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Consolidating and Virtualizing Datacenter Networks with Oracle's Network Fabric

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Introduction

The private cloud is fundamentally changing the nature of IT organizations from that of a technology cost center to that of a service provider that supports business goals. This transformation is made possible by the elastic IT infrastructure of the private cloud.

Server, storage and operating system virtualization technologies are already widely deployed within datacenters, and are considered an integral component to drive cost savings and agility. These technologies are now being combined with network virtualization to usher in a new era of cloud computing.

Oracle provides a networking fabric that delivers cloud-ready network services based on Ethernet or InfiniBand fabrics that are tightly integrated with application infrastructure. Oracle's network fabric provides the performance and manageability required for any Oracle application environment or private cloud infrastructure.

Oracle's unique ability to deliver extreme performance and scale by tightly integrating network services across application infrastructure is demonstrated in the Oracle Exalogic Elastic Cloud and the Oracle Exadata Database Machine. These engineered solutions offer up to 5X and 10X performance gains respectively compared to traditional multi-vendor architectures where the offerings are not engineered to work together.

By integrating advanced networking capabilities across the entire hardware and software stack, Oracle's network fabric can help maximize application performance and scale, reduce the number of network components, and simplify datacenter operations through integrated network management and orchestration.

Today's Datacenter Challenges

The discussion of containing IT costs has given way to a larger discussion of the transformation of IT from cost center to profit center. However, years of innovation, expansion, and acquisition have resulted in sprawling infrastructures that stretch the limits of manageability. The sheer scale of the ongoing IT investments required to keep up with business needs has emerged as a dominant concern.

IT executives are turning to cloud computing as a means to help increase efficiency and create a flexible infrastructure that can align with business needs. However, they are still facing challenges that result in the following needs:

- **Reduce cost, time, and risk** – It can easily take weeks or months to plan, architect, configure, and deploy the infrastructure for an enterprise application. It typically requires assembly, integration, test, and validation of many components from multiple different vendors, making the process time-consuming, risky, and costly. A delay in integrating any single component pushes back the entire project and there is always the risk that an integration issue will go undetected until the system is in production.
- **Simplify datacenter infrastructure** – Even when best-of-breed technologies, open standards, market-leading vendors, and modern architectural practices have been employed pervasively, most enterprises now find themselves with too many platforms, too many technologies, too many domains of expertise, and too many vendors to coordinate and manage effectively.
- **Enhance application performance and scalability** – Today's mission critical applications drive corporate revenues and profitability, but they can be a challenge to maintain and operate. Scaling an application's capacity to meet growing business needs can be costly and time-consuming. Businesses need flexible, high-performing application infrastructures that can run applications efficiently and can elastically scale up or down to meet business needs.
- **Illuminate application health and operation** – Deploying an application-optimized infrastructure is only the first step. Maintaining efficient operations requires the ability to look at every point within an application's infrastructure. Blind spots resulting from the need to use several different management platforms can hide potential problems, including performance-robbing bottlenecks. IT teams need a way to quickly verify application health and operation with the ability to drill down and expose the cause of problems. More important still is the ability to pro-actively discover issues that may cause future problems.
- **Further virtualization and consolidation efforts** – To support virtualization and consolidation efforts, networks need to hold up their end of the bargain. Consolidating multiple smaller pipes into bigger pipes is great, but what about outmoded parallel networks running server-to-server, server-to-storage and server-to-LAN communication? Converging these various networks can introduce new complications. Administrators must be able to ensure that each traffic type can be securely partitioned with the guaranteed class of service required to meet application requirements. Network convergence also requires the ability to orchestrate network provisioning across all of the various components of an application's infrastructure.

Oracle's Network Fabric

Oracle's approach to network fabrics is to tightly integrate the fabric with the application infrastructure. This means that hardware and software components throughout the stack are optimized for network throughput and support virtualization of the network fabric (Figure 1). As a single source provider for all of the components of a complete application stack, Oracle is in a unique position to:

- Deliver maximum application performance and scale by removing hardware and software I/O bottlenecks across the entire technology stack.
- Attack network sprawl with network virtualization and convergence that seamlessly integrates into existing datacenter infrastructure.
- Simplify datacenter operations by integrating network management and orchestration into Oracle's application-to-disk management.

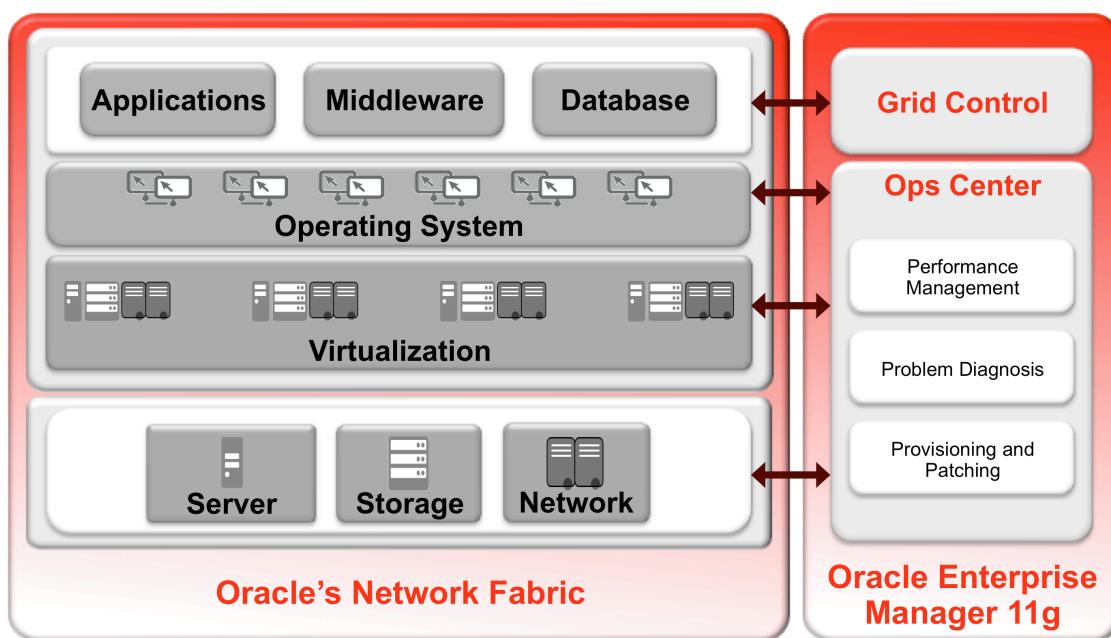


Figure 1. Logical architecture of Oracle's network fabric.

Oracle's network fabric goes beyond typical fabric architectures that focus on network connectivity for servers and storage. In order to realize the promise of a private cloud, the entire hardware and software stack must be engineered to take advantage of the high-performance network fabric. Oracle engineers the components of its network fabric to work together, including tuning and optimizing the entire technology stack to help prevent I/O bottlenecks and ensure maximum application efficiency and mobility.

Another important part of Oracle's network fabric is the management platform that provides operational control from application to disk. Oracle Enterprise Manager 11g helps customers easily

manage the applications, operating systems, and hypervisors running across the servers and storage systems in their IT infrastructure.

Oracle's unique approach to network fabrics not only helps consolidate IT resources, but also enables IT to deliver on-demand services rapidly and efficiently. As organizations virtualize more complex and business-critical workloads, Oracle's complete, integrated technology stack can help deliver operational efficiencies in addition to lowering costs.

Key advantages of Oracle's network fabric include:

- Improves application performance by removing I/O bottlenecks across both hardware and software components.
- Delivers high availability through a network fabric that is 100% redundant.
- Removes CPU overhead involved in processing communication traffic.
- Converges network communications to eliminate outmoded parallel network infrastructures.
- Simplifies management through integration with Oracle Enterprise Manager Ops Center 11g.

Maximizing Performance

Recent innovations in CPUs, memory, storage, and I/O components have all helped drive performance gains through new approaches to deploying applications. When all of these components are engineered to work together, they empower a dramatic improvement in application efficiency, allowing customers to reduce the complexity of their private cloud infrastructure and experience maximum performance with minimum set-up time and operational cost.

The best application performance and scale is achieved when server, storage and network components are deployed in a balanced system that eliminates I/O bottlenecks. Bottlenecks slow down applications making it impractical to deploy applications that require heavy communication between servers or with storage components.

Oracle's network fabric eliminates the need for customers to architect, engineer, and tune a multi-vendor component stack in an attempt to achieve a balanced system. Oracle provides a complete hardware and software stack that has already been optimized to remove I/O bottlenecks and deliver maximum application performance. As shown in Figure 2, Oracle offers customers a wide range of products and technologies that are engineered to work well with Oracle's network fabric.

Integration of Oracle's Network Fabric		
Management	Fabric Management	Oracle Enterprise Manager Ops Center 11g CMM, ILOM, Events, Monitoring, Topology Views
Applications/Middleware/Database	Fabric Performance	Application Performance and Scale RDMA, Stack Bypass, CPU Offload, Zero buffer copies
Virtual Machine	Fabric Virtualization	Oracle VM for x86 and Oracle VM for SPARC Server adapter and network partitioning
Operating System	Fabric Services	Oracle Solaris and Oracle Linux Oracle Solaris network virtualization and resource controls
Servers and Storage	Fabric Interfaces	10GbE CNAs, InfiniBand HCAs FCoE, iSCSI, iSER, SRP, PoIB, RDS, SDP, EoIB
Network	Fabric Hardware	10GbE Switches and InfiniBand Switches and Gateways

Figure 2. Integrated Oracle products span every layer of the application stack.

These product offerings include the following hardware and software capabilities that can be leveraged to optimize application performance:

Hardware:

- High bandwidth fabric built with low communication blocking factors
- Low and predictable latency
- Remote Direct Memory Access capable server cards and network switches
- CPU offload capable server cards

Software:

- Remote Direct Memory Access support in OS and application software
- Parallel I/O architecture support in application software
- CPU offload support in OS
- Bypass network software stack support in OS
- Optimized kernel and network stack in OS

Attacking Infrastructure Sprawl

Many traditional network companies approach datacenter fabrics with mindsets that are driven by their legacy network equipment built with service providers in mind. Their new products are often encumbered with unnecessary feature sets and old architectures. Oracle's network fabric takes a fresh approach, offering network convergence that reduces network complexity while also speeding up

applications and simplifying datacenter management. The use of open, standards-based interfaces also helps increase flexibility and makes it easy to integrate the fabric with a customer's existing datacenter network infrastructure and management tools.

Consolidation of the network infrastructure is accomplished through intelligent engineering that eliminates network tiers, converges parallel-outmoded networks and provides radical reductions in the number of required network components.

As an example of Oracle's fresh approach and intelligent engineering, the Sun Network Quad Data Rate (QDR) InfiniBand Gateway Switch combines Ethernet and InfiniBand connectivity in a single network component that enables IT staff to leverage the application accelerating performance of InfiniBand with the ease of Ethernet connectivity.

Servers connect to both InfiniBand and Ethernet using a single fabric. This results in a 67% reduction in network hardware and enables datacenter administrators to save time by leveraging their existing Ethernet management tools. The reductions in network hardware also deliver savings in datacenter real estate as well as reduced power and cooling costs.

As another example, datacenters can combine the Sun Blade 6000 10GbE Switched Network Express Module 24p and the Sun Network 10GbE Switch 72p top-of-rack switch to deploy a high-performing 10 Gigabit Ethernet fabric that eliminates a tier of networking and provides a 4:1 reduction in cabling.

Oracle's network fabric also provides a high level of fault tolerance with near-instant failover and 100% isolation of applications. This enables enterprises to consolidate numerous mission-critical applications on a single system with extremely low risk.

Simplifying Datacenter Management

Getting the best return on investment (ROI) from purchased hardware and software requires all systems to be running at peak efficiency. This is next to impossible if you need to bounce between several vendors' tools to manage servers, storage, networks, applications, and virtualization. Oracle Enterprise Manager 11g provides a single management platform that spans the entire Oracle stack.

Designed to handle the entire deployment lifecycle, Oracle Enterprise Manager Ops Center 11g is a single platform that helps to bring complexity under control by managing multiple server architectures, and multiple operating systems running on bare hardware or in virtualized environments. This open, extensible system can operate on a massive scale. It can be used to automate workflow, enforce compliance through policy-based management, and manage heterogeneous environments with virtualized and non-virtualized systems — all through a single intuitive interface.

Oracle is the only vendor in the marketplace today with combined management capabilities that span from applications to infrastructure, enabling support for physical and virtual datacenters as well as private cloud computing environments. Now companies can take advantage of Oracle's unique applications-to-disk approach to physical and virtual systems management to administer the full stack and gain application environment efficiency while reducing complexity.

For example, Oracle Enterprise Manager 11g provides a single integrated console that administrators can use to monitor, manage, provision, and patch the entire Oracle software stack—whether it resides

on a physical or virtual system, or is part of the network fabric. Monitoring, management, and life cycle management capabilities for Oracle solutions and a wide variety of third-party technologies are available to help simplify administration across the enterprise. In fact, Oracle Enterprise Manager 11g integrates with many other event management systems and help desk applications to ease datacenter integration and management.

Putting Oracle's Network Fabric to Work

The fact that Oracle can engineer hardware and software together means that customers are required to do far less in setting up the environment to begin running applications. Purpose-built systems such as Oracle Exadata Database Machine and Oracle Exalogic Elastic Cloud are complete systems that are engineered to optimize performance for a specific application while also simplifying deployment and management. Oracle Validated Configurations and optimized solutions are pre-tuned and tested to support demanding enterprise computing environments. All of these offerings greatly reduce the need for onsite configuration of system parameters.

This translates to as much as 95% lower setup time for Oracle customers. Not only does this mean that there is less work to do for setup, it also means that all customers run configurations that have already been tuned and tested by Oracle. A pre-tuned and pre-tested environment substantially reduces the risk of errors, simplifies problem diagnosis, and enables more efficient, lower-cost operation. Total costs can be reduced by as much as 60%.

The sections below describe three key Oracle solutions that take advantage of Oracle's network fabric to deliver maximum performance, reduced network sprawl, and simplified datacenter operations. These systems are engineered and supported together, delivering on Oracle's promise of integration from application to disk.

These integrated systems offer a range of product components, providing the flexibility for IT architects to match the network fabric to their application environment and I/O throughput requirements. Oracle's pre-engineered solutions offer a choice of:

- 10 Gigabit Ethernet or 40 Gigabit InfiniBand networks
- Oracle's Sun x86 or SPARC servers
- Oracle Solaris or Oracle Linux operating systems
- Oracle VM for SPARC or Oracle VM for x86
- A wide range of storage options including Sun Unified Storage systems

Oracle Exadata Database Machine

The Oracle Exadata Database Machine is an easy-to-deploy solution for hosting Oracle Databases with the highest levels of database performance available. Extreme performance is delivered for all types of database applications by leveraging a massively parallel grid architecture using Oracle Database 11g Release 2 with Oracle Real Application Clusters (Oracle RAC), Oracle Exadata Storage Servers, and an

InfiniBand fabric. The system delivers breakthrough performance with linear scalability, is simple to use and manage, and delivers mission-critical availability and reliability.

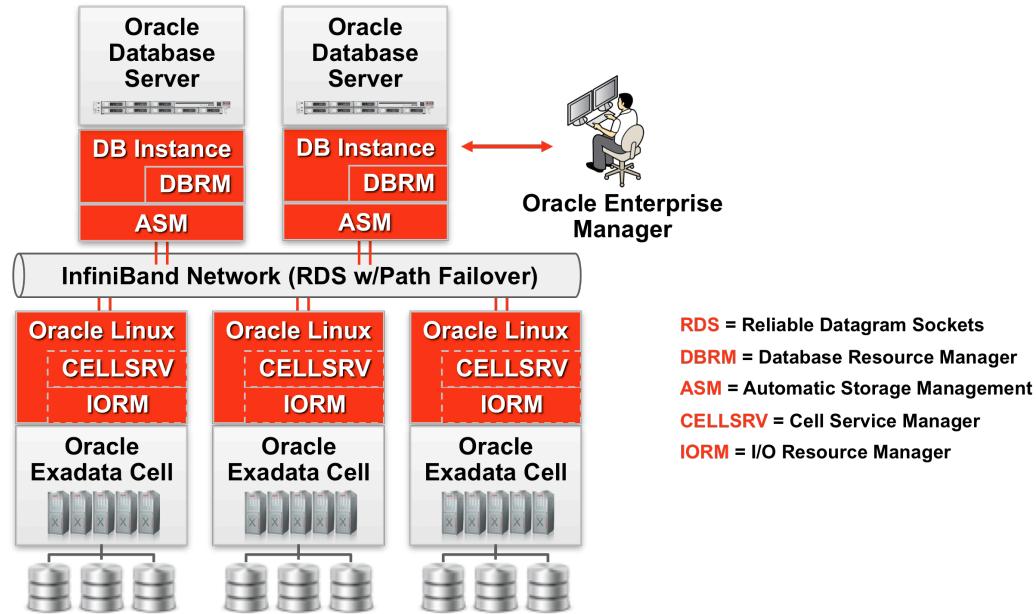


Figure 3. Oracle Exadata Database Machine system architecture.

There are several software enhancements to Oracle Linux, Oracle RAC, and the Oracle Exadata Storage Server software to remove I/O bottlenecks and enable the extreme performance improvement delivered by this engineered system. Oracle Linux Unbreakable Enterprise Kernel has been optimized to speed up InfiniBand messaging by 200%. Oracle RAC and the communication between Oracle Database servers and Oracle Exadata Storage Servers have been enabled with the ability to eliminate buffer copies, offload the CPU, and use Remote Direct Memory Access (RDMA). The improvements to Oracle RAC alone have led to 63% greater application transactions per second.

While an Oracle Exadata Database Machine is an extremely powerful system, a building block approach utilizing Oracle's network fabric allows Oracle Exadata Database Machines to scale to almost any size as illustrated in Figure 4. Multiple Full Rack and Half Rack systems can be connected using the InfiniBand fabric in the system to form a larger single system image configuration. The InfiniBand infrastructure (switches and port cabling) is designed to provide this growth option.

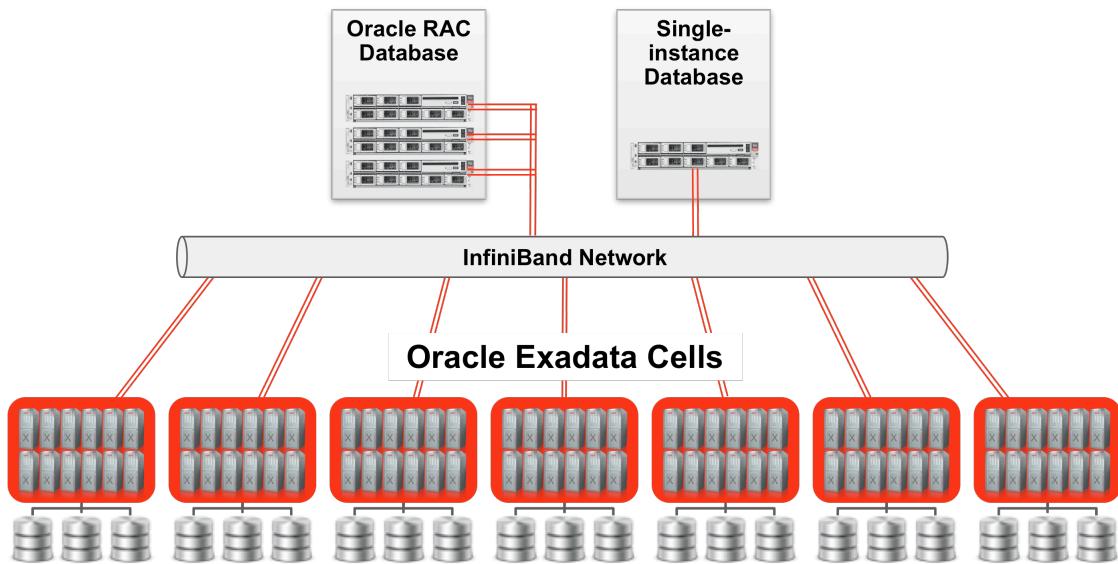


Figure 4 Oracle Exadata Database Machine with Oracle's network fabric

Oracle Exalogic Elastic Cloud

Oracle Exalogic Elastic Cloud is the world's first engineered system specifically designed to provide enterprises with a foundation for a secure, mission-critical private cloud infrastructure. Oracle Exalogic is capable of virtually unlimited scale, unbeatable performance, and previously unimagined management simplicity. By engineering the software, servers, storage, and networking components in Oracle Exalogic to perform well together, Oracle is able to deliver a 12X improvement in Internet application performance and a 4.5X improvement for Java applications.

Oracle Exalogic consists of hot-swappable compute nodes, a storage subsystem, and a high-bandwidth InfiniBand fabric. The fabric is engineered to connect individual components within an Oracle Exalogic system and uses 10 Gigabit Ethernet connectivity for easy integration into the datacenter. All Oracle Exalogic configurations are fully redundant at every level and are designed with no single point of failure. The system also provides the ability to easily scale out by adding additional Oracle Exadata cells.

InfiniBand technology in Oracle's network fabric is fundamental to the Oracle Exalogic Elastic Cloud. In addition to providing an extremely fast, high-throughput interconnect between all of the hardware units within a deployment, it also provides extreme scale, application isolation, and elasticity. Traditional approaches to growing a datacenter's compute capacity involve either vertically scaling individual computers or networking together many individual computers using common technologies such as Ethernet. By contrast, the lossless switched InfiniBand I/O fabric on which Oracle Exalogic is based connects all configurations together essentially forming a single large computer.

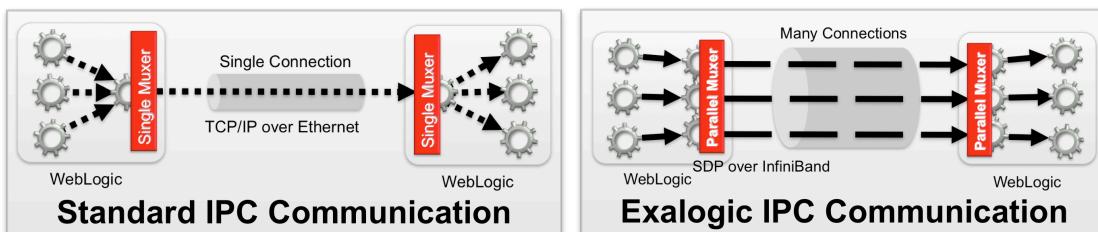


Figure 5. Oracle Exalogic Elastic Cloud architecture.

Oracle Exalogic Elastic Cloud includes software optimizations to improve an applications ability to take advantage of the InfiniBand fabric including the development of a new architecture for parallel I/O and the use of large message sizes, CPU offloading and the elimination of buffer copies. These software enhancements to the application and operating system result in 60% higher workloads and half the latency.

Oracle Exalogic systems scale horizontally, meaning that there is no degradation of system performance as the size of the cloud increases. It is possible to connect as many as eight full racks of Oracle Exalogic hardware (or any combination of Oracle Exalogic and Oracle Exadata configurations) together without the need for any external switches. In cases where more than eight racks of Oracle Exalogic or Oracle Exadata hardware are required, Oracle offers a choice of several high-capacity datacenter switches that allow the creation of Oracle Exalogic clouds comprising hundreds of racks and tens of thousands of processors.

Equally importantly, an Oracle Exalogic cloud is a resource pool that can be dynamically sub-divided into secure units of capacity. This capability is delivered by InfiniBand technology, which can be used to create partitions. Communication between end-points on the I/O fabric can then be strictly controlled through hardware, ensuring that applications have guaranteed access to shared resources.

Oracle VM Blade Cluster Reference Configuration

Another example how Oracle is integrating and optimizing critical IT infrastructure and leveraging a private cloud fabric is the Oracle VM Blade Cluster Reference Configuration. The Oracle VM Blade Cluster Reference Configuration makes use of pre-configured virtual machines based on Oracle VM Templates, enabling quick and easy deployment of the fully configured hardware and software stack. The templates include pre-installed versions of Oracle Linux and Oracle Solaris as well as Oracle VM Server and Oracle VM Manager. The entire virtualized infrastructure can be up and running in hours as opposed to weeks.

As shown in Figure 6, the network fabric for this reference configuration is based on 10 Gigabit Ethernet. The Sun Blade 6000 Modular System is equipped with a redundant pair of Oracle's Sun Blade 6000 Ethernet Switched NEM 24p 10GbE switches. Each switch is dedicated to one head of the Sun ZFS Storage Appliance cluster, providing connectivity between the storage appliance and all blade servers in the Sun Blade 6000 Modular System chassis. This approach leverages the bandwidth of 10 Gigabit Ethernet while ensuring no single points of failure and also reduces complexity by eliminating the need for an external network switch.

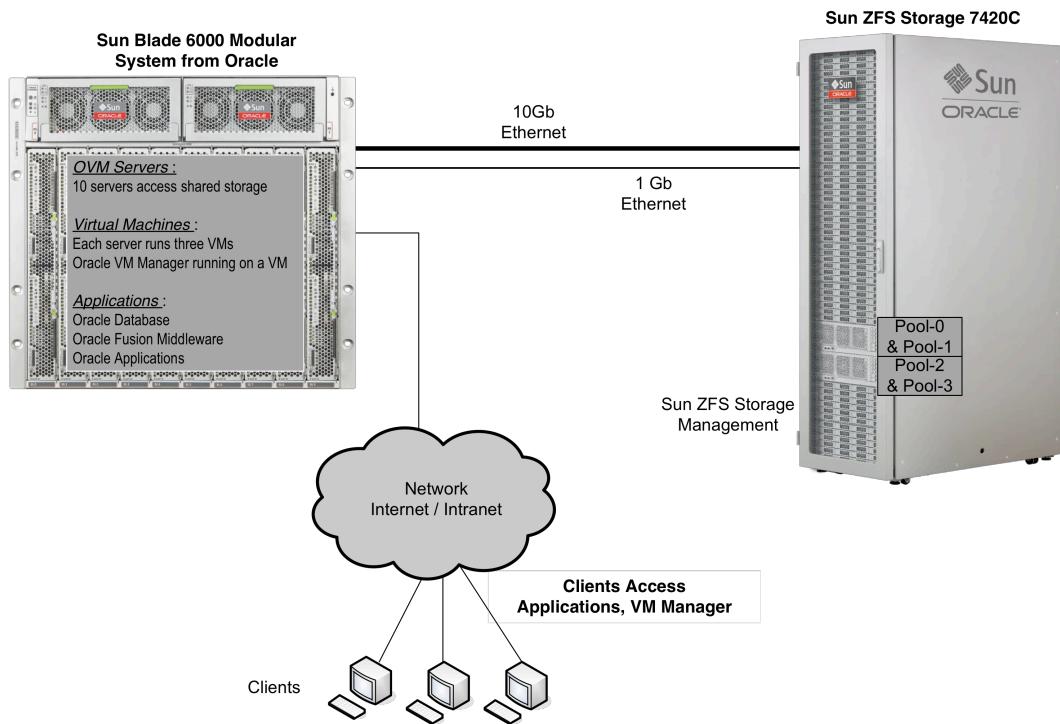


Figure 6. Oracle VM Blade Cluster Reference Configuration

Conclusion

Oracle's ability to deliver a converged infrastructure of compute, storage and network components in a private cloud enables customers to achieve extreme performance and scalability while reducing network sprawl. Its dynamic network capabilities combined with a single management platform provide the agility and efficiency required for today's fast-changing business environments.

In addition, Oracle's approach also helps reduce IT costs. Figure 4 illustrates some of the potential cost savings that can be achieved using Oracle's network fabric. By moving away from traditional datacenter network architectures that require many tiers of networking and parallel networks to support server-to-server, server-to-storage and server-to-LAN traffic, customers can experience substantial reductions in infrastructure complexity. This can result in business benefits such as:

- Reduced acquisition costs
- Lower power and cooling costs
- Reduced management costs
- Faster deployment
- Greater agility in meeting changing business needs

	Traditional Infrastructure	ORACLE®	
Acquisition Cost 	\$337k	\$203k	40% Less
Power Cost 	\$1,638/year	\$864/year	47% Less
Network Sprawl 	368 Network Elements	106 Network Elements	71% Less
Management Tools 	3 Tools	1 Tool	2/3 Less
Performance 	18.4 Gb/S	32 Gb/S	74% More Performance

Figure 7 Savings with Oracle's network fabric

For More Information

For more information about Oracle technologies related to Oracle's network fabric, visit oracle.com, or call +1.800.ORACLE1 to speak to an Oracle representative. The tables below provide Web resources for additional product information as well as related white papers.

TABLE 1. WEB RESOURCES FOR FURTHER INFORMATION

WEB RESOURCE DESCRIPTION	WEB RESOURCE URL
Sun Networking	http://www.oracle.com/goto/networking
Oracle Exadata Database Machine	http://www.oracle.com/us/products/database/database-machine/index.html
Oracle Exalogic Elastic Cloud	http://www.oracle.com/us/products/middleware/exalogic/index.html
Oracle Enterprise Manager	http://www.oracle.com/us/products/enterprise-manager/
Oracle Enterprise Manager Ops Center	http://www.oracle.com/us/products/enterprise-manager/opscenter/
Oracle Real Application Clusters (RAC) with Oracle Database 11g Enterprise Edition	http://www.oracle.com/us/products/database/options/real-application-clusters/index.html
Oracle Solaris	http://oracle.com/solaris
Oracle Linux	http://oracle.com/linux
Oracle VM Templates	http://www.oracle.com/technetwork/server-storage/vm/templates-101937.html
Oracle Virtualization	http://oracle.com/virtualization
Sun Blade Systems	http://www.oracle.com/goto/blades
Sun Storage	http://www.oracle.com/storage
Sun ZFS Storage Appliances	http://www.oracle.com/us/products/servers-storage/storage/unified-storage/
Oracle Premier Support for Systems	http://www.oracle.com/us/support/systems/premier/

TABLE 2. RELATED WHITE PAPERS

WHITE PAPER TITLE	WEB URL
<u>Sun Datacenter InfiniBand Switch 36, Sun Datacenter InfiniBand Switch 72, Sun Datacenter InfiniBand Switch 648: Architecture and Deployment</u>	http://www.oracle.com/us/sun/sun-datacenter-ib-switches-arch-wp-071733.pdf
<u>Oracle Solaris Networking</u>	http://www.oracle.com/technetwork/articles/servers-storage-admin/solaris11enetwork-186212.pdf
<u>Oracle Solaris 10 Networking</u>	http://www.oracle.com/us/products/servers-storage/solaris/solaris-networking-ds-067319.pdf
<u>Oracle Exadata Storage Server and Database Machine</u>	http://www.oracle.com/technetwork/database/exadata/exadata-technical-whitepaper-134575.pdf?ssSourceSiteId=ocomen
<u>Oracle Exalogic Elastic Cloud: A Brief Introduction</u>	http://www.oracle.com/us/products/middleware/exalogic-wp-173449.pdf



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