

Oracle RAC Migration Guide from RISC/UNIX to the Cisco Unified Computing System - Rationale and Case Studies

White Paper

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What You Will Learn

A massive shift is underway in the underlying computing architecture and platforms used to run enterprise applications. Traditional RISC/UNIX server platforms have not kept pace with current demands for faster application deployments, flexible and simpler provisioning, and cost-effective licensing, support, and management. The industry has moved on, as the diminished value of RISC/UNIX systems has been widely acknowledged. The Cisco Unified Computing System™ (Cisco UCS™) provides innovative architectural advantages that simplify and accelerate deployment of enterprise-class applications running in bare metal, virtualized, and cloud computing environments. Cisco UCS offers an alternative server architecture to RISC/UNIX, based on the lower-cost, high-performance x86 processor. This document discusses the factors that contribute to the lower total cost of ownership (TCO) of Cisco UCS and the platform's unique features and product components. The document also includes two case studies that demonstrate the migration to Cisco UCS from traditional server environments by two of the largest IT environments in the world, hosting large, mission-critical applications: EMC IT and Cisco IT.

Overview

Just as the microprocessor has become smaller, more powerful, and more cost effective over time - boosting the capabilities and performance of the devices and applications it enables - the server environment that runs business and infrastructure applications has moved to a new state of the art. Since the mainframes in the 1960s and 1970s and the minicomputers and client-server architectures in the 1980s, the server design of choice for both general and mission-critical application workloads from the mid 1990s to the early years of the twenty-first century has been based on reduced instruction set computer (RISC) processor architectures, mostly running UNIX operating systems.

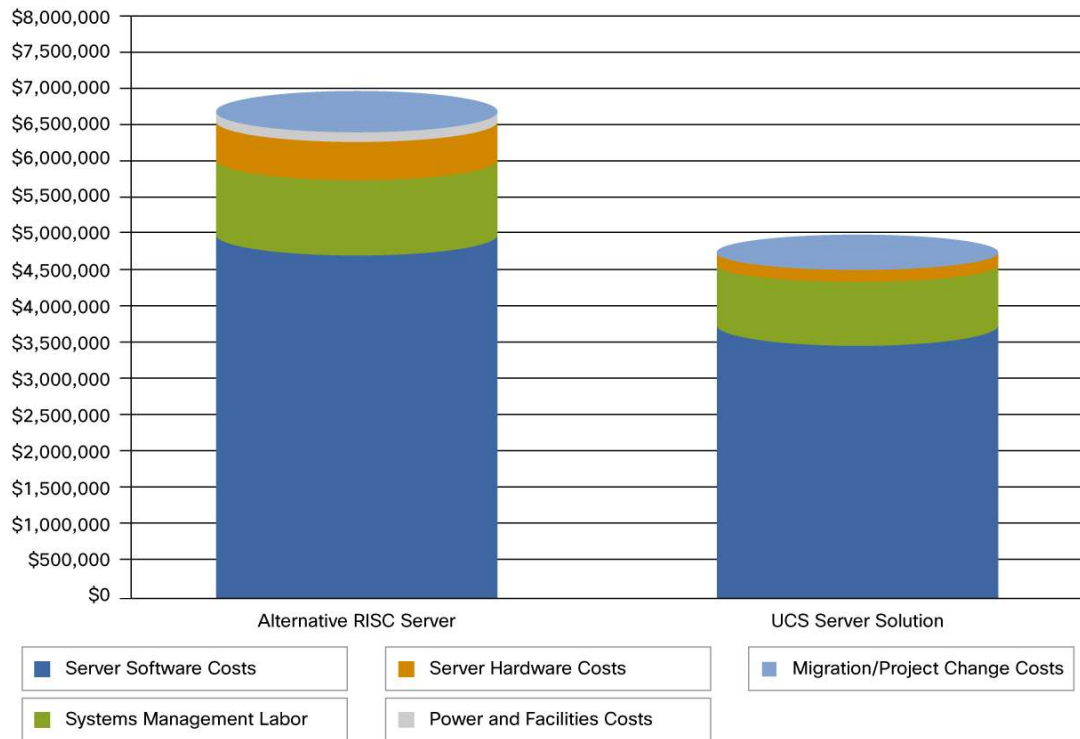
These server platforms have been tremendously successful, providing reliability, availability, scalability, and many other features required of the most demanding computing environments. But now a new generation of servers, based on the x86 processor architecture and open standards operating systems such as Linux, have caught up with RISC/UNIX server platforms. Within this new generation, Cisco Unified Computing System is a highly unique x86-based server architecture and product line that many large customers have found offers features and efficiencies that meet enterprise-class levels of reliability, availability, and serviceability (RAS) while providing faster, simpler, more agile application deployment.

Cisco UCS is proving itself in some of the largest, most demanding application environments in the world. It is becoming a ubiquitous platform as part of solutions from Oracle, SAP, BMC Software, Citrix, EMC, Microsoft, NetApp, Red Hat, and VMware. In addition, it is positioned to coexist with RISC infrastructure, to host traditional UNIX applications, and to serve as a versatile and dynamic solution for cloud computing and data center consolidation. Less than two years since its introduction, Cisco UCS has 10 percent of the global x86 market and 20 percent of the U.S. market, according to IDC. More than 42 technology partners have integrated their management platforms with Cisco UCS APIs.

Changing Server Economics and Market Share

One of the reasons behind the mass migration now underway to the x86 server architecture is the greatly reduced TCO of x86 systems (Figure 1) in comparison to the high acquisition, maintenance, environmental, and licensing costs of RISC/UNIX systems. RISC/UNIX systems have a larger footprint, increasing space requirements, and higher power and cooling costs, all also components of TCO.

Figure 1. TCO Comparison of x86 Server Blade and RISC/UNIX Tower Server



Source: Cisco

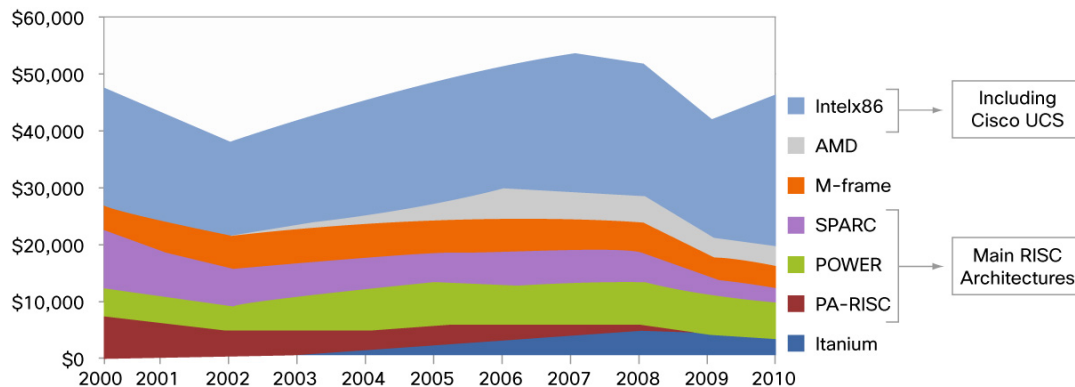
Additional factors behind the move from RISC/UNIX to x86 servers include:

- Savings in operating costs: Maintenance of traditional RISC/UNIX systems requires costly staff and training for new hires, many of whom come out of school having worked on and studied x86-based server architectures. Virtualization has increased geometrically the number of logical servers being managed, and this has contributed to soaring costs for server management and administrative labor. Although virtualization can eliminate the need for many new servers, it aggravates the management problem in a traditional environment.
- Unclear future for RISC: RISC systems have an unclear future because of the move to x86. Fewer applications are being developed for RISC systems due to a declining software ecosystem, and existing applications have longer lead times for updates and new capabilities along with premium prices due to a declining skill base.
- Demand for increased processing power: Mission-critical workloads are increasing, and traditional RISC/UNIX systems are difficult and expensive to scale.
- Complexity of traditional systems: RISC/UNIX systems have many distinct components that must be integrated and many different points of system management, resulting in a high degree of complexity that is compounded with new applications, enhancements, and scaling.

- Shift from scale up to scale out: Mission-critical workloads are now being redesigned to scale out across multiple smaller servers, rather than scaling up monolithically through the addition of RISC/UNIX server clusters. This scale-out design enables much greater flexibility in application workload distribution and a higher utilization rate for server resources. The main factors influencing this trend include virtualization, cloud technologies, and server clustering.

It is therefore no surprise that deployment of servers based on RISC/UNIX architectures has dramatically declined while deployment of x86-based products has grown (Figure 2).

Figure 2. Server Revenue by CPU Architecture



Source: IDC Q4 2010 Server Tracker

Amid mixed signs of a global economic recovery, IDC charted the growth of the server market and found that x86 server sales were up 17 percent in 2010 while RISC server sales declined by 18 percent. Customers running Oracle applications on RISC-based SPARC servers with the Sun Solaris operating system have become wary about an uncertain roadmap since Oracle purchased Sun and has announced long release schedules for upgrades and a newer Linux offering for hosting Oracle applications.

New Demands on Data Center Architectures

Product vendors have long been familiar with just-in-time manufacturing and time-to-market as measures of efficiency. Now application services - which enable new business capabilities to support strategic initiatives and are deployed in response to competitive challenges - are being similarly measured. IT departments are looking at the relative agility of their computing environments: the capability to quickly deploy, modify, and scale applications. What they see are rigid, inflexible traditional computing environments that have not kept pace with demands for speed, capacity, and scale.

Today's traditional and still predominant data center architecture contains separate, individual computing, networking, and storage components. Provisioning, integration, and modification of applications are generally handled manually. These time-consuming tasks reduce the amount of time administrators have to devote to other initiatives. A Forrester study in 2008 found that more than 70 percent of IT budgets is devoted simply to maintaining and managing existing infrastructure, and this problem may have become even worse since then.

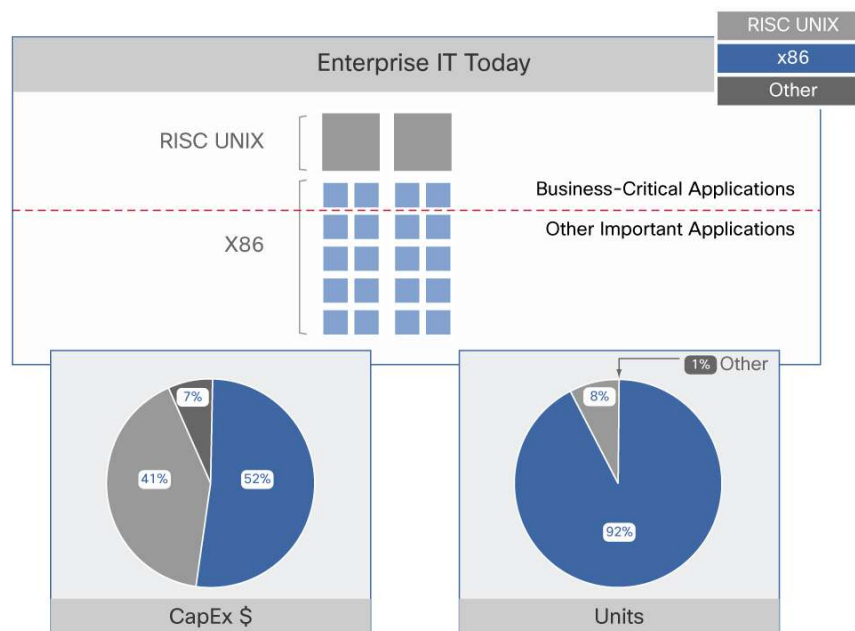
Many data centers have focused on consolidating their physical servers using virtualization to improve server utilization. But virtualization of traditional server and storage hardware has added new complexity and challenges when used with old infrastructure, including:

- **Overwhelmed RISC/UNIX server capacities:** RISC/UNIX and other older servers based on traditional processor technologies cannot achieve the desired workload scalability, are typically memory and I/O constrained, and use excessive power. The resulting capital expenditures (CapEx) and operating expenses (OpEx) required to maintain an aging server farm can quickly grow out of control. Many environments are facing server hardware and software that is approaching the end of its life.
- **Reduced cost effectiveness:** RISC/UNIX acquisition and maintenance costs have become an increasingly significant component of IT costs. Not only are these platforms expensive to purchase, but maintenance costs are high and per-core software licensing puts RISC/UNIX systems at a disadvantage.
- **Inability to meet needs for performance and flexibility:** Businesses are faced with increasing amounts of data to process and growing numbers of users wanting access to the data. The demands for additional performance are frequent and unpredictable. Today's aging and proprietary RISC/UNIX infrastructure does not provide the performance or the flexibility required to support rapidly changing business requirements, and the cost to provide additional performance is high. With data centers moving to cloud computing, the need for standard, nonproprietary platforms and solutions is even greater.
- **An uncertain future:** The installed base of RISC/UNIX systems in many organizations is ready to be replaced or refreshed, prompting either wholesale upgrades or migrations to better platforms. Historically, the RISC/UNIX platform was the best option for mission-critical applications. Today, however, RISC/UNIX servers may no longer be the only option. Since 2006, the RISC/UNIX market has declined by 46 percent, according to the IDC Q4 2010 Server Tracker study. Processor roadmaps have been changed, delaying the release of newer, faster capabilities. For example, SPARC processor release dates have been missed. In addition, with the acquisition of Sun by Oracle, SPARC customers must weigh the risk that Oracle's focus on appliances may increase the risk of vendor lock-in.
- **High costs of technology silos:** Current infrastructures contain separate silos of computing, networking, and storage technologies. Deployment of virtualization in this infrastructure can lead to incremental increases in CapEx and OpEx because each silo must be addressed separately.
- **Complexity of server management:** Every traditional rack-mount or blade server and chassis constitutes a separate point of management, with its own unique identity and I/O configuration that is tied to the hardware. This complexity limits the capability to respond quickly to workload changes. Server, blade, switch, and chassis firmware updating is a manual and time-consuming process.
- **Network complexity and fragmentation:** The network access layer has fragmented into multiple levels, including access-layer switches, switches integrated into blade chassis, and software switches required by virtualization software. Each switch has its own unique set of features and limitations that add new layers of management and management domains to an already complex environment.
- **Virtual server sprawl:** The ease of deploying virtual machines has resulted in a significant increase in virtual machine populations. These virtual machines create a new set of management challenges. The increasing number of components in data center environments has evoked a proliferation of management tools, making network policy difficult to track and to enforce. This sprawl increases the difficulty of ensuring that server, storage, and network resources adhere to the same standards as the servers and operating systems in traditional architectures.

- Higher SAN costs: Shared storage is a requirement for many of virtualization's most valuable features, such as dynamic virtual machine movement and high availability. Providing access to a Small Computer System Interface over IP (iSCSI) or Fibre Channel SAN for every server in a rack dramatically increases the number, costs, and administration of cables, adapters, and upstream switch ports.
- Growing power and cooling costs: The growth of in the number of physical servers, coupled with dramatically increasing demand, has increased power and cooling costs and effects on the environment. IT departments are looking for the highest performance with the lowest energy requirements in new computing solutions, as green initiatives and regulations proliferate throughout the world. Improved space and power utilization can postpone or prevent expensive new data center build-outs.

IT departments are already beginning to migrate infrastructure applications (file server, mail server, print server, etc.) to x86 server architectures to take advantage of their expanded features, higher performance, and better cost efficiency (Figure 3).

Figure 3. Server Distribution by Application Type



Source: IDC, 2008

The next step is the migration of large, business-critical applications. These applications include software solutions from such vendors as Oracle, SAP, and IBM that may rely on middleware components, along with custom applications for specific industries and the newest application architectures for access using the network cloud.

Case Study: EMC IT Migrates from RISC/UNIX to the Cisco Unified Computing System

Between 2009 and 2010, the IT department of global storage vendor EMC migrated its Oracle 11i E-Business Suite customer relationship management (CRM) solution from Sun Enterprise 25000 servers based on Scalable Processor Architecture (SPARC) - a RISC variety - running the Oracle Solaris (a UNIX variety) operating system to Cisco UCS based on x86 and Linux. The migration included deployment of Oracle Real Application Clusters (RAC) to create a database grid that could scale horizontally with the addition of more Oracle RAC nodes.

The goal of the migration was to move to a more open computing platform that would enable EMC to:

- More easily deploy applications on a private cloud
- Take advantage of CapEx and OpEx savings from reduced software and hardware maintenance, software licenses, general support, and environmental costs in the data center
- Transition from Sun SPARC platforms that were approaching the end of life

After evaluating several options for a next-generation computing platform, EMC decided to move to a new platform using Cisco UCS. EMC chose the Cisco® system because of Cisco, EMC, and VMware's mutual commitment to virtualization and Vblock™ Infrastructure Packages. Choosing a new platform was only the beginning. Migration from SPARC to Cisco UCS was going to be a complex effort. An aggressive timeline also made a smooth cutover to the new platform, with no impact on EMC's business, critical.

The EMC CRM system supports 40,000 users worldwide, with up to 4000 concurrent users during peak periods. The implementation is one of the top four Oracle transactional applications deployments in the world in terms of scale and volume.

Prior to the migration, EMC IT completed three preliminary projects to prepare their CRM infrastructure:

- Virtualization of the EMC CRM middle-tier infrastructure: Servers were transitioned from 71 physical servers to 80 virtual machines on eight VMware ESX servers.
- Virtualization of Oracle E-Business Suite implementation: The Oracle E-Business Suite Release 12 (R12) applications stack was virtualized using VMware on x86 infrastructure running Linux.
- Migration from traditional business intelligence and data warehouse applications: The applications were moved from a traditional Fujitsu platform running Solaris to an open platform running x86 and Linux on Cisco UCS with an expandable infrastructure. The infrastructure is based on a consolidated physical Oracle RAC and Business Intelligence grid that supports EMC's virtualized business intelligence toolset reporting architecture based on VMware, Oracle Business Intelligence Enterprise Edition (OBIEE), and Oracle Business Intelligence Publisher (BIP).

Those initial projects gave EMC IT a deeper understanding of critical considerations for the migration, including details related to the people, processes, and technologies required for migration to an open, scalable platform.

In autumn 2010, the Cisco Advanced Services Unified Computing Architecture team engaged with EMC IT to assist with the migration. The architecture used a standard Cisco UCS configuration with little or no customization, a high-availability design with no single point of failure within the data center, and a maximum I/O throughput of 80 Gbps per chassis for the fabric interconnect and external fabric. Fabric extender and fabric interconnect cabling was increased for oversubscription to 80 Gbps, and Fibre Channel capabilities were expanded with a six-port expansion module. As a foundation for a cloud architecture, the design provided the flexibility to add or remove Cisco UCS computing and I/O fabric components, both external and interconnected.

Deployment and Testing of Oracle RAC Database Servers

Oracle RAC allows database management systems to be scaled incrementally, using lower-cost two-socket servers instead of more expensive four-socket servers. This approach allows data warehouses to scale as the business grows, starting small and growing as needs dictate.

The capability to easily, efficiently, quickly, and cost effectively scale a data warehouse is crucial for businesses that depend on database applications. Scalability is achieved by adding units of computing power and hopefully achieving a commensurate improvement in capacity. With traditional symmetric multiprocessors, however, as the infrastructure scales, the performance and capacity per incremental resource declines. This decline occurs because of the increased overhead of communications and data transfer between the different data warehouse elements and the increased latency (for example, when multiple, simultaneous queries to a database are processed), resulting in lack of access for some users for periods of time.

Server provisioning is another challenge that can hinder easy, fast, efficient data warehouse scalability. As each server is added, it must be individually configured, a cumbersome and time-consuming process. The server's operating system and firmware on the network card, Fibre Channel host bus adapters (HBAs), BIOS, and other elements must be loaded. In addition, the network connection must be manually configured.

Cisco UCS provides a better, faster, more cost-efficient and scalable server architecture for Oracle data warehouses because it unites networking, computing, and virtualization resources into a cohesive system that simplifies setup, improves business metrics, and enables just-in-time resource provisioning. Six x86-based Cisco UCS B440 M1 High-Performance Blade Servers were deployed and configured using Oracle RAC to protect against physical node failure during the migration, with four ultimately used in the environment. The Oracle cluster is designed to function with more or fewer than six blades, but in the event of an extended blade outage or the need for additional short-term computing power, a failed Cisco UCS server profile can be used to configure an additional blade from the pool.

The six-server chassis is spread across three cabinets, with each cabinet having redundant power feeds. Each Cisco UCS B440 blade server has dual converged network adapter (CNA) cards, each presenting multiple network interface card (NIC) and Fibre Channel over Ethernet (FCoE) devices. The public and interconnected NICs are further protected with the N+1 interfaces on each server and are configured with Linux bonding.

Access to the storage devices is also protected using N+1 Fibre Channel interfaces on each server, and these are configured with EMC PowerPath to protect against a CNA card or port failure. Each server boots from mirrored SAN devices.

The major benefits of Cisco UCS for EMC include:

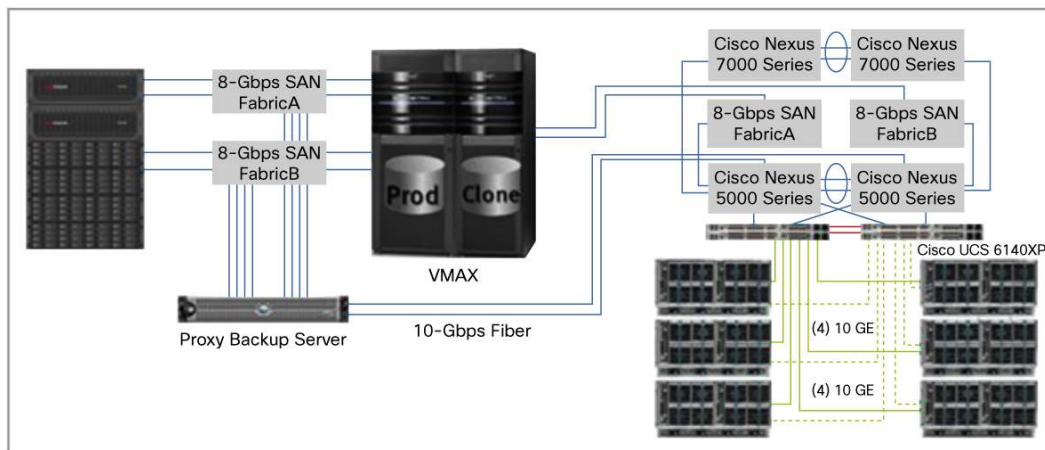
- Lower CapEx: No additional power cables, connectivity wiring, patch panels, Ethernet ports, power supplies, or physical rack space are needed.
- Lower OpEx: Electricity consumption is lower, hardware support contracts are less expensive, and no onsite repair or installation visits are needed.
- Lower energy consumption: A typical Cisco UCS server blade draws 300 fewer watts of power than a typical, RISC/UNIX tower server.
- No additional hardware support contracts: The hardware support services for the networking devices typically cover hardware support for the Cisco UCS server as well.
- Fewer onsite visits: Upgrading or replacing a Cisco UCS server is a simple "plug-and-play" process that does not require a senior administrator or specialized skills. A costly onsite visit is replaced by a shipping cost.
- Enhanced platform for future growth: High-performance, high-capacity, general-purpose Cisco UCS servers allow customers to scale with changing business needs.

- Improved use of hardware: Some Cisco UCS x86 server blades can be used as alternatives to rack or tower servers and as platforms for deploying branch-office networking applications. If business requirements change, these servers can quickly be repurposed without costly onsite visits.

The new environment, shown in Figure 4, from right to left, includes:

- Six Cisco UCS 5108 Blade Server Chassis fully configured with Cisco UCS 2104XP Fabric Extenders.
- Fourteen Cisco UCS B200 M1 Blade Servers (half-width, 2-socket, 4-core Intel Xeon x5680 processor, 2.93 GHz, 130W, 8-MB cache, and 96 GB of memory using twelve 8-GB dual inline memory modules [DIMMS]).
- Twelve Cisco UCS B440 M1 High-Performance Blade Servers (full-width, 4-socket, 8-core Intel Xeon x7560 processor, 2.26 GHz, 130W, 24-MB cache, and 128 GB of memory using thirty-two 4-GB DIMMS).
- Twenty-eight 2-port 10-Gbps Cisco UCS M81KR Virtual Interface Cards (VICs).
- Four 2-port, 10-Gbps Cisco UCS M71KR-E Emulex CNAs.
- Two Cisco UCS 6140XP 40-Port Fabric Interconnects.
- Two Cisco Nexus® 7000 18-Slot Switches (LAN switches), to be shared with other domains through separate virtual LANs (VLANs).
- Two Cisco Nexus 5020 Switches (aggregation-level switches) that connect to Cisco UCS 6100 Series Fabric Interconnects for backup SAN traffic and network-attached storage (NAS) devices.
- Two Cisco MDS 9513 Multilayer Director SAN switches, to be shared with other domains through separate virtual SANs (VSANs).
- One EMC Symmetrix Virtual Matrix Architecture (V-MAX) System with four engines for production.
- One EMC Symmetrix V-MAX System with four engines for development, testing, and performance.

Figure 4. EMC Migration to Cisco UCS: Production Infrastructure



The EMC Symmetrix V-MAX storage array was configured to include 450 devices, including enterprise flash drives, Fibre Channel, and SATA drives. The disk format was RAID 1 and RAID 5, with concatenated metavolumes. SAN connectivity was enabled in an 8-Gbps infrastructure and 4-Gbps Fibre Channel connection to the SAN.

Migrating the Oracle CRM Database

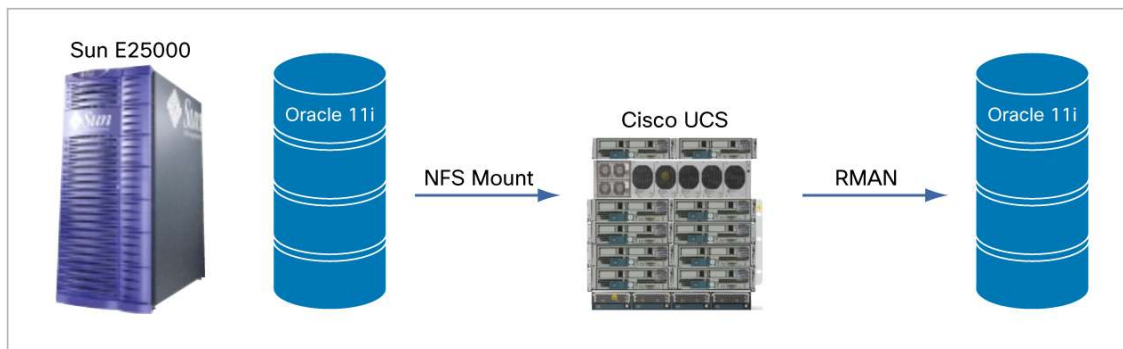
EMC used two methods to move the database to the new platform:

- Import and export: Data was imported into the appropriate tier according to performance characteristics and the significance of the data. After the data was imported, a team validated the data while the data was replicated and exported to the production cluster using Symmetrix Remote Data Facility (SRDF).
- Transportable tablespaces: The Oracle Transportable Tablespaces (TTS) feature allows users to move a nonsystem tablespace across Oracle databases. It provides an efficient and much faster way to move bulk data between databases than does performing either an export-and-import or unload-and-load operation for the same data because transporting a tablespace requires only the copying of data files from the source to the destination and then integrating the tablespace structural information.

Migrating the Sun SPARC Server to an x86 and Linux Cisco UCS Server

EMC migrated the Oracle 11i E-Business Suite CRM application from UNIX to Linux using the recovery manager (RMAN) data file conversion feature (Figure 5).

Figure 5. Oracle 11i CRM Database Migration



EMC IT chose to use Network File System (NFS) protocol mounting of the source logical unit numbers (LUNs). This approach allowed EMC IT to migrate the data files without having to first stage them in temporary storage in the new cluster. Copying 8 terabytes (TB) of database files can take more than 12 hours to complete, so this step removed hours from the migration process. A more efficient method would have been to mount the actual LUNs directly for the new cluster. However, since the source file system was Veritas, EMC IT chose not to do this, due to the expense of the license. This decision cost some valuable time, because the NFS protocol was a bottleneck.

Here are the main database migration steps:

- On the source, mark the tablespaces in the transportable set as read only.
- Create a transportable tablespace for Oracle E-Business Suite (standard and custom) schemas and help ensure that violations are addressed.
- From the source, export the transportable tablespace metadata for all schemas except sys, system, and source. (Note: Apply expdp patches 6354875, 5249074, and 5120780 on the source to improve performance. Confirm that patch 6730429 is applied on the target before starting the impdp process there; the absence of this patch can cause loss of the database.)

- From the source, export the Oracle E-Business Suite APPS user, miscellaneous data (package sequences and procedures), and resource list server (RLS) policies for the full database. Note the assignment queue information from dba_queues to restart the queues later on the target system.
- Export the SYSTEM schema and global temporary tables.
- EMC IT used RMAN to convert each data file. RMAN was needed because of the conversion occurring on the target servers. It also allowed EMC to use the increased speed of the target hosts and better parallelism. The data files were split into multiple threads to run on each target host. EMC IT used RMAN parallelism rather than channels for the best throughput. EMC IT used six hosts (multiple threads per hosts) instead of a single host and multiple channels.
- Import the transportable tablespace metadata into the target database. Then plug the data files (set of transportable tablespaces) into the target database. Make sure to exclude table statistics and index statistics; in EMC IT's case, these exclusions saved more than 20 hours.
- Make the transportable tablespaces read-write on the target.
- In the target database, follow these steps:
 - Import the Oracle E-Business Suite APPS user. Update the default tablespace and tablespace quotas for all users and match them to the source.
 - Import the procedural objects. Import the RLS policies.
 - Restart queue tables and rebuild all spatial indexes.
 - Import the schema statistics taken on the source.
 - Import the system schema.
- Rebuild queue tables and all spatial indexes.

EMC IT joined the early adopters program in the first quarter of 2010 after using Oracle TTS to migrate the CRM database to the new platform. Oracle Metalink note 454574.1 was released in the second quarter to serve as an officially supported method, but it supports only Oracle E-Business Suite 11.5.10.2 on Oracle Database 10.2.0.4. This method, as well as EMC IT's migration method, will work on Oracle Database 10gR1 and later.

Lessons Learned in the Move to the New Platform

Table 1 summarizes the lessons learned in the move from the traditional Sun SPARC platform to the open, scalable x86 and Linux Cisco UCS platform.

Table 1. Lessons Learned in the Migration to Cisco UCS

From Sun SPARC to Cisco UCS
Physical disks were removed from all blades, and the blades were configured to boot from the SAN. This process required setup of the kickstart configuration to build the boot drives using the Linux logical volume manager (LVM) since EMC PowerPath was used across all devices.
For accelerated provisioning: <ul style="list-style-type: none"> • Service profile templates were used to create service profile instances. • Firmware upgrades for blades were performed by using Cisco UCS policies and rebinding service profiles to templates. Firmware problems arose using initial releases and were resolved with a more current update.
Operating System Changes
Red Hat 5.3 contained a flaw that could lead to silent file system corruption. All nodes were upgraded to Red Hat Enterprise Linux 5.4.
Kudzu was shut off to prevent any MAC address changes from altering device paths.
All servers were reconfigured to send kdump core files to a central server using Secure Copy Protocol (SCP).
The latest enic and fnic drivers were needed to resolve early code release problems.

Infrastructure Changes

The Cisco Nexus 7000 Series Switches no longer supported the automatic forwarding of Network Information Service (NIS) broadcast packets, so EMC had to hard-code NIS servers instead of using a broadcast configuration. EMC IT will change to Lightweight Directory Access Protocol (LDAP) authentication.

A "Compute by Purpose" design was used, and blade pools were set up by purpose (production, development, Cisco UCS B200 blade servers, Cisco UCS B440 blade servers, etc.).

Operational Changes

Changes were made for ease of management through a single restricted access login:

- A single Cisco Technical Assistance Center (TAC) account was set up to funnel all calls and provide a central contact point.
- A keyboard, video, and mouse (KVM)-only (console) Cisco UCS access account was created for command center staff.
- Active Directory integration could not be set up due to a requirement of the modified Active Directory schema, which is fixed in Cisco UCS Version 1.4 firmware.

Oracle Applications Deployment Changes

A separate proxy backup host was installed outside Cisco UCS.

Oracle Lessons Learned

Table 2 summarizes lessons learned in the Oracle migration to the new OS and platform.

Table 2. Oracle Lessons Learned

Memory

Migrating from Sun Solaris to Red Hat Linux necessitated implementation of the Linux kernel feature HugePages.

HugePages is a feature integrated into the Linux 2.6 kernel. It enables a larger page size that is useful for working with very large amounts of memory. The entire system global area (SGA) must fit within the reserved HugePages space; otherwise, the SGA will not use the configured HugePages space and that memory will be wasted.

Performance

EMC IT discovered that it had not accounted for the extremely large bursts of data changes that the Cisco UCS platform was capable of processing:

- Batch jobs that generated more than 100 GB of redo processing would have spread those changes over many hours on the traditional Sun platform.
- With the new capabilities of Cisco UCS, these jobs now complete in a fraction of the time.
- The old platform could generate only a maximum of 1 GB per minute of redo changes. Since it takes approximately one minute to perform a checkpoint in EMC's 8-TB CRM database and the old system could generate 1 GB of redo processing per minute, EMC had a minimum redo size requirement of 2 GB.
- Cisco UCS is capable of significantly more throughput, and the EMC CRM workload now generates 8 GB of redo processing per minute. This rate did not allow the redo logs to be archived because the checkpoint would not complete, and it ultimately led to a hung archive process.
- The same problem also led EMC to undersize the archive area. Due to the significantly larger bursts of data changes, the archive area, 630 GB, was filling up in hours, and RMAN was barely able to keep up with it. The archive area was resized to 2 TB to allow approximately one day's worth of archive logs.

EMC IT's Oracle Best Practices

EMC IT used a variety of best practices in the migration of the Oracle CRM system, listed in Table 3.

Table 3. Oracle Best Practices Used in the Migration

Cisco UCS

The EMC IT common design pattern and templates were applied to the Cisco UCS domain. The templates made the platform disaster-recovery ready and provided flexible computing.

A maximum I/O throughput of 80 Gbps was established for the deployed Cisco UCS infrastructure.

The data center was made high-availability ready with no single point of failure.

Operating System

An adjustment was made to the Oracle RAC interconnect networking. Jumbo frames were applied to Red Hat configurations.

An override was specified for the maximum size that can be locked in memory (ulimit -l) in /etc/init.d/ohasd for Oracle Cluster Ready Services (CRS) startup.

As recommended as a best practice, /etc/sysconfig/o2cb was changed.

No Oracle spfiles were used in init.ora:

- The benefit is a single copy of init.ora and the capability to document changes to init.ora.
- The init.ora file was used for Oracle maintenance scripts.

Modifications were made to /etc/security/limits.conf for memory locking, total open files, and processes limits.

Oracle Applications Deployment

HugePages was configured in Linux to match the SGA size.

Redo logs were sized to allow checkpoints to complete prior to switching to the next online redo log.

Application partitioning was applied through Oracle Services (for batch services and services for online users).

EMC's enterprise flash drives (EFDs) were used for hot objects (tables and indexes). EFDs perform exceedingly well for random-read operations (for example, random-read access for data and indexes). This benefit applies particularly in Oracle RAC and can significantly reduce interconnect latency times for extremely hot objects.

EMC used a tool called DB*CLASSIFY from partner Zettapoint both to confirm EMC IT knowledge and to automate the analysis of the hot objects' promotion to EFDs. EMC IT has tested this tool to compare it with its own recommendations. EMC IT used the Automatic Workload Repository (AWR) reports, application knowledge, and wait events in a long and painstaking process and compared the results with the output of Zettapoint DB*CLASSIFY. The results were almost identical, although DB*CLASSIFY had several objects that EMC IT had missed.

Interprocess communication (IPC) modifications were made to /etc/sysctl.conf based on Oracle recommendations and IT best practices.

Infrastructure Changes

An interconnect was set up to use Fabric B as the default primary switch in all cases to avoid routing through the Cisco Nexus 7000 Series Switch.

Operational Changes

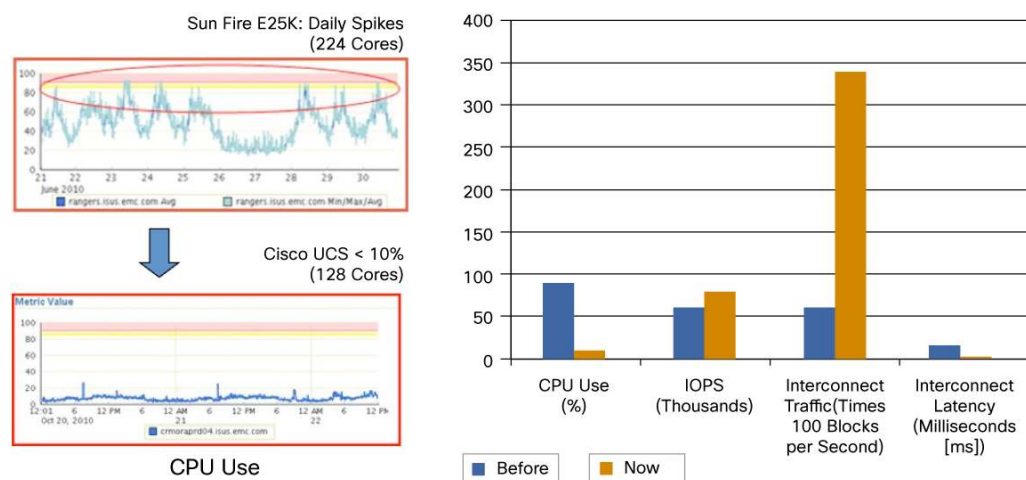
New training and a knowledge transition session were provided to the EMC IT teams.

Results from the EMC Migration

EMC achieved a smooth cutover of the CRM application during one weekend with the Cisco Services team onsite and ready to address any challenges. After the migration was complete, performance testing achieved improvements that were 2 to 20 times faster than previous results, depending on the transaction. For example, customer service quote renewal transactions improved from 11.5 to 5.6 seconds. In EMC Channel Express, "save and array configuration" transactions improved 800 percent, from 27.4 to 3.3 seconds. "Create a new version" transactions improved from 133.6 to 36.3 seconds, and "save a configuration" transactions improved from 27.9 to 3.4 seconds.

The IT department also measured large reductions in average CPU utilization, from up to 100 percent down to 10 percent (Figure 6). Batch runtimes and user response times have accelerated by up to 60 percent.

Figure 6. Performance Improvements



The Cisco UCS platform significantly lowers costs by using industry-standard hardware, fewer cables, and simpler management. EMC implemented the latest Intel Xeon processor technology to improve performance, while lowering energy, power, and cooling costs. The system offers high-availability capabilities that are far more affordable than those previously available.

Taking into account the replacement of traditional hardware with Cisco UCS, reduced software and hardware maintenance costs and third-party software licenses, and environmental savings (power, cooling, and space), EMC has estimated that the migration saved approximately US\$5 to 7 million annually in OpEx and CapEx.

Additionally, the migration to the Cisco UCS platform enables EMC IT to provide an open and scalable computing platform with a strategic architecture that enables incremental growth, as needed, and the infrastructure for private cloud computing and IT as a service (ITaaS).

Case Study: Cisco IT Migrates from Traditional HP-UX Platforms to the Cisco Unified Computing System

In 2009, Cisco decided to migrate its Oracle and SAP enterprise applications from Hewlett-Packard UNIX/RISC-based servers to Cisco UCS and Cisco Nexus switches within a private cloud. The decision was based on the desire to reduce TCO, help ensure adequate capacity for growth, provide business continuity, and support business agility and innovation by accelerating application provisioning. Additionally, the RISC-based server architecture on the traditional server platforms did not allow Cisco to take full advantage of virtualization, and the cost to maintain these systems was high. In addition to the migration to Cisco UCS, applications running on HP-UX, Solaris, Linux, and Microsoft Windows operating systems were consolidated to run on just Linux and Windows. The migration also coincided with relocation of the computing environment from a data center in San Jose, California, to a data center in Richardson, Texas.

The Oracle Migration

Prior to the migration, Cisco IT had approximately 200 HP-UX servers in the United States and Europe that were hosting Oracle RAC and Oracle E-Business Suite. The new environment reduced the server footprint to just 4 Cisco UCS B200 M1 Blade Servers, each with 48 GB of RAM.

Cisco IT began migrating the Oracle E-Business Suite from HP-UX servers to Cisco UCS in October 2009. The actual conversion takes less than 24 hours, but Cisco IT typically also performs application upgrades during the migration process, so the team completed multiple test cycles to test application functions and performance in the new environment.

Cisco IT started with the Goal to Commission (G2C) application, which has a 4-TB database that previously resided on a two-node HP-UX cluster with 32 cores. The web presentation layer and applications are virtualized, using VMware on the Cisco UCS. The Oracle database operates on bare metal in the same Cisco UCS chassis as the virtualized components.

The migration was somewhat more complicated for Cisco IT than it would be for most organizations because Cisco was moving to a new data center at the same time. To reduce downtime, Cisco IT performed the following steps prior to the migration:

- Set up a standby instance using Oracle Data Guard on Cisco UCS in the Richardson data center
- Created the target database in Oracle RAC 10g
- Imported metadata (read-only) from Oracle Data Guard to the target
- Copied static data from the standby Richardson instance to the target, in read-only mode; Cisco migrated about 50 percent of the data in advance, using custom scripts
- Copied the Oracle E-Business Suite R12 code tree to the target Richardson data center hosts
- Cloned the Oracle E-Business Suite R12 target and prepared context files

Then, during a one-hour downtime window on a weekend evening, Cisco IT completed the migration and the move to the new data center with these steps:

- Shut down the San Jose G2C production application after synchronizing it with the Richardson Data Guard instance
- Activated the Richardson Data Guard instance
- Imported the remaining data

HP-UX uses the Big Endian system for data storage, and Linux uses the Little Endian system. (The name indicates whether the big end or little end of a byte is stored first.) To convert database tables to the Little Endian format, Cisco IT used the Oracle Data Pump utility or Oracle TTS, which allowed Cisco to skip all the tables with zero rows because the metadata had already been imported.

- Created indexes, constraints, and triggers

To reduce conversion time, the team split the indexes into multiple scripts that run in parallel across all four Cisco UCS blade servers. Then sequences were adjusted because metadata had been imported earlier, so the sequences might have advanced.

- Audited the import by comparing rows and objects
- Ran autoconfig on the Oracle E-Business Suite R12 front end to validate Apache, concurrent managers, forms, and workflow
- Upgraded from Oracle RAC 10g to 11g

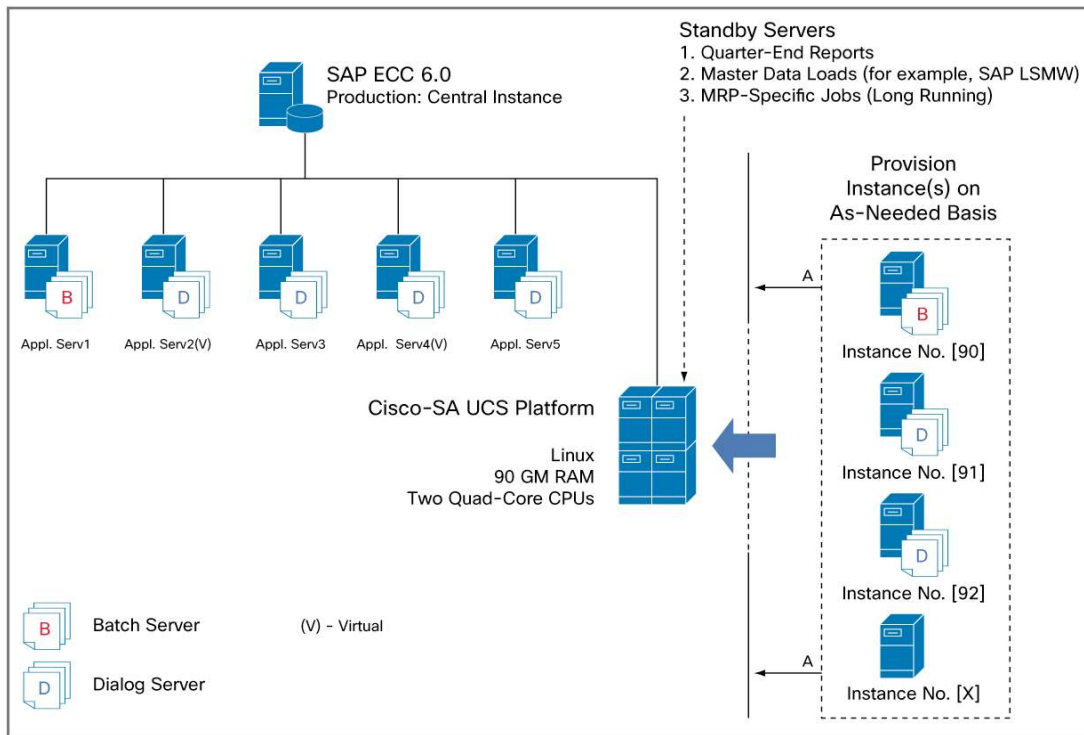
The SAP Migration

The SAP ERP Central Component (ECC) 6 and SAP Exchange Infrastructure (XI) applications, which support manufacturing processes for the Cisco Scientific Atlanta division, resided on five HP-UX servers. The SAP back end included an Oracle RAC 10-GB database and a 3-TB SAP production database. The new Cisco UCS environment included Cisco UCS B200 M1 Blade Servers in a Cisco UCS 5000 Series Blade Server Chassis powered by an Intel Xeon 5500 series processor.

The Cisco IT team had previously completed four major SAP upgrades since beginning to use the SAP software in 1995. The last major upgrade was in 2008, when Cisco switched from SAP ECC 4.6 to ECC 6 to acquire Unicode support for multiple languages. Because the software version was current, the migration from HP-UX to Cisco UCS did not require a software upgrade.

The first step in the migration to Cisco UCS was to move SAP ECC 6 and SAP XI, used to manage application-to-application and business-to-business interfaces, such as inbound files from contract manufacturers (Figure 7).

Figure 7. SAP Applications on the Cisco UCS Platform



Over one weekend in November 2010, Cisco IT converted the SAP ERP database in the test environment from HP-UX to Cisco UCS. The team used the following process:

- Built a copy of the entire production environment, including servers and storage, for parallel unloading and reloading: The test environment for Cisco UCS consisted of 20 Cisco UCS B200 M1 Blade Servers. Sixteen of the servers had 96 GB of RAM for high-use applications, and the other four had 48 GB of RAM. Cisco IT configured multiple blade servers for unload and reload operations. The more servers used, the less time it took to convert the data from Big Endian to Little Endian. The virtualization capabilities in Cisco UCS therefore provided a big advantage: after the conversion to Little Endian, Cisco IT was able to reclaim two servers for other uses.
- Moved applications from the HP-UX platform to Cisco UCS: Organizations can migrate SAP applications and a database to Cisco UCS at the same time, or else migrate the applications first and temporarily keep the database on the HP-UX servers to migrate later. Cisco IT took the latter approach. SAP can operate in a multiplatform environment, and Cisco IT decided to replace the HP-UX servers gradually, to avoid disrupting other projects. End users cannot tell which platform a given application runs on because the user experience is faster than before.
- Converted the back-end Oracle RAC database from Big Endian to Little Endian: Although Cisco IT waited to move the production database to Cisco UCS until after the application servers had been moved, the team wanted to test the converted database beforehand. With practice, Cisco IT learned to perform the conversion faster, converting to Little Endian in 2008, to adopt Unicode. After 10 full-scale practice runs, during which the staff also fine-tuned the configuration, Cisco reduced the conversion time from 42 hours to 8 hours.

- Moved applications from test to production: To move a SAP application on Cisco UCS into production, Cisco IT simply points the SAP clients to the server's new location. Cisco UCS service profiles enable a stateless computing model. Stateless computing alleviates the need to change the individual IP addresses and names of the original servers. When users opened the SAP GUI on the Monday following the conversion, they connected to the new servers without noticing any difference.

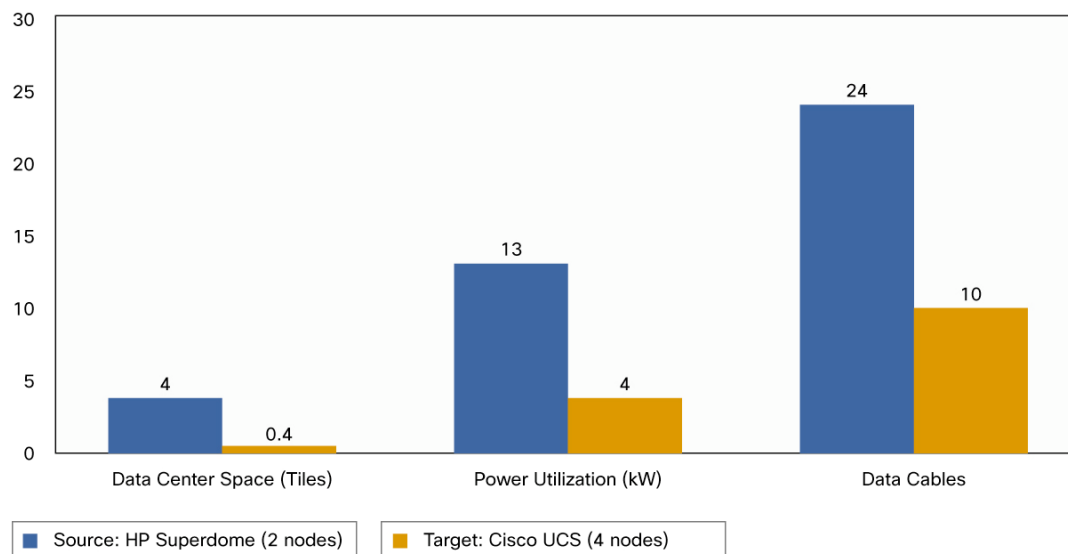
The next step will be converting the smaller development environment. Then Cisco IT will start practicing the production conversion process. The practice sessions will let them know the optimum number of servers they will need to perform the unload-and-reload process. Cisco IT expects SAP ERP on Cisco UCS to be in full production by late 2011.

Migration Results

Cisco IT can see a variety of results from the migration to Cisco UCS from traditional RISC/HP-UX servers, including lower TCO, increased business agility, greater resilience, and a better user experience for increased productivity.

Lower TCO (Figure 8) is achieved through reduced data center space, power, and cooling; use of fewer than half the cables of the previous environment; lower licensing, support, and maintenance costs; and lower hardware costs because blade servers can be repurposed following the migration.

Figure 8. Lower TCO Following Migration



Increased business agility was measured based on reduction of application server deployment time from 6 to 8 weeks to 15 minutes. Resilience was also measured in minutes: If a server fails, Cisco IT can provision any other available server in minutes by applying a Cisco UCS Manager service profile and then using VMware tools to move the application to another server. Previously, this provisioning required a call to the vendor to install a new part, a process which took hours or days to complete.

User experience was measured in faster application performance for Oracle (Figure 9) and SAP (Figure 10) applications.

Figure 9. Measuring Oracle Performance After Migration to Cisco UCS (in Milliseconds)

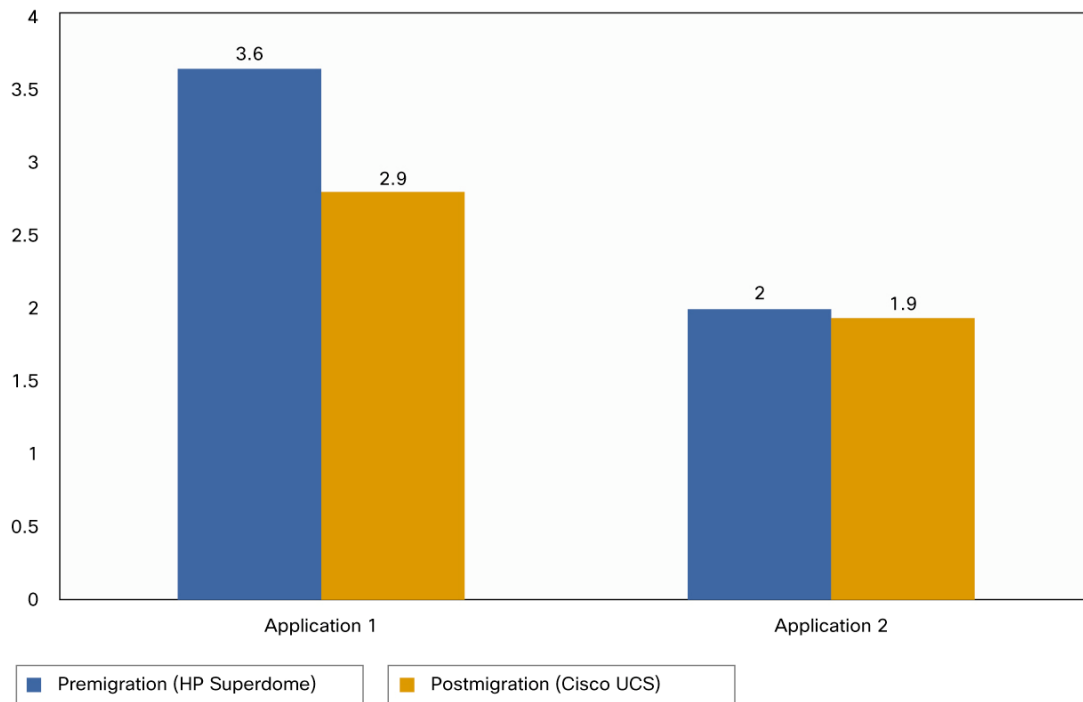
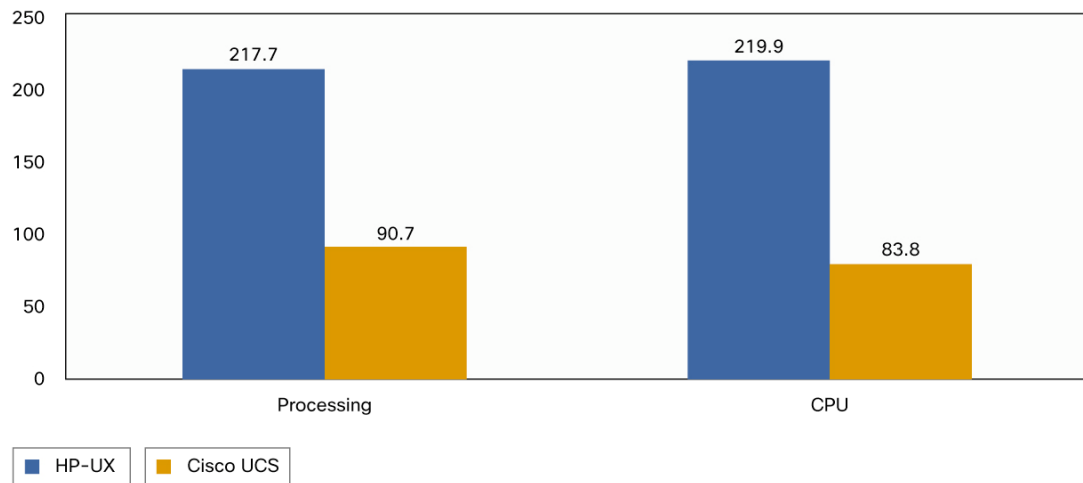


Figure 10. Measuring SAP Performance After Migration to Cisco UCS (in Milliseconds)



Lessons Learned in the Move to the New Platform

Table 4 summarizes the lessons Cisco IT learned in the move from the traditional HP-UX platforms to the open, scalable x86 and Linux Cisco UCS platform.

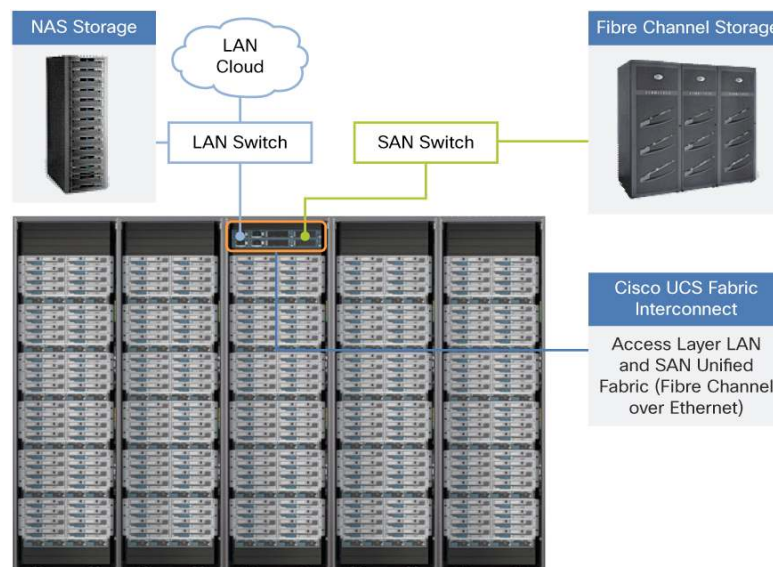
Table 4. Lessons Learned in Migration of Oracle and SAP Applications to Cisco UCS

Oracle Applications
When Oracle certifies cross-platform transportable tablespaces (XTTS) to migrate an Oracle E-Business Suite R12 database from Big Endian to Little Endian, use XTTS to simplify the migration process.
Migration is simpler if the same storage is used in the test and production environments.
For subsequent migrations, Cisco IT will use the Cisco UCS B440 blade servers to take advantage of their higher capacity and then remount the storage on Cisco UCS B200 blade servers.
SAP Applications
Perform test runs before going live. Practice allows administrators to understand how long the process will take so there are no surprises.
For SAP migrations, use parallel unload and reload servers to save time. Use the SAP Distribution Monitor system copy tool in a way that takes advantage of the parallel processing capabilities of Cisco UCS. Experiment to find the optimum number of servers. Cisco used 10 unload and reload servers to convert the test environment.
Create separate unload and reload network segments. Enable jumbo frames on both segments. When this was done for SAP Unicode conversion, system copy time decreased by 25 to 30 percent for Cisco IT.
Take advantage of the storage array's on-disk backup capability to eliminate the need for long database restore operations.
Consider converting SAP applications to Unicode during the migration. Converting from non-Unicode to Unicode on RISC platforms is very time consuming. The virtualization capabilities in Cisco UCS allow the conversion to be performed relatively quickly.

Cisco Unified Computing System: Benefits and Differentiators During Migration and Beyond

Various vendors have an array of x86-based server offerings on the market, but Cisco UCS is a truly unique product line that integrates networking, computing, storage, and virtualization into a single cohesive system. Figure 11 shows a sample Cisco UCS topology. It is a “wire once” environment, with a fraction of the cabling required in traditional server environments.

Figure 11. Cisco UCS Blade Server Topology



Cisco UCS integrates a low-latency, lossless 10 Gigabit Ethernet unified network fabric with enterprise-class x86-architecture servers based on the Intel Xeon 5600 and 7500 series processors. These powerful new processors allow IT to curb the exponential proliferation of servers required to support new and expanding workloads by consolidating more of these workloads onto fewer physical hardware components. Cisco UCS takes advantage of the enhanced performance offered by Intel Xeon processors, together with expanded memory options and higher I/O capacity, to enable greater virtual machine scalability.

Cisco Extended Memory Technology provides twice as much memory (384 GB) as traditional 2-socket servers, increasing performance and capacity for demanding virtualization and large-data-set workloads. On the same day in April 2011 that Intel announced the new Intel Xeon E7 processor family, Cisco UCS set nine world records for performance. Since the system was first introduced, it has established 44 new world performance records.

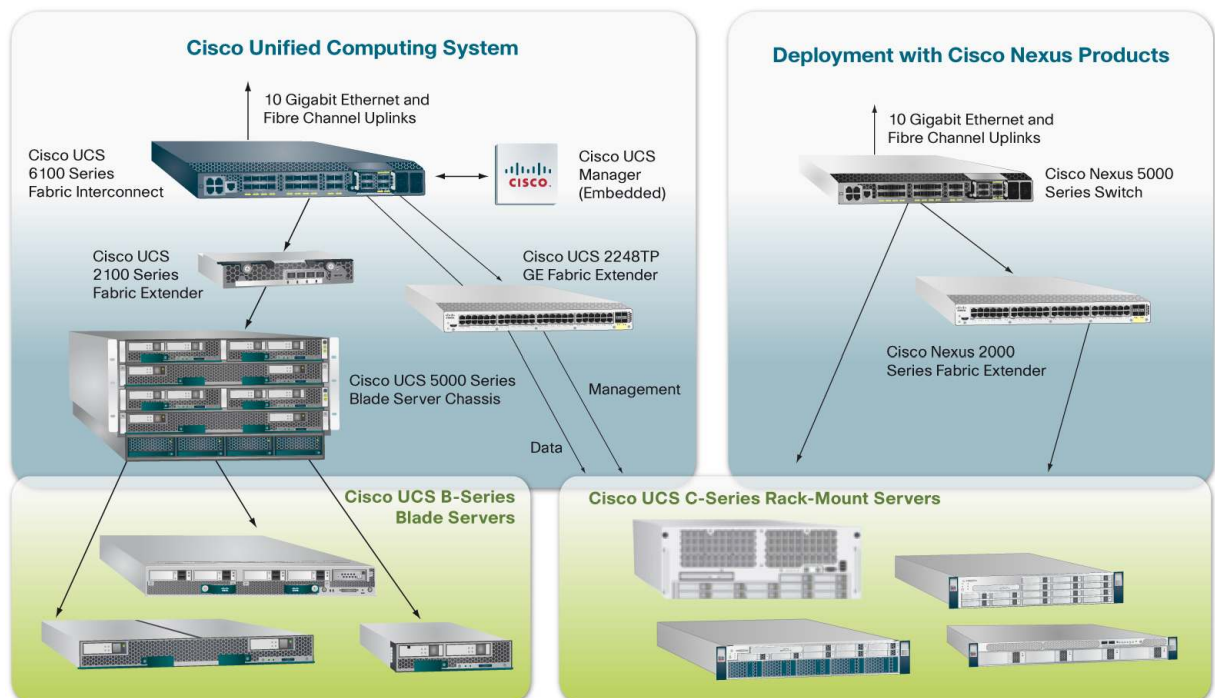
Aside from business-critical applications, the Cisco Extended Memory Technology offers a more cost-effective memory footprint for less-demanding workloads. Together, these features reduce the cost of physical servers required to support new and expanding workloads.

Cisco UCS delivers a world-class computing platform capable of addressing the most demanding, mission-critical requirements of today at far lower cost and with greater flexibility and security than proprietary UNIX/RISC solutions. At the same time, it provides specific architectural advantages that simplify and accelerate deployment of enterprise-class applications running in bare-metal, virtualized, and cloud computing environments.

Cisco UCS is a self-aware, self-integrating, and self-documenting system that provides complete visibility into the results of a RISC migration. The system is built so that its configuration can be programmed through software. The unified, integrated management configures every aspect of server personality, from firmware and BIOS settings to network and storage connectivity. Server deployment is reproducible and scalable, helping make the migration process fast, smooth, and error-free. Migrated applications can scale with ease, improving business agility while helping prevent configuration errors that can cause downtime.

The system integrates an industry-standard, x86-architecture - with servers in blade or rack form factors - with a unified fabric. The fabric carries IP, storage, and IPC with a single, high-bandwidth, low-latency Ethernet and Fiber Channel over Ethernet (FCoE) network, eliminating up to two-thirds of network infrastructure at the rack level. Cisco Fabric Extender technology is used to eliminate blade server and hypervisor-resident switching, condensing three network layers into one (Figure 12). Cisco Fabric Extender technology interconnects physical servers and virtual machines equivalently, with exceptional visibility and control.

Figure 12. Cisco UCS Components



The architectural advantages of Cisco UCS deliver rapid migration and deployment and an improved scalability model compared to traditional RISC/UNIX servers. The result is a new level of business application agility through vast resource flexibility managed through a single interface. All this is available at a greatly reduced TCO.

The Cisco Advantage

Cisco augments its own RISC/UNIX migration capabilities with those of strategic partners that provide best-in-class migration services to help ensure an efficient and organized transition of traditional mission-critical applications to state-of-the-art Cisco UCS on x86 and Linux systems. This collaboration gives customers great flexibility in migrating applications from traditional RISC systems.

Cisco Services has a template-based process for providing reliable and efficient application migration. After the migration is complete, Cisco can provide onsite operational support, including mentoring and knowledge transfer.

Conclusion

Cisco's vision of the next-generation data center focuses on simplicity, speed, and reduced CapEx and OpEx. With Cisco UCS as the modular building block, companies now can more easily evolve their data centers to take advantage of the latest architectures for cloud computing and other innovations. Cisco UCS offers a wide variety of benefits beyond the RISC/UNIX-based server platforms of yesterday. These traditional systems were at one time the state of the art for mission-critical applications. Today, Cisco UCS provides an open-standard, cost-effective, simpler, high-performance alternative to improve IT responsiveness to rapidly changing business demands.

For More Information

- Migrate from RISC Servers to Cisco UCS http://www.cisco.com/en/US/partner/prod/ps10265/uc_risc.html.
- Cisco UCS Services: Accelerate Your Transition to a Unified Computing Architecture
http://www.cisco.com/en/US/services/ps2961/ps10312/Unified_Computing_Services_Overview.pdf.
- Cisco UCS B440 M1 High Performance Blade Server: World-Record Virtualization Performance
http://www.cisco.com/en/US/prod/collateral/ps10265/ps10280/LE_671311_PB_VMmark_B440.pdf.
- Cisco Leads the Industry on Oracle E-Business Suite Benchmarks with Three Number 1 Results
<http://www.cisco.com/en/US/prod/collateral/ps10265/LE-212505-PB-Oracle-B200.pdf>.
- Cisco UCS C460 M1 High-Performance Rack-Mount Server: World-Record Virtualization Performance
http://www.cisco.com/en/US/solutions/collateral/ns340/ns517/ns224/ns955/ns971/c45-606742-00_VMmarkBrief_aag.pdf.
- Cisco UCS Delivers World-Record Application Server Performance
http://www.cisco.com/en/US/prod/collateral/ps10265/LE-212506_PB_iAppServer_B230.pdf.
- x86 Blades: Shrinking the Branch Office
http://www.cisco.com/en/US/partner/prod/collateral/modules/ps10598/white_paper_c11-613183_ps11273_Products_White_Paper.html.



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