faster results and improving the end-user experience. This combination of high IOPS and ultralow latency makes the EF550 flash array an ideal choice for database-driven applications that require extreme performance.

The EF550 flash array runs on the enterprise-proven NetApp SANtricity® platform, which is optimized for flash solutions and allows storage administrators to achieve maximum performance and capacity utilization. The extensive configuration flexibility, custom performance tuning, and complete control over data placement make it an ideal choice for mission-critical applications. Its GUI-based performance tools provide key information on storage input/output (I/O) from multiple viewpoints, allowing administrators to make informed decisions about configuration adjustments to further refine performance.

The NetApp EF550 flash array delivers extreme performance, reliability, and availability to drive greater speed and responsiveness from the applications controlling your key business operations.

The NetApp EF550 flash array can:

- Increase the speed of business with submillisecond response times.
- Eliminate overprovisioning and improve IT efficiency.
- Achieve the transactional performance of 1,000 15K RPM drives in a two-rack-unit (2 RU) enclosure that requires just 5% of the available rack space, power, and cooling as compared to storage systems that run on spinning disks.
- Detect and resolve issues quickly with advanced monitoring and proactive repair.
- Protect against data loss and downtime with NetApp point-in-time images, remote replication, and other advanced data protection.
- Create copies of the database by using the NetApp Snapshot® volume feature.
- Replicate data to either an EF550 flash array or an E-Series system.
- Leverage the enterprise-proven SANtricity software platform.

By combining extreme IOPS, submillisecond response times, scale-up capacity, and enterprise-grade reliability, the NetApp EF550 flash array helps you to increase productivity and achieve faster business results.

Cisco Unified Computing System

The Cisco Unified Computing System is a next-generation solution for blade- and rack-server computing. The system integrates a low-latency, lossless 10 Gigabit Ethernet (10GbE) unified network fabric with enterprise-class, x86 architecture servers. The system is an integrated, scalable, multichassis platform in which all resources participate in a unified management domain. Cisco UCS accelerates the delivery of new services simply, reliably, and securely through end-to-end provisioning and migration support for both virtualized and nonvirtualized systems.

Cisco Nexus 5000

Cisco Nexus 5000 series switches are designed to deliver high-density, top-of-rack layer 2 and layer 3, 10GbE with unified ports in compact one- and two-rack-unit form factors. The Cisco Nexus 5000 series includes Cisco Nexus 5500 and 5600 platforms as part of the Cisco Unified Fabric portfolio.

The Cisco Nexus 5500 switches simplify convergence through broad connectivity support. This makes them ideal top-of-rack access switches for traditional and converged deployments. The Cisco 5500 switches are designed to meet the scalability demands of today's data centers. Key Cisco Nexus 5500 series features include:

- Up to 1,152 ports in a single management domain that uses Cisco Fabric Extender (FEX) architecture
- Up to 96 unified ports

Oracle Database

The Oracle Database 11*g* R2 Enterprise Edition provides industry-leading performance, scalability, security, and reliability on clustered or single servers with a wide range of options to meet the business needs of critical enterprise applications. Oracle Real Application Cluster (RAC) brings an innovative approach to the challenges of rapidly increasing amounts of data and demand for high performance. Oracle RAC uses a scale-out model in which active-active clusters utilize multiple servers to deliver high performance, scalability, and availability.

Oracle Automatic Storage Management (Oracle ASM) provides an integrated cluster file system and volume-management features that remove the need for third-party volume management tools and reduce the complexity of the overall architecture.

Some of the key Oracle ASM features include:

- Automatic file and volume management
- Database file system with performance of raw I/O
- Automatic distribution and striping of data
- A choice of external (array-based) data protection, two-way, and three-way mirror protection
- Control over which copy of mirrored data should be used preferentially

With these capabilities, Oracle ASM provides an alternative to the third-party file system and volume-management solutions for database storage management tasks, such as creating or laying out databases and managing the use of disk space. Oracle ASM provides load balancing of I/O across all LUNs or files in an Oracle ASM disk group by distributing the contents of each data file evenly across the entire pool of storage in the disk group.

The NetApp SANtricity plug-in for Oracle Enterprise Manager (Oracle EM) provides Oracle database administrators (DBAs) with powerful capabilities designed to increase their productivity and simplify their jobs. The plug-in is designed to access E-Series and EF-Series storage arrays used in conjunction with Oracle EM database software. This allows Oracle DBAs to monitor and report on the storage subsystems, with the ultimate goal of confirming the performance and availability of the infrastructure they use. Performance views that come with the plug-in help DBAs easily identify bottlenecks in the system. The plug-in also gives a view of the end-to-end database mapping to the storage and allows DBAs to create a database-to-storage topology report without accessing the storage layers underneath. The plug-in is free and does not require a license.

Key features of the Oracle EM plug-in include:

- Integration with Oracle Enterprise Manager 12c

- Support for NetApp E-Series and EF-Series storage arrays
- End-to-end storage volume-to-database mapping
- Integrated business intelligence publisher reports
- Automatic metric collection on key storage array components
- Integrated database performance homepage

3.2 Use-Case Summary

The NetApp FlexPod Select for Oracle solution, which can run high-performance Oracle databases in a highly resilient architecture, is competitive in terms of both price and performance. As part of this solution, the following use cases were validated.

- Deliver an architecture and a prescriptive reference deployment that provides a high level of resiliency against component failure.
- Deliver 1 million random read IOPS with submillisecond latency by using an 8K request size.
- Demonstrate consistent performance and response time utilizing a workload that consists of 90% random reads and 10% random writes by using an 8K block size.
- Demonstrate consistent performance and response time utilizing a workload that consists of 80% random reads and 20% random writes by using an 8K block size.

4 Solution Design

4.1 Compute Design Elements

In the FlexPod Select for High-Performance Oracle RAC solution, Cisco UCS hosts are deployed to serve as the RAC nodes. Specific features of the Cisco UCS B-Series blades, chassis, and fabric interconnects are used to maximize reliability, performance, and efficiency. Those features are described in detail in this section. For additional information about Cisco UCS features and benefits, refer to the Cisco website.

FCoE SAN Boot

Local storage devices on a server can constitute a single point of failure. For this reason, the environment uses enterprise storage to hold the operating system partitions for each server. Cisco UCS B-Series blades support boot from SAN by using Fibre Channel over Ethernet (FCoE) connectivity to a storage network. The boot volumes are located on the same EF550 arrays that hold the Oracle database data. In this way, the boot volumes are provided the same degree of fault tolerance as the production data, which, in turn, generates both a high degree of protection against node downtime and extremely fast boot times.

In other solutions, it may be necessary to spread operating system boot volumes across multiple storage arrays to prevent boot storms. However, that creates additional complexity and operational overhead as new servers are provisioned or decommissioned. Because this solution utilizes flash storage, disk I/O contention becomes highly unlikely. As a result, the environment can be simplified by hosting all boot volumes on a single EF550 storage array without risking performance degradation.

Alternatively, the solution fully supports alternative boot methods including spreading boot disks across multiple arrays and local boot disks. However, these boot methods were not tested as part of the solution validation and may negate the benefits described.

Service Profile Templates

Service profiles are an integral component of the Cisco UCS product. They contain a logical server identity, BIOS-level configuration parameters, and hardware compatibility requirements. A service profile can be applied to any physical servers that match the service profile's system requirements for a given Cisco UCS environment.

Service-profile templates help simplify the management of a proven service profile. A service-profile template allows an administrator to create multiple service profiles based on a known set of configuration parameters and administrator-defined pools of unique identifiers. For more information about service profiles and service-profile templates, refer to Understanding Cisco Unified Computing System Service Profiles.

Although storage performance concerns are minimized by using EF550 flash arrays, storage network throughput could become a potential bottleneck. To maximize the throughput and minimize concerns about storage path contention during times when many servers may be booting simultaneously, two service profiles are created.

Both service profiles contain two FCoE SAN interfaces – one for each of the two SAN fabrics of the solution. One service profile boots primarily from the SAN port on fabric A. The other service profile boots primarily from the SAN port on fabric B. This balances boot-time traffic across both network paths to prevent network bandwidth contention. Both service profiles use the remaining SAN fabric as a secondary boot path. In this way, boot will not fail if one of the SAN fabrics fails.

Virtual Interface Cards

Cisco virtual interface cards (VICs) allow a server to present multiple physical interfaces to the host operating system. The physical interfaces presented can be both network interface cards (NICs) and host bus adapters (HBAs). Traffic from the presented physical interfaces converges within the VIC and is passed through the FEXs to the fabric interconnects for delivery to the network layer of the infrastructure. Physical network interfaces can be configured to fail between the two fabrics of the Cisco UCS environment; this maximizes fault tolerance within the network layer of the servers.

The FlexPod for High-Performance Oracle RAC solution demonstrates the use of Cisco UCS VIC 1240 cards with Cisco UCS FEX 2204 modules to connect the chassis to the fabric interconnects. This combination of hardware enables a maximum bandwidth of 20Gb/s to each server (10Gb/s to each fabric). Each FEX 2204 is fully cabled, which provides a total of 80Gb/s of bandwidth from each fabric interconnect to each chassis. Without oversubscribing throughput, a maximum of four servers can be used with this configuration.

Optionally, additional Cisco UCS adapters and FEXs can be used to provide additional aggregate throughput to a Cisco UCS chassis and to each server within a chassis. A maximum of 160Gb/s of aggregate bandwidth can be provided to each chassis with the Cisco UCS FEX 2208 fully cabled, and a maximum of 80Gb/s can be provided to each server with the VIC 1280. For more information about these technologies, refer to Cisco Unified Computing System Adapters and the Cisco UCS 2200 Series Fabric Extenders Data Sheet.

4.2 Network Design Elements

In the FlexPod Select for High-Performance Oracle RAC solution, Cisco Nexus switches are leveraged for client access and to serve data. Data access is achieved through native Fibre Channel (FC) from the storage device and by FCoE from the Cisco UCS hosts. Client access and Oracle RAC cluster interconnect traffic occur over traditional Ethernet.

Specific features of the Cisco Nexus 5548 are leveraged to maximize reliability, performance, and efficiency. Those features are described in detail in this section. For additional information about Cisco Nexus features and benefits, refer to the Cisco Nexus Family website.

Fabric Convergence

As previously mentioned, this design leverages FC-based NetApp storage and FCoE-enabled Cisco UCS with the VICs. This topology requires a switching infrastructure that supports both traditional Ethernet traffic and all types of storage traffic, including the lossless requirements for block-level storage transport over FC or FCoE. The Cisco Unified Fabric, enabled by the Cisco Nexus 5548UP switch, creates high performance, low latency, and highly available networks to serve a diverse set of data center needs.

This FlexPod design supports multiple LAN and SAN protocols, most notably FCoE and FC. The solution provides a 10GbE-enabled fabric that is defined by dedicated FCoE uplinks and dedicated Ethernet uplinks between the Cisco UCS fabric interconnects and the Cisco Nexus switches, as well as native 8 Gbps FC between the NetApp storage devices and the same multipurpose Cisco Nexus platforms.

This design does not employ a dedicated SAN switching environment because the Cisco Nexus 5548UP switch is capable of satisfying FC SAN requirements. The Cisco Nexus 5500 series switches are configured in N_Port ID Virtualization (NPIV) mode to provide storage services for the FCoE-based traffic that traverses its fabric.

Port Channels and Link Control Aggregation Protocol

In terms of fabric resiliency, two technologies that complement each other are link aggregation and link control aggregation protocol (LACP). Port channeling is a link aggregation technique that offers link fault tolerance and traffic distribution (load balancing) for improved aggregate bandwidth across member ports. LACP is an enhanced feature that greatly simplifies link aggregation procedures. LACP works by enabling all ports on both ends of the aggregated link to send and receive LACP data unit (LACPDU) frames. All participating devices use LACPDU frames to communicate and negotiate which ports are allowed to perform as part of the aggregated link. This technology greatly simplifies the link aggregation procedure and minimizes the risk of misconfiguration.

The Cisco port channels and Cisco virtual port channels (vPCs) used in this solution all support and leverage LACP for Ethernet traffic. In addition, the Cisco Nexus 5500 series features vPC capabilities. A vPC allows links that are physically connected to two different Cisco Nexus 5500 series devices to appear as a single logical port channel to a third device, essentially creating device fault tolerance. vPC addresses aggregate bandwidth, link, and device resiliency. Cisco UCS fabric interconnects benefit from the Cisco Nexus vPC abstraction, gaining link and device resiliency as well as full utilization of a nonblocking Ethernet fabric. Ethernet traffic for the Cisco UCS environment is satisfied with two-port Ethernet port channels from the fabric interconnect to the Cisco Nexus switches.

SAN Port Channels

Similar to Ethernet port channels, SAN port channels also provide link aggregation. SAN port channels provide a resilient connection between interswitch links (ISL), which are also represented as E ports on the fabric. SAN port channels increase the available bandwidth on an ISL by spreading the traffic load among all ports in the channel. SAN port channels also provide high availability for the SAN traffic in the environment. All links are active in the SAN port channel, and in the upper layer, protocols are unaware. Bandwidth may be reduced, but the client and storage continue to operate normally.

The Cisco Nexus 5500 series switches support a maximum of four SAN port channels with up to eight interfaces per port channel. This dedicated uplink design leverages FC-capable NetApp EF550 storage arrays. The Cisco UCS fabric interconnects operate in the N-Port Virtualization (NPV) mode, meaning the servers' FC traffic is either manually or automatically pinned to a specific FCoE uplink, in this case, either of the two eight-port FCoE port channels. The use of discrete FCoE SAN port channels with distinct VSANs allows an organization to maintain traditional SAN A/B fabric separation best practices, including separate zone databases.

FC Fabric Considerations

The Cisco Nexus 5500 series switches have robust FC SAN capabilities whether you require native FC or FCoE. FCoE is uplinked from the Cisco UCS environment and the NetApp EF550 storage array provides native FC. A variety of FC SAN features are leveraged to enable communication between the hosts and the storage, including:

- **Virtual storage area network (VSAN).** VSANs are logical partitions of the SAN fabric. This type of environment is configured as fabric A and fabric B.
- **Worldwide node names (WWNN) and worldwide port names (WWPN).** WWNN, representing a node in the SAN fabric and WWPN, representing a specific port of the node, are identified in the fabric with a unique 16-character identifier. Host initiators and storage targets are identified on the FC SAN fabric with WWNNs and WWPNs.
- **Device aliases.** Device aliases can be used to assign naming conventions or labels to WWNNs or WWPNs in the FC SAN fabric. These labels can be used for configuration instead of recording complex WWNNs or WWPNs.
- **Fabric zoning.** Fabric zoning can be used to segment the SAN fabric to restrict access, increase security, and simplify management. Zoning can be employed through physical port-based zoning or zoning based on WWPN. This topology employs zoning based on WWPN with a single-initiator, multiple-target methodology.

4.3 NetApp EF550 Storage Array Elements

RAID Options

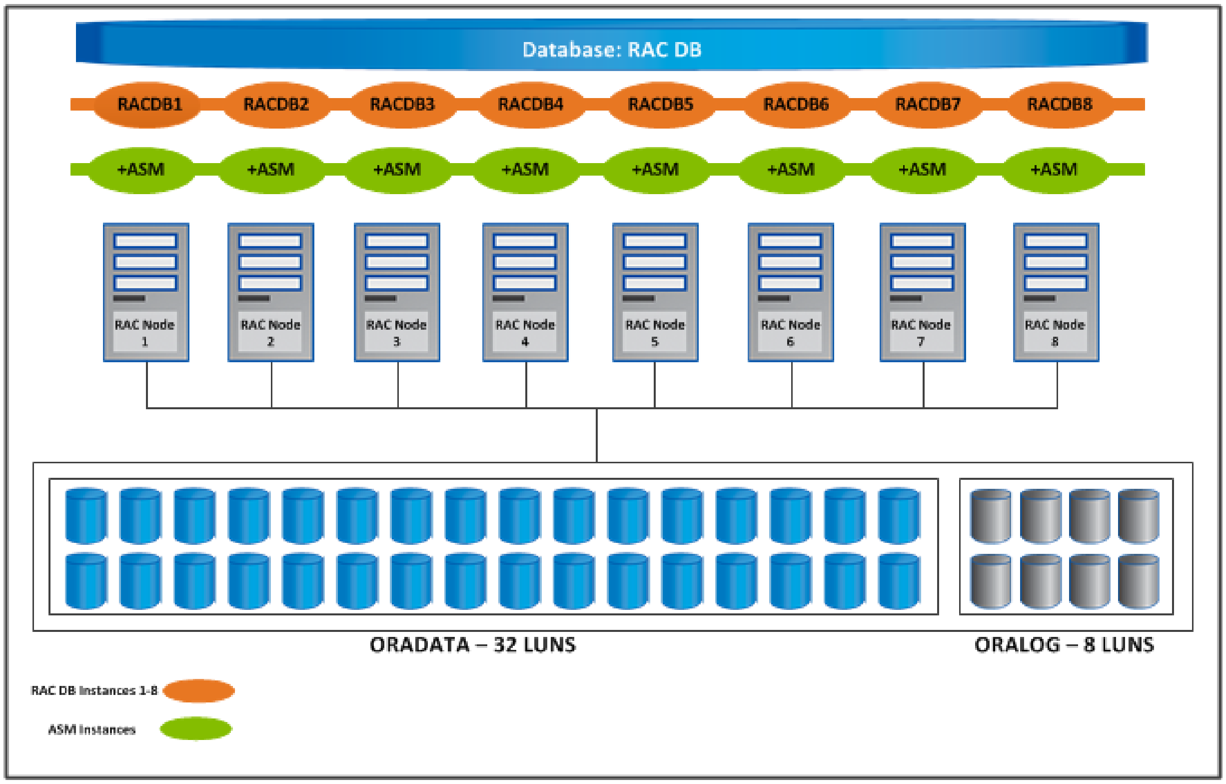
The EF550 flash array storage controllers support traditional RAID levels (0, 1, 5, and 6) as well as Dynamic Disk Pools (DDPs) to provide both flexibility and simplicity for storage administrators. For this solution, RAID 10 was chosen to get the maximum performance out of the storage arrays. Refer to Table 7 for a detailed layout of the storage setup.

Data Layout

Figure 2 illustrates how the Oracle RAC database was configured with the EF550 all-flash arrays for an eight-node RAC database. The `ORADATA` and `ORALOG` LUNs were provisioned on the EF550 all-flash arrays by using SANtricity and were presented to the Oracle RAC nodes. A single ASM disk group was created that spanned all of the LUNs to present a single file system from a database and host perspective. Refer to Table 7 for information about LUN sizes and names.

The result of this configuration was that the workload was evenly distributed across all the storage LUNs and volumes on all arrays. External redundancy was chosen for the ASM disk groups because the NetApp EF-Series already provided protection at the array level. Optionally, customers can choose ASM mirroring to increase data protection, provided the storage arrays are provisioned with enough capacity.

Figure 2) ASM layout for eight-node RAC.



Storage Network Connectivity

To prevent failures that would cause disks to become inaccessible to storage, EF-Series storage arrays contain multiple redundant hardware components. The redundant hardware is also redundantly connected to both network fabrics to make sure that hardware at either the network layer or the storage layer can fail without causing data-traffic disruptions.

Each EF550 storage array comes with two controllers, both of which can access the disks in the array. In this high-availability configuration, if a controller fails, the other controller in the array takes over communication between the disks and servers. Each of these controllers contains an FC host interface card (HIC) that has four ports (eight ports total per array).

To maximize throughput, all eight ports are cabled. In each controller, two ports are connected to SAN fabric A, and two ports are connected to SAN fabric B. Each port can provide a maximum of 16Gb/s of bandwidth, but they will negotiate down to 8Gb/s, which is the maximum throughput of an FC port on a Cisco Nexus 5548UP.

5 Solution Validation

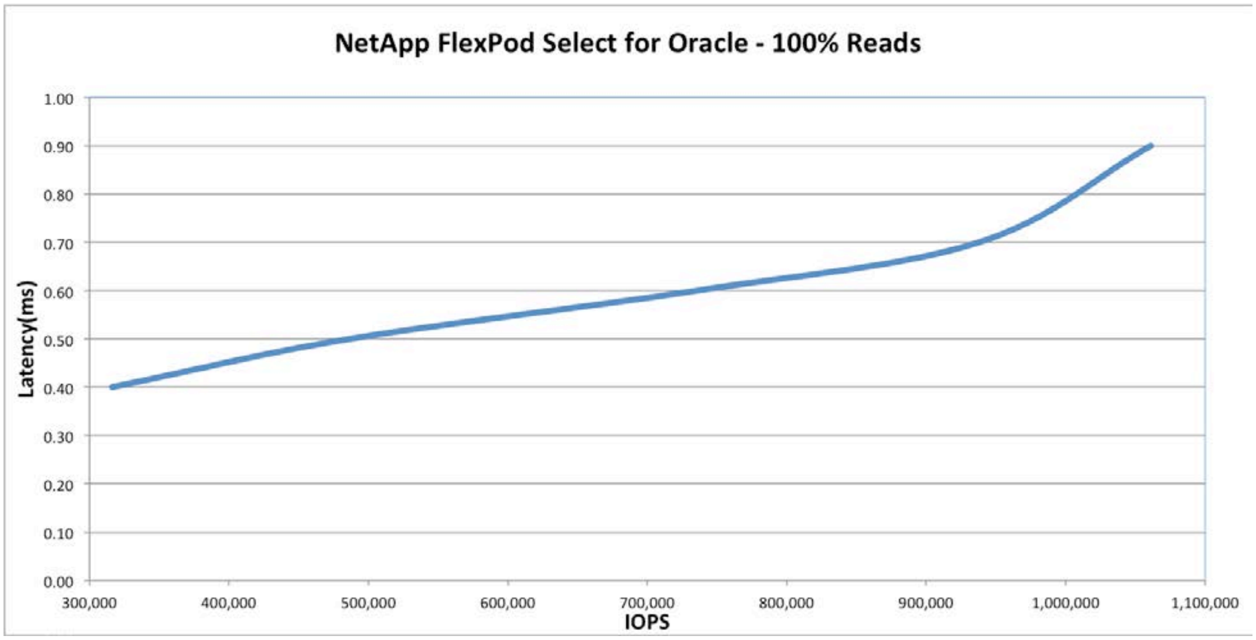
To validate the defined use cases, NetApp configured an eight-node Oracle RAC database test environment accessing a total of four EF550 all-flash-array storage controllers. NetApp then ran performance tests by using a workload generator that generated a series of transactions that delivered different load levels to the Oracle database. The solution's objective was achieved through the validation of the use cases, and the results are available in the "Performance Test Results" section.

5.1 Performance Test Results

For all tests, NetApp used the Silly Little Oracle Benchmark (SLOB2) workload generator to simulate the I/O patterns that are likely to be encountered in actual Oracle production environments. SLOB2 drives different levels of simulated users, each generating the specific I/O patterns described previously in the use-case section. After each test, NetApp recorded the physical database reads and average latency from the Oracle automatic workload repository reported by the Oracle database.

Figure 3 shows the IOPS and average latency observed by the database during testing with 100% random 8K reads. The load on the database was increased incrementally until the IOPS exceeded 1 million while simultaneously observing the application latency under 1 millisecond (ms). The storage arrays are capable of delivering higher levels of IOPS provided the users have a tolerance for higher latency.

Figure 3) FlexPod Select for Oracle with eight RAC nodes showing 100% 8K random reads.



The results of the mixed workload use cases, shown in Table 1, indicate how the solution performed when there were writes on the Oracle database. The workload was also run in incremental loads to generate maximum IOPS by enabling latency to be as close to 1ms as possible.

Table 1) Solution validation results for all use cases.

Use Case	Maximum IOPS	Average Latency
100% reads	1,061,092	0.90
90% reads and 10% updates	797,147	1.10
80% reads and 20% updates	619,680	0.90

6 Technology Requirements

This section describes the technology requirements for the FlexPod Select for High-Performance Oracle RAC solution.

6.1 Hardware Requirements

Figure 4 shows the hardware components associated with this solution.

Figure 4) FlexPod Select for High-Performance Oracle RAC solution architecture.

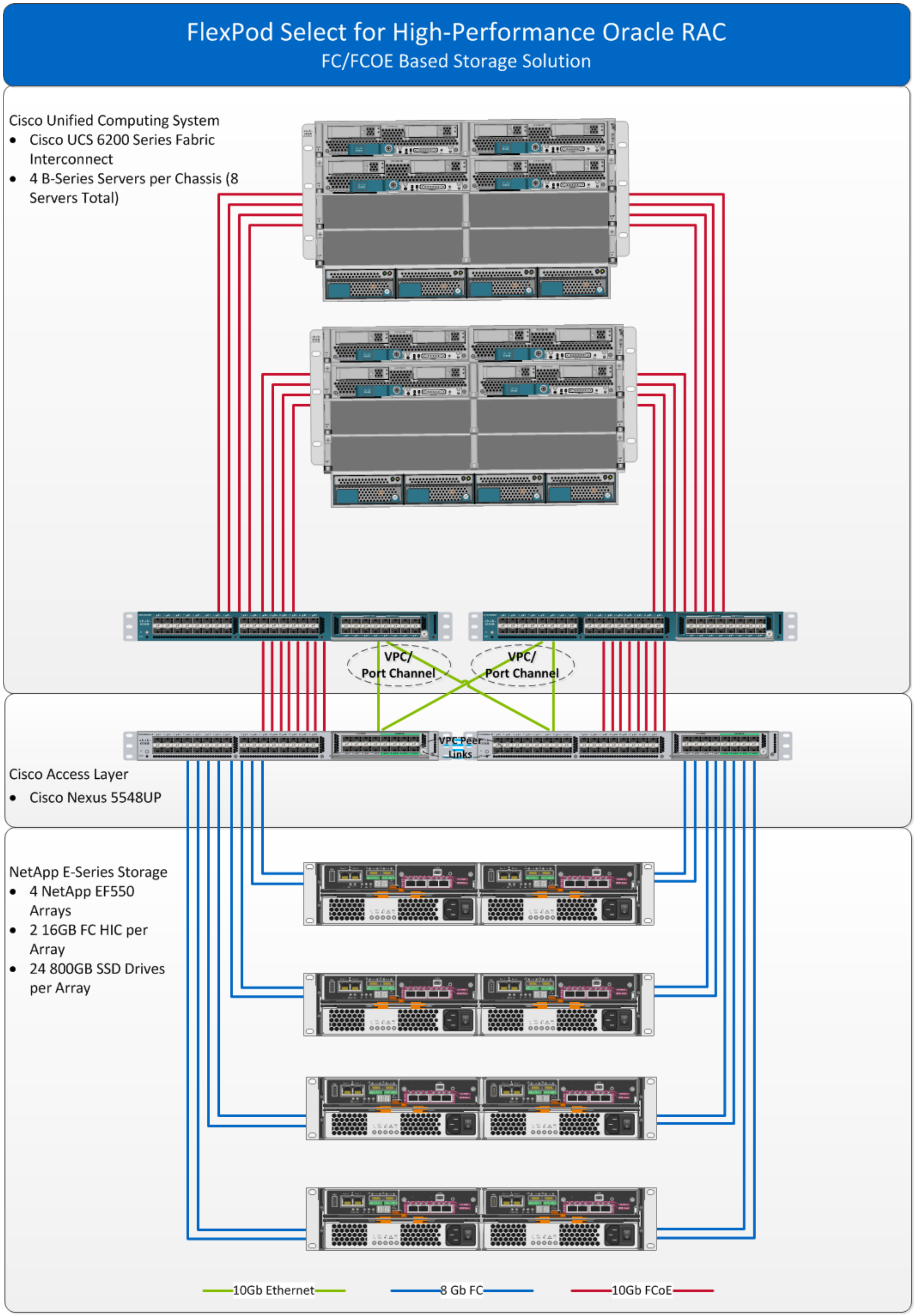


Table 2 lists the hardware components required to implement the solution and to achieve the previously defined performance objectives. The hardware components used in any particular implementation of this solution may vary based on customer requirements.

Table 2) Hardware requirements.

Hardware	Quantity
NetApp EF550 dual controller array	4
NetApp 16Gb Fibre Channel host interface card	8
NetApp 800GB SSD	96
Cisco UCS fabric interconnect 6248	2
Cisco UCS 5108 chassis	2
Cisco B200M3 compute blade with 2 Intel® Xeon® E5-2650 v2 processors and 64GB RAM	8
Cisco UCS 1240 virtual interface card (VIC)	8
Cisco UCS 2204 FEX	4
Cisco Nexus 5548UP switch	2

6.2 Software Requirements

Table 3 lists the software components required to implement the solution. The software components used in any particular implementation of the solution may vary based on customer requirements.

Table 3) Software requirements.

Software	Version
NetApp EF550 firmware version	8.10.11
NetApp SANtricity Storage Manager	11.10.0300.0020
Cisco UCS Manager	2.2(2c)
Cisco UCS firmware bundle	2.2(2c)
Cisco UCS 1240 VIC fnic driver	1.6.0.10b
Cisco UCS 1240 VIC enic driver	2.1.1.66
Cisco Nexus NX-OS	6.0(2)N1(2a)
Red Hat Enterprise Linux® (RHEL)	6.5
Oracle Real Application Clusters (RAC)	11.2.0.4
Silly Little Oracle Benchmark (SLOB) tool	s2

7 Best Practices

As part of the solution validation, some recommendations are used to reach optimal performance. The configuration settings used in this document will not always be appropriate for all customer requirements. Contact NetApp for comprehensive storage system design assistance.

7.1 Storage Recommendations

Table 4 shows the basic tuning parameters and the default settings, as well as some of the settings that were used for this solution from a storage array perspective.

Table 4) Storage tuning parameters.

Name	Context	Default	Available Options	Solution Recommendations
Cache block size	Array	32	4, 8, 16, 32	8K
Automatic cache flushing	Array	80%	0–100	80
Segment size	Volume	128K	32K, 64K, 128K, 256K, 512K	64K or 128K
Read caching	Volume	Enable	Enable/disable	Enable
Dynamic cache read prefetch	Volume	Enable	Enable/disable	Disable
Write cache	Volume	Enable	Enable/disable	Enable
Write cache mirroring	Volume	Enable	Enable/disable	Enable

7.2 Oracle ASM Recommendations

Table 5 shows the basic tuning parameters for the Oracle ASM and database instance.

Table 5) Oracle ASM and instance settings.

Name	Default	Available Options	Solution Recommendations
ASMU AU	1MB	1MB–64MB	64MB
File system I/O options	None	None	Not used
db_file_multiblock_read_count	128	8–128	Default

7.3 Linux Recommendations

Table 6 shows the basic tuning parameters used on the RAC nodes running RHEL.

Table 6) Linux tuning parameters.

Name	Default	Available Options	Solution Recommendations
I/O scheduler	cfq	cfq, anticipatory, deadline, noop	noop

8 Conclusion

The FlexPod Select for High-Performance Oracle RAC solution is designed for applications that are looking for extreme performance and reliability. The architecture is also highly scalable, which allows the customer to select the number of Cisco UCS server blades and EF-Series storage units required for the workload. The NetApp EF550 all-flash storage array is a true enterprise-class storage array designed for applications that expect high IOPS with submillisecond latencies. The fully redundant enterprise-class high-availability feature on the storage controllers provides maximum availability and delivers the required performance for mission-critical applications for which superior performance and low latency are imperative.

Appendix

Table 7 describes the consolidated storage layout for an eight-node Oracle RAC environment.

Table 7) Storage layout for eight-node RAC.

Storage Array	Type	Volume Group RAID 10	Volume/LUN Name	Number of Physical Disks	Allocated Capacity in GB	Total Capacity	Spare Disks	Mapped Host Group Name/Host Name
EF550-1	Redo logs boot LUNs	A1LOGVG	RAC1BOOT	2	100	800GB	2	RAC-A01
			RAC2BOOT		100			RAC-A02
			RAC3BOOT		100			RAC-A03
			RAC4BOOT		100			RAC-A04
			RAC5BOOT		100			RAC-B01
			RAC6BOOT		100			RAC-B02
			RAC7BOOT		100			RAC-B03
			RAC8BOOT		100			RAC-B04
			LOG1		50	100GB		RAC
			LOG2		50			
	Data	A1VG1	DATALUN1	10	500	4TB		
			DATALUN2		500			
			DATALUN3		500			
			DATALUN4		500			
		A1VG2	DATALUN5	10	500			
			DATALUN6		500			
			DATALUN7		500			
			DATALUN8		500			
EF550-2	Redo logs	A2LOGVG	LOG3	2	50	100GB	2	RAC
			LOG4		50			
	Data	A2VG1	DATALUN9	10	500	4TB		
			DATALUN10		500			
			DATALUN11		500			
			DATALUN12		500			
			CRS1		1			
			CRS2		1			

Storage Array	Type	Volume Group RAID 10	Volume/LUN Name	Number of Physical Disks	Allocated Capacity in GB	Total Capacity	Spare Disks	Mapped Host Group Name/Host Name
			CRS3		1			
		A2VG2	DATALUN13	10	500			
			DATALUN14		500			
			DATALUN15		500			
			DATALUN16		500			
EF550-3	Redo logs	A3LOGVG	LOG5	2	50	100GB	2	RAC
			LOG6		50			
	Data	A3VG1	DATALUN17	10	500	4TB		
			DATALUN18		500			
			DATALUN19		500			
			DATALUN20		500			
		A3VG2	DATALUN21	10	500			
			DATALUN22		500			
			DATALUN23		500			
			DATALUN24		500			
EF550-4	Redo logs	A4LOGVG	LOG7	2	50	100G	2	RAC
			LOG8		50			
	Data	A4VG1	DATALUN25	10	500	4TB		
			DATALUN26		500			
			DATALUN27		500			
			DATALUN28		500			
		A4VG2	DATALUN29	10	500			
			DATALUN30		500			
			DATALUN31		500			
			DATALUN32		500			

References

This report references the following documents and resources:

- Cisco UCS Virtual Interface Card Drivers for Linux Installation Guide
- Cisco UCS 2.2(2) Hardware and Software Interoperability Matrix
- Cisco UCS fnic Tunables
- Oracle Database Quick Installation Guide 11g Release 2 (11.2) for Linux x86

- NetApp EF550 Flash Array Installation Guide
- TR-4305: NetApp Extreme Performance Solution for Oracle Database

Version History

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Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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