Virtualized SAP Solution using Cisco Unified Computing System and EMC® CLARiiON® Storage

Featuring Intel® Xeon® Processor 5600 Series and Cisco Extended Memory Technology

White Paper

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1 Executive Summary

SAP provides a comprehensive range of enterprise software applications and business solutions to empower every aspect of commerce and drive operational efficiency.

Customers realize SAP services either by using an IT deployed model or through a hosted model, with the former being the more common platform. Traditional deployments have SAP installed on dedicated servers, usually calibrated to meet the peak workload rather than the average workload. This results in system under-utilization and corresponding high rates of IT expenditure for both hardware and maintenance.

The emergence of virtualization as a mainstream enterprise technology has dramatically altered the way IT leverages its infrastructure. Consequently, SAP customers are using virtualization technology more and more to optimize their IT landscape and to cut their hardware and operating costs. By running SAP in a virtualized environment, additional qualitative benefits accrue. Easier system maintenance, the flexibility to move applications from server to server, and enabling higher levels of system availability and scalability can be achieved resulting in increased business agility.

Even though virtualization has created a market transition, customers are facing challenges in achieving the full benefits of the technology. IT organizations are constantly working against existing rigid, inflexible hardware platforms. To address these issues and also as a natural next step in Cisco's Data Center 3.0 vision, Cisco has developed the Unified Computing System (UCS). UCS is the next-generation data center platform that unites compute, network, and storage access. The platform, optimized for virtual environments, is designed within open industry standard technologies and aims to reduce TCO and increase business agility. Servers in UCS are powered by Intel® Xeon® processors.

This document details the performance scalability of Cisco UCS with EMC® CLARiiON® Storage. Specifically, it compares the UCS B200 blade server with standard memory to the UCS B250 blade server with Cisco's extended memory technology running the virtualized SAP ERP workload. Both servers are powered by best-in-class Intel Xeon 5600 series processors. The study demonstrates why Cisco UCS platform, coupled with Intel Xeon 5600 series processors and EMC CLARiiON storage is a great fit for implementing virtualized SAP solutions.

2 Introduction

End-to-end Infrastructure Services optimization being the order of the day, application service providers (ASPs) as well as users are aligning their practices that help drive cost benefits while not compromising with the expected performance metrics for their applications.

There has been a logical transition in the way IT works: where once ASPs and users had dedicated server hardware for their application on a one-to-one basis then to simple infrastructure hosting and now utilize cloud computing strategies. Additionally, the delivery model has transitioned from a state of shipping software on CDs through the availability as standard application software and to today's on-demand services. These dynamics in the current IT space have fuelled the need for product companies, in particular, to work on transitioning their offerings to cost-effective software delivery models.

Business Case

To cater to a large potential customer base of midsize companies or small businesses that want the benefits of large-scale business applications without the need for a large IT infrastructure, companies like SAP have come up with many Software-as-a-Service (SaaS) offerings such as SAP Business ByDesign and SAP CRM-on-Demand. These on-demand offerings are usually based on multi-tenant / multi-client architecture where providing similar services to multiple customers out of a single optimized implementation platform becomes possible.

This business scenario establishes the premise for this white paper; where SAP application service is conceived to be provided from a template-based environment in which the development, quality and testing environments operate out of individual Virtual Machines (VMs) and customer instances function out of separate individual VMs. This approach also establishes the needed logical isolation of customer sensitive data from other data.

Proposed Solution

Cisco, EMC and Intel have jointly developed a reference architecture that addresses this business case.

In a nutshell, a number of fully provisioned VMs are built on the Cisco UCS Blade server powered by Intel Xeon processor 5600 series with EMC storage as backbone. Each VM can potentially be assigned to a customer. This enables companies to maximize the number of customers served per hardware platform and achieve outstanding SAP application performance and scalability while lowering IT costs. By setting up and managing virtual connections, the Cisco Unified Computing System (UCS) helps solve the most vexing virtualization performance issues. With the SAP application running on UCS, the culminating result is a price to performance ratio for supporting virtual machines unrivalled in the industry.

Tests were conducted to determine the maximum number of VMs each Cisco UCS blade could support. The qualifying factor was to meet a user response time SLA of less than or equal to 1 second. The platforms tested include:

- Cisco UCS B200 M2 Blade Server with Intel Xeon X5680 3.33 GHz with 96 GB total memory
- Cisco UCS B250 M2 Blade Server with Intel Xeon X5680 3.33 GHz with 192 GB total memory
- EMC CLARiiON CX4-480 was used as the storage platform for both cases.

The following sections in this document detail the Cisco UCS system, Intel Xeon 5600 series processors and EMC CLARiiON used in case study, the solution implemented, performance results and applicability.

3 Product Overview

Cisco Unified Computing System

The Cisco Unified Computing System (UCS) is a next-generation data center platform that unites compute, network, and storage access. The platform, optimized for virtual environments, is designed within open industry standard technologies and aims to reduce TCO and increase business agility. The system integrates a low-latency, lossless 10 Gigabit Ethernet unified network fabric with enterprise-class, x86-architecture servers. The system is an integrated, scalable, multi-chassis platform in which all resources participate in a unified management domain.

The Cisco Unified Computing System represents a radical simplification of the traditional blade server deployment model by providing simplified, stateless blades and a blade server chassis that is centrally provisioned, configured, and managed by Cisco UCS Manager. The result is a unified system that significantly reduces the number of components while offering a just-in-time provisioning model that allows systems to be deployed or redeployed in minutes rather than hours or days.

The Cisco Unified Computing System is designed to deliver:

- Reduced TCO at the platform, site, and organizational levels
- Increased IT staff productivity and business agility through just-in-time provisioning and mobility support for both virtualized and non-virtualized environments
- A cohesive, integrated system that is managed, serviced, and tested as a whole
- Scalability through a design for up to 320 discrete servers and thousands of virtual machines, and the capability to scale I/O bandwidth to match demand
- Industry standards supported by a partner ecosystem of industry leaders

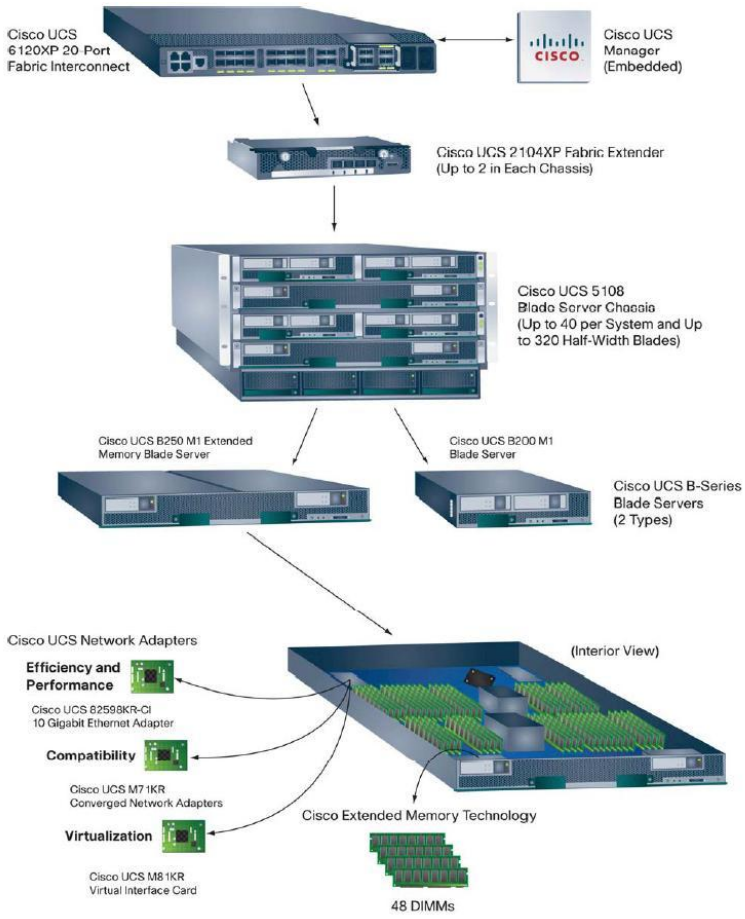
Innovations Supporting Business Benefits

Each of the system's business benefits is supported by a rich set of technical innovations that contribute to this first implementation of the Cisco® unified computing vision:

- Embedded system management through Cisco UCS Manager
- Just-in-time provisioning with service profiles
- Unified fabric using 10-Gbps Ethernet
- VN-Link virtualization support
- Cisco Extended Memory technology
- State of the art performance using Intel Xeon Processors
- Energy efficient platform design

The following section details the Cisco UCS components.

Cisco UCS Components



Cisco UCS 6100 Series Fabric Interconnects—Comprising a family of line-rate, low-latency, lossless, 10-Gbps Ethernet interconnect switches that consolidate I/O within the system. Both 20-port one-rack-unit (1RU) and 40-port 2RU versions accommodate expansion modules that provide Fibre Channel and 10Gigabit Ethernet connectivity.

Cisco UCS Manager—Provides centralized management capabilities, creates a unified management domain, and serves as the central nervous system of the Cisco Unified Computing System.

Cisco UCS 2100 Series Fabric Extenders—Bring unified fabric into the blade-server chassis, providing up to four 10-Gbps connections each between blade servers and the fabric interconnect, simplifying diagnostics, cabling, and management.

The Cisco UCS 5100 Series Blade Server Chassis—The Cisco UCS 5100 Series Blade Server Chassis (model 5108) is a logical part of the Cisco Unified Computing System's fabric interconnects, adding no management complexity to the system.

The Cisco UCS 5108 fits on a standard rack, is 6RU high and physically houses blade servers and up to two Cisco UCS 2100 Series Fabric Extenders. It also houses eight cooling fans and four power supply units. The cooling fans and power supply are hot swappable and redundant. The chassis requires only

two power supplies for normal operation; the additional power supplies are for redundancy. The highly-efficient (in excess of 90%) power supplies, in conjunction with the simple chassis design that incorporates front to back cooling, makes the UCS system very reliable and energy efficient.

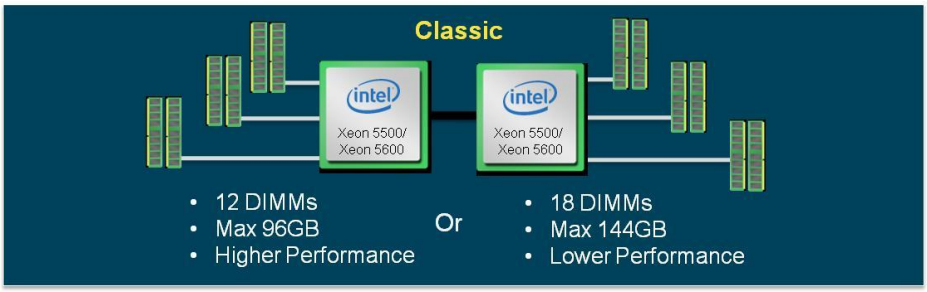
Cisco UCS network adapters—Offers a range of options to meet application requirements, including adapters optimized for virtualization, converged network adapters (CNAs) for access to unified fabric and compatibility with existing driver stacks, Fibre Channel host bus adapters (HBAs), and efficient, high-performance Ethernet adapters.

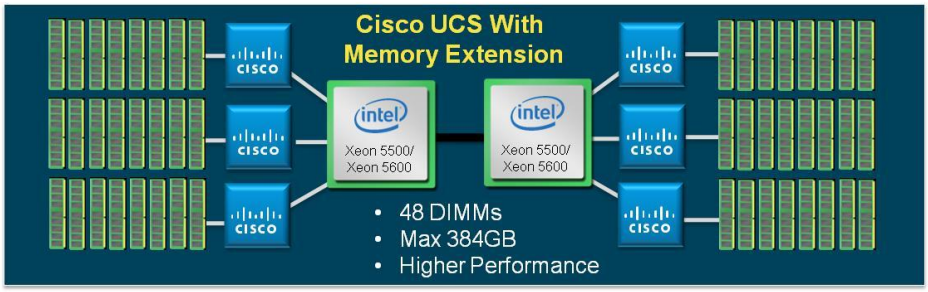
Cisco UCS B-Series Blade Servers—Based on Intel Xeon 5500 and 5600 series processors, adapt to application demands, intelligently scale energy use, and offer best-in-class virtualization. These socket blade servers come in two forms: the UCS B200 half-slot, and the UCS B250 full-slot extended memory server. Cisco UCS first generation, M1 series, features the Intel Xeon processor 5500 series while the next generation, M2 series, features the Intel Xeon 5600 processor.

Each Cisco UCS B200 server uses one CNA and each Cisco UCS B250 server uses two CNAs for consolidated access to the unified fabric. This design reduces the number of adapters, cables, and access-layer switches needed for LAN and SAN connectivity.

The Cisco UCS B250 features Cisco's patented Extended Memory Technology. This Cisco technology provides more than twice as much industry-standard memory (384 GB) as traditional two-socket servers, increasing performance and capacity for demanding virtualization and large-data-set workloads. Alternatively, this technology offers a more cost-effective memory footprint for less-demanding workloads.

Cisco Extended Memory Technology—Modern CPUs with built-in memory controllers support a limited number of memory channels and slots per CPU. The need for virtualization software to run multiple OS instances demands large amounts of memory and that, combined with the fact that CPU performance is outstripping memory performance, can lead to memory bottlenecks. Even some traditional non-virtualized applications such as databases demand large amounts of main memory for improved performance. To obtain a larger memory footprint, most IT organizations are forced to upgrade to larger, more expensive four-socket servers. CPUs that can support four-socket configurations are often more expensive, require more power, and entail higher licensing costs.





Cisco UCS Extended Memory Technology expands the capabilities of CPU-based memory controllers by logically changing the main memory while still using standard DDR3 memory. The technology makes every four DIMM slots in the expanded memory blade server appear to the CPU's memory controller as a single DIMM that is four times the size. For example, using standard DDR3 DIMMs, the technology makes four 8-GB DIMMS appear as a single 32-GB DIMM.

Cisco UCS Extended Memory Technology provides flexibility between memory cost and density. This Extended Memory Technology uses a high-performance, ultra-fast technology that is implemented in its ASIC to allow 48 memory modules (DIMMs) to be addressed at high speed. The total memory address space per blade jumps to 384 GB at 1333 MHz speed compared to 96 GB at 1333 MHz, or 144 GB at 800 MHz, on alternative hardware provided by other Intel based 2-socket server vendors that can use up to 18 memory modules (DIMMs).

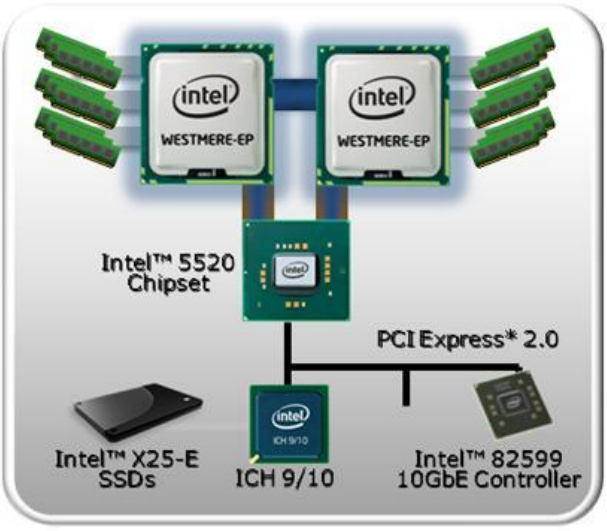
This patented technology allows the CPU to access more industry-standard memory than ever before in a two-socket server:

- For memory-intensive environments, data centers can better balance the ratio of CPU power to memory and install larger amounts of memory to maximize compute resources. With a larger main memory footprint, CPU utilization can improve because of fewer disk waits on page-in and other I/O operations making more effective use of capital investments.

- For environments that need significant amounts of main memory but which do not need a full 384 GB, smaller-sized DIMMs can be used in place of 8-GB DIMMs, with resulting cost savings

Intel Xeon Processor 5600 Series

The Intel® Xeon® processor 5600 series delivers substantial increases in performance and energy-efficiency versus the previous generation Intel® Xeon® processor 5500 series. It also provides embedded technologies that give business, creative, and scientific professionals the power to solve problems faster, process larger data sets, and meet bigger challenges. This processor family introduces Intel AES-NI, which accelerates core encryption and decryption processes to enable strong security with less impact on overall server performance.



In addition to Intel AES-NI, server platforms based on the Intel® Xeon® processor 5600 series continue to support features from the previous generation processor that enable it to respond intelligently to workloads to provide additional improvements in performance and energy-efficiency.

- Intel® Turbo Boost Technology boosts performance as needed by dynamically adjusting core frequency to increase execution speed for peak workloads.

- Intel® Intelligent Power Technology adjusts core frequencies to conserve power when demand is lower.

- Intel® Hyper-Threading Technology improves throughput and reduces latency for multithreaded applications and for multiple workloads running concurrently in virtualized environments.

EMC CLARiiON

The EMC CLARiiON CX4 series with UltraFlex™ technology is based on a new breakthrough architecture and extensive technological innovation, providing a midrange solution that is highly scalable, meeting the price points of most midrange customers. The unique modularity of the UltraFlex technology allows you to use a combination of protocols within a single storage system, providing online-expandable connectivity options. It also includes new levels of ease of use, making the CX4 easy to install, manage, and scale. The CX4 is the fourth-generation CX series, and continues EMC's commitment to maximizing customer's investments in CLARiiON technology by ensuring that existing resources and capital assets are optimally utilized as customers adopt new technology. The innovative technologies in the CX4 includes fully automated storage tiering and support for the latest generation of disk drive technologies, such as Flash dDrives.

The CLARiiON CX4 series introduces thin LUN technology that builds on CLARiiON virtual LUN capabilities and seamlessly integrates with CLARiiON management and replication software. With CLARiiON Virtual Provisioning™, you can choose between traditional LUNs, metaLUNs, and thin LUNs. The ability to non-disruptively migrate data to different LUN and disk types allows you to deploy the best solution without incurring downtime. Virtual Provisioning enables organizations to reduce costs by increasing utilization without over provisioning of storage capacity, simplifying storage management, and reducing application downtime.

CX4-120

- Up to 120 drives
- 6 GB cache
- Standard 4 Fibre Channel/4 iSCSI
- Maximum 16 front-end Fibre Channel and/or iSCSI

CX4-240

- Up to 240 drives
- 8 GB cache
- Standard 4 Fibre Channel/4 iSCSI
- Maximum 20 front-end Fibre Channel and/or iSCSI

CX4-480

- Up to 480 drives
- 16 GB cache
- Standard 8 Fibre Channel/4 iSCSI
- Maximum 24 front-end Fibre Channel and/or iSCSI
- Flash drives

CX4-960

- Up to 960 drives
- 32 GB cache
- Standard 8 Fibre Channel/4 iSCSI
- Maximum 32 front-end Fibre Channel and/or iSCSI
- Flash drives

CLARiiON also provides the Navisphere® Management Suite, which is a suite of tools that allows centralized management of CLARiiON storage systems. Navisphere provides a centralized tool to monitor and configure CLARiiON storage. The Navisphere suite includes Navisphere Manager, which has a web-based UI, Navisphere Secure CLI (Command Line Interface). CLARiiON provides functional capabilities like point-in-time local replicas and remote replication options for business continuity using the Navisphere management tool. Navisphere Management Suite also includes EMC Navisphere Quality of Service Manager, Navisphere Analyzer, SnapView™, SAN Copy™, and MirrorView™.

4 Case Study

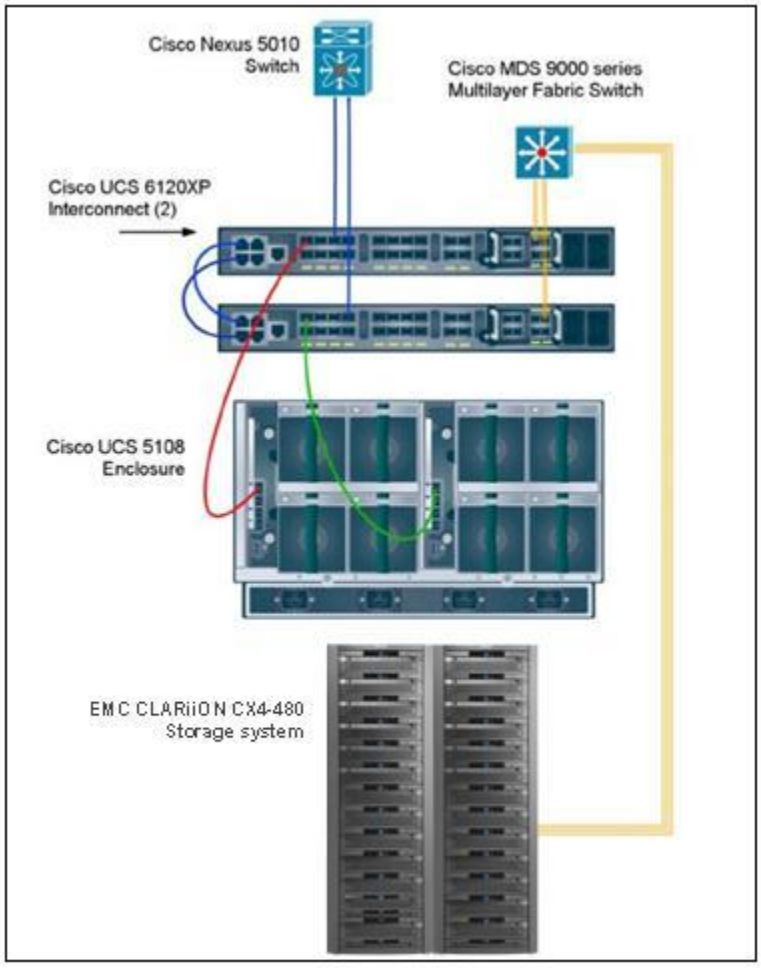
The case study involved the use of Cisco UCS B200 M2 and UCS B250 M2 servers running SAP ERP 6.0 EHP4 in Virtual Machines of ESX4.0 with storage carved out of EMC CLARiiON CX4-480 backbone. Both servers were running Intel Xeon processor X5680.

Solution architecture

SAP ERP 6.0 EHP4 with the SLES 10 SP2 x86-64 and Oracle 10.2.0.4 OS/DB combination has been installed on the ESX 4.0 Virtual Machines. Virtual Machines have a uniform configuration with 4 virtual CPUs with 12GB memory and configured to support maximum of 300 concurrent users.

As typical with any customer implementation, each VM configured to represent a customer installation had 250GB of storage allocated.

The graphic shown below describes the network topology of the test set-up:



Hardware and Software Configuration

The following are the test configurations:

- UCS B200 M2 with Intel® Xeon® processor X5680 and 96GB memory.
- UCS B250 M2 with Intel® Xeon® processor X5680 and 192GB memory.

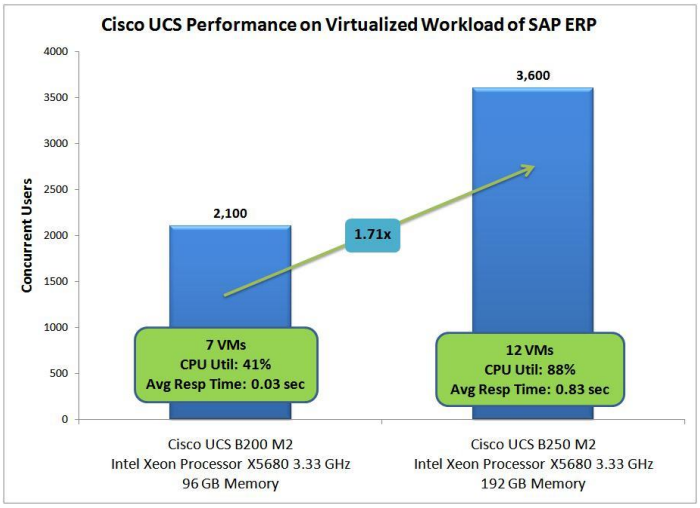
Blade name	UCS B200 M2	UCS B250 M2
Platform ID	SS500GD	SS500GD
Mezznine card(s)	1x (Cisco CAN M71 KR-Q)	2x (Cisco CAN M71 KR-Q)
NICs	2x (Intel 82598EB 10Gb NIC) from the Mezznine card	4x (Intel 82598EB 10Gb NIC) From two Mezznine cards
HBAs	2 x (Qlogic ISP2434 4Gb FC) from the mezzanine card	2 x (Qlogic ISP2434 4Gb FC) from the two mezzanine cards
Local storage	2x(Fujitsu 146GB 10K-RPM SAS)	2x(Seagate 146GB 10K-RPM SAS)
UCS firmware version	1.3(0.128)	1.3(0.128)
Processors	2xXeon X5680 (3.33GHz)	2xXeon X5680 (3.33GHz)
Processor code name	X5680	X5680
Frequency	3.33GHz	3.33GHz
QPI speed	6.4GT/s	6.4GT/s
L1 cache/core	32KB	32KB
L2 cache	256KB	256KB
L3 cache/socket	12GB	12GB
Memory	96GB = 12x 8GB DDR3 1333MHz	192GB = 48x 4GB DDR3 1333MHz
BIOS version	S5500.1.2.0.3	S5500.1.2.0.6
BIOS date	2/11/2010	3/2/2010
HT	Enabled	Enabled
Turbo	Enabled	Enabled
NUMA	Enabled	Enabled
VT	Enabled	Enabled
Hypervisor	ESX4.0 U1 build 208167 on local storage	ESX4.0 U1 build 208167 on local storage
Number of vCPUs per VM	4	4
Memory per VM	12GB	12GB
Storage per VM	250GB LUN from EMC CLARiiON CX4-480 with FC disks	250GB LUN from EMC CLARiiON CX4-480 with FC disks
Number VMs run	7	12
Guest OS	SLES10-SP2 SUSE Linux x86_64	SLES10-SP2 SUSE Linux x86_64
SAP version	ERP 6.0 EHP4	ERP 6.0 EHP4
Database	Oracle 10.2.0.4.0	Oracle 10.2.0.4.0

Workload Description

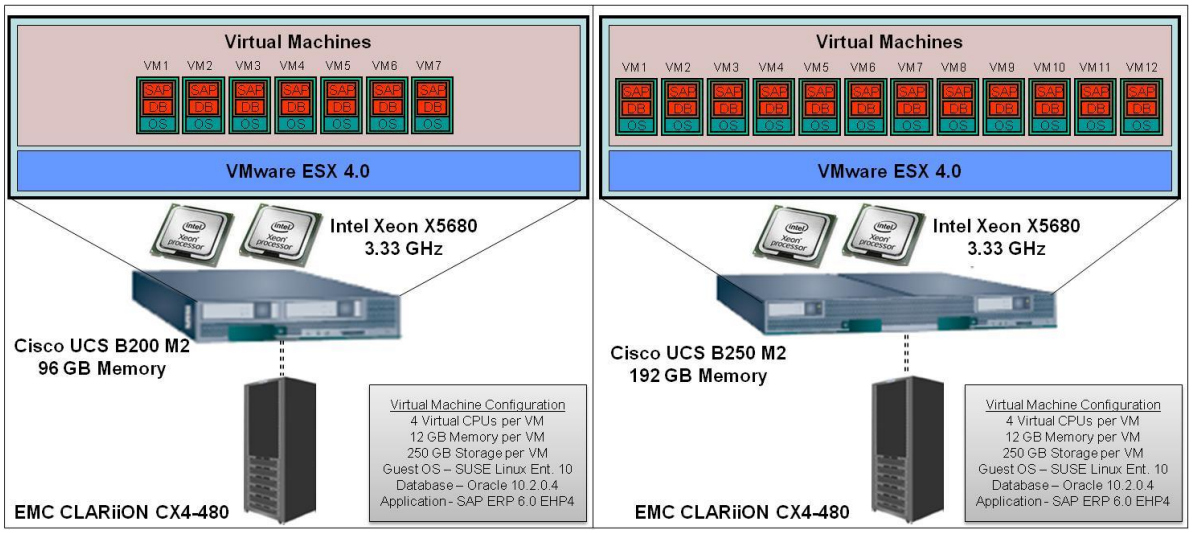
For the test, each VM represents one customer deployment of the SAP ERP solution. Each VM is driven with a maximum user load based upon the Sales and Distribution Center workflow. VMs were added until the average user response times across all VMs exceeded the SLA of less than or equal to 1 second. Performance is reported as the total number of VMs supported, the aggregate number of concurrent users across all VM, the average response time across all VMs and the physical CPU utilization

Performance Results

The chart below shows the results that were achieved on these two platforms. As it can be seen, B200 M2 was able to scale to 7 VMs which corresponds to 2100 users. At this stage the platform is maxed out on memory while CPU capacity was still available. The B250 M2 was able to support 12 VMs, corresponding to 3600 users. At this performance the CPU capacity was fully utilized due to the availability of the additional memory. Thus B250 M2 can support 71% more users when compared to B200 M2.



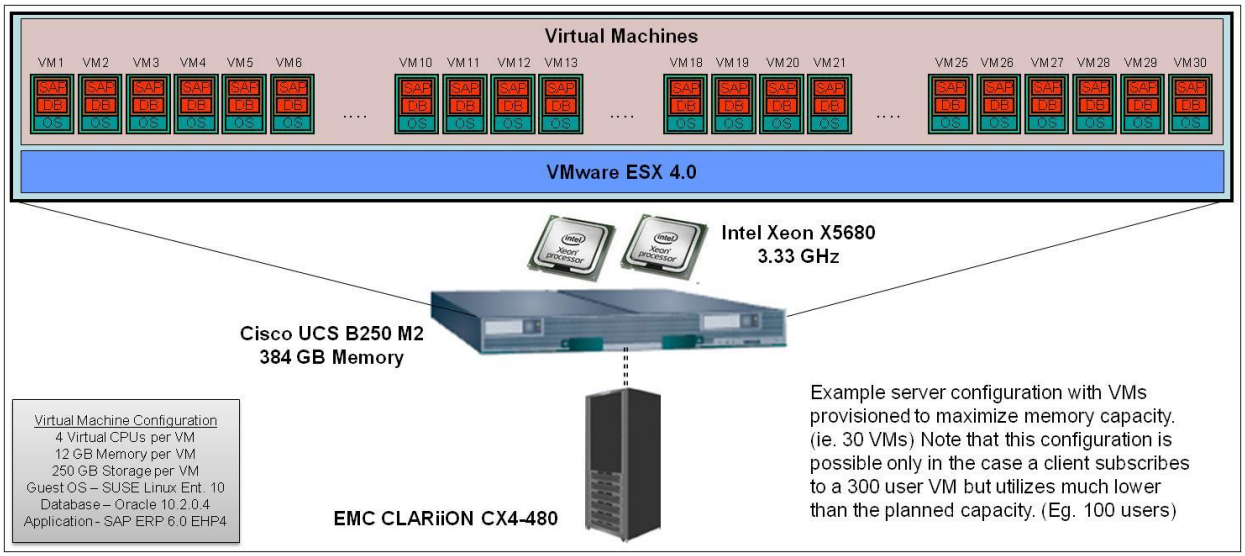
Shown below is a graphical representation of the result as described above in the Performance Results:



Applicability of result to real-world scenarios

Extended memory and over provisioning of clients

In the case study, each customer was assigned a VM capable of supporting up to 300 users. The test case ran 300 concurrent users in each VM, all operating at the same time. In the real world, most customers do not connect that many users at any given time and they usually plan for peak usage patterns when they buy the capacity. This means that the cpu may not be as busy. But SAP's best practice recommends that physical memory should not be over-subscribed and hence memory is committed to the client and won't be freed up even if there is minimal activity. This implies that a service provider can assign more clients (ie create more than 13 VMs) if he has additional memory resource. This makes the case for why UCS with up to 384GB of memory can be a great fit to host more number of clients on a given B250 blade server thereby maximizing the resources. The graphic below depicts this case.



It shows that a service provider can host about 30 clients (for example, 30 VMs) each provisioned to support up to 300 users based on the 12GB memory allocated per VM. Obviously if all clients simultaneously operate all 300 users the server won't be able to handle this due to the compute requirement. But for example if each client connects 30-40% of its planned user at any given time (for example, 100 users/VM) then the server will likely be able to sustain the load. If a scenario arises where the server starts seeing higher CPU utilization, the service provider can bring up additional servers on the fly and migrate VMs to the new server, assuming he has planned for that.

Cloud implementation considerations

The study is very relevant to infrastructure service providers who are building a Cloud offering. But this study in itself does not constitute a whole Cloud strategy as it entails a lot of additional capability. Cisco UCS platform is built with many such technologies which can be leveraged for this. Technologies such as Embedded system management through Cisco UCS Manager, Just-in-time provisioning with service profiles, Unified fabric using 10-Gbps Ethernet, VN-Link virtualization support, Scalable platform architecture, Stateless computing model, combined with best-in-class EMC CLARiiON can form a strong building block in realizing the goal.

5 Conclusion

The study demonstrates the benefits of Cisco UCS platform powered by Intel Xeon Processor 5600 series along with EMC CLARiiON Storage for Virtualized SAP applications. It illustrates a reference architecture for building a scalable SAP service offering with optimal resource utilization. The study also shows the benefit of Cisco Extended memory technology for this enterprise application.