A Reference Architecture for SAP Solutions on Dell and SUSE

This Dell white paper describes small, medium and large reference architectures for SAP solutions running on Dell hardware and SUSE Linux Enterprise Server.

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Executive Summary

Moving from UNIX on RISC to Linux on industry standard x86 hardware has many benefits for the organization, particularly when what you're moving is something as mission critical as an SAP application. Once you've decided to move your SAP applications from UNIX to Linux, you have to then find the right Linux distribution and hardware. This paper describes three example architectures for SAP applications running on SUSE Linux Enterprise Server on x86-based Dell PowerEdge servers and other Dell hardware.

The architectures cover three different sizes: a small architecture for approximately 10-100 concurrent users, a medium architecture for 100-500 users and a large architecture for 1000 users. Organizations can expand these basic implementations for larger needs.

Descriptions of the Dell hardware and SUSE Linux Enterprise Server software are also included.

Intended Audience
This reference architecture is meant for SAP basis managers, SAP architects, SAP database or basis administrators and others responsible for the SAP solutions in their organization.

Scope
This document is meant for organizations considering moving their SAP solutions from UNIX on RISC to Linux on standard x86 hardware.

For those making business decisions or interested in more of the financial benefits of moving from UNIX to Linux on Dell and SUSE, see our white paper *Unix to Linux: How SAP Business Suite Customers Can Reduce TCO by 50% While Boosting Performance.*

Introduction

For many organizations, SAP applications are mission-critical tools. That is why, historically, organizations have run them on expensive, high-performance UNIX systems such as Solaris SPARC, HP-UX and AIX on RISC hardware. With the impressive performance increases made by Linux on x86 hardware in the past years, it is clear proprietary UNIX is a much more expensive solution that no longer provides the unmatched performance it once did.

The same is true for the hardware itself. Costs are significantly lower with x86 than with any other CPU architecture, and analysts have found that on a performance level, x86 CPUs from Intel are likely the best solution for SAP applications and databases[1]. It is no surprise that many are considering the move from UNIX to Linux. In this paper we'll show you three different example architectures of SAP applications running on the SAP NetWeaver platform, SUSE Linux Enterprise Server operating system and Dell x86 PowerEdge servers. The small, medium and large examples that follow will help you see what your organization's SAP application might look like on SUSE and Dell.

Sizing for SAP Solutions

When building a hardware solution to host your SAP applications, one of the most important steps is to size the hardware properly. The SAP Application Performance Standard (SAPS) is a hardware-independent unit of measurement that describes the performance of a system configuration in the SAP environment. The standard comes from the Sales and Distribution (SD) benchmark, where 100 SAPS is defined as 2,000 fully processed order line items per hour. You can use SAPS to determine the hardware system configuration you need to run your SAP solution. In the Dell PowerEdge Servers section we describe the SAPS provided by various Dell systems. A full list of SAP benchmarking can be found on the SAP SD standard application benchmarking site here.

Accurate sizing for SAP solutions is an intricate and detailed process, and there are multiple methods to determining how many SAPS you will need. For detailed sizing work you can use SAP's Quick Sizer tool to translate usage in to SAPS.

This paper uses generalized sizing based on the number of users concurrently using the SAP solution. Knowing the number of users using your SAP application at one time is one way to get an idea of how many SAPS you will need. SAP classifies users as licensed users, named users and concurrent users. Each of the concurrent users can be categorized as a low, medium or high activity user. These categories match those in the Quick Sizer tool. In this document, when we say *user* we mean concurrent users in the high range—that is, users interacting with the system every ten seconds. Most organizations' mix of users will involve fewer high-activity or power users and a broader range of low or medium users.

Another method of sizing SAP solutions is throughput sizing, which takes into account the number of objects moving through a database or application. For certain SAP applications, the number of objects is more important than the number of users. Throughput sizing is also more detailed and is a good step to consider taking after you read this document and before you move forward with your implementation.

You can analyze Early Watch reports from an existing SAP system to provide guidance on your current system load. To get the most accurate and detailed sizing for your SAP environment, you should use the

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[1] "The Trend from Unix to Linux in SAP Data Centers," REALTECH Consulting, Oct 2012.

SAP Quick Sizer tool. These specifics can then form the basis for your discussion with Dell on the sizing for your environment.

A Single Solution in Production

These architecture examples are sized for a single SAP solution. Obviously many organizations use multiple SAP solutions. Dell and SUSE can certainly accommodate as many SAP solutions as your organization needs. This document focuses on a single SAP solution to give a general guide for organizations considering a migration.

Expanding these systems to run multiple SAP solutions would require less hardware than you would get by simply multiplying the equipment shown here, as consolidation and sharing across systems becomes more effective as you implement more solutions. Three SAP solutions, for instance, will *not* require three times the hardware.

Building for multiple SAP solutions or for both production and non-production environments is mostly outside the scope of this paper. Though the following examples will touch on these subjects, the examples are designed to give you an idea of what a single SAP solution in production will look like.

Common Components:

The three reference architectures that follow make use of some of the same components. Let's look at these common components separately before viewing the example architectures.

SAP NetWeaver Applications

The SAP NetWeaver technology platform is the foundation for many SAP solutions, including the popular SAP Business Suite. It enables the composition, provisioning and management of SAP applications across a heterogeneous software environment.

NetWeaver applications function on three layers: the application server (AS), the central services instance (ASCS) and the database layer (DB). The application tier typically handles most of the processing load, coordinated by the ASCS system, and using the database to store the results. All three parts are required, and you would need to protect each if you require high availability (HA). Multiple instances of the application servers can be used to provide HA and handle additional load, and similarly you can protect the ASCS and DB instances as needed. These instances can all share the same server, or operating system instance, or can be separated out each to their own. They can run physically on the server, or on virtual servers through the use of a hypervisor.

SAP Sybase Adaptive Server Enterprise (SAP Sybase ASE) is a relational database management system designed for high-performance transaction-based applications involving massive volumes of data—and thousands of concurrent users. The systems below assume you are using SAP Sybase ASE.

Dell PowerEdge Servers

Dell provides a range of servers specifically certified for SAP NetWeaver, in addition to configurations for other SAP systems such as SAP's HANA in-memory appliance. The majority of the NetWeaver deployments on Dell and Linux, which would include applications such as SAP Business Suite or Business Warehouse, use Dell servers with Intel E5 series CPUs.

These servers are available in a variety of configurations of memory, CPU, I/O connections and so on. Physically the servers come in multiple forms:

- Blade based within a chassis (M620, etc.)
- Rack based individual servers (R620, etc.)
- Free standing towers (T620, etc.)

Many factors will influence your choice of form, but regardless of specific form, the servers can provide the same application capacity.

The Dell line of rack servers certified for SAP NetWeaver consists of:

- R620 – 1U two socket Intel E5-26xx V2 CPU-based server. Capable of over 50,000 SAPS.
- R720 – 2U format of the R620 with enhanced I/O options.
- R820 – 2U four socket E5-46xx CPU-based server. Capable of over 70,000 SAPS.
- R910 – four socket E7 CPU-based server, typically used for the SAP HANA appliance.

Each of these servers allow for a great variety of configurations for memory, CPU, storage and I/O, as shown in the following table. Though you can use many of these variations to support SAP applications, we typically recommend a specific optimized subset for simplicity, as described in the reference architectures later in the paper.

CPU	Unless you have to restrict core count for license reasons, you'll typically benefit from faster CPUs with more cores. The E5-2697 is particularly beneficial with parallelization at the application tier. An alternative CPU, the E5-2643, is specifically for providing performance while minimizing core count and can be used for database instances.	2 socket - E5-2697 v2 - E5-2643 v2 4 socket - E5-4650 *V2 released in 2014*
Memory	The E5 CPUs now support memory with access speed up to 1800 MHz. Each CPU has four memory channels, and these should all be used for optimum memory access. To use all four channels with two CPUs means 8 or 16 DIMMs – having more than two DIMMs per channel can lower the access speed.	1800 MHz - 128GB - 256GB - 512GB

Local Disk	You don't need local disks with Dell PowerEdge servers, but you can use them. You can boot VMware ESX from redundant imbedded SD cards, or from a local RAID1 pair of disks. Without a hypervisor the server can boot from SAN or boot from a local RAID1 disk pair. In addition to operating system and application boot images, you could also use local drives for system paging. If so, performance of these drives is important and 15,000rpm drives are usually used.	- SD internal - R1 15,000rpm/SAS
LAN/SAN	With SAP applications, LAN and storage I/O are both key to performance. Dell provides an increasing range of offerings to meet these needs, including a range of converged network adapters (CNAs).	- 10Gbps LAN - 4, 8, 16Gbps FC - CNA

Sample servers:
Once you consider all your options, you might end up with something like one of these samples.

Application Layer 2 socket, E5-2690 128GB - 256GB R1 local boot 10Gbps DP LAN	**Medium Database** 2 socket, E5-2643 v2 256GB R1 local boot 10Gbps DP LAN 16Gbps FC SAN	**Large Database** 4 socket, E5-4650 256GB - 512GB R1 local boot 10Gbps DP LAN 16Gbps FC SAN

Dell Infrastructure

In addition to the servers required to deploy SAP, you'll also need well-performing networking and storage. Dell provides a range of options to meet these needs, providing the right level of performance at an appropriate cost. Flexible, non-disruptive storage options including flash-optimized solutions through denser archive drives which can be accessed through Fibre Channel or iSCSI interfaces.

Dell provides a range of LAN and SAN switches through the PowerConnect and Force10 product lines. Organizations are moving rapidly from using 1Gbps infrastructure for LANs to 10Gbps. With SAP applications' sensitivity to transit delays, 10Gbps-capable switches are a good choice. The Dell MXL switch allows direct traffic between blades at a full 10Gbps without leaving the M1000e chassis, and allows the use of converged adapters for mixed Fibre Channel and LAN traffic.

SUSE Linux Enterprise Server

SUSE Linux Enterprise Server is a preferred Linux platform of SAP. More than 10,000 SAP customers rely on it to run their SAP implementations. It is based on the newest SUSE Linux Enterprise technology, a highly reliable, scalable, secure and optimized server operating system that is built to power physical, virtual and cloud applications.

SAP and SUSE validated and developed SUSE Linux Enterprise Server for SAP Applications jointly to eliminate potential software incompatibilities, and the two companies continue to test and validate the software stack. Because SUSE Linux Enterprise Server for SAP Applications is validated and certified by SAP it is uniquely positioned to support all of your SAP software solutions, including appliances.

In fact, SUSE Linux Enterprise Server for SAP Applications is the only supported operating system for SAP HANA. For SAP solutions like HANA, which keep business information in memory, SUSE Linux Enterprise Server can use a page cache limit parameter to tune the amount of page cache the Linux kernel uses, thus providing excellent performance for large in-memory workloads.

SUSE Linux Enterprise Server for SAP Applications provides other significant benefits over other Linux deployments, including:

- **Optimization for fast deployment** – An end-to-end installation framework installs and deploys applications in hours, not days.
- **A separate, dedicated SAP update channel** – Fixes and patches specifically for SUSE Linux Enterprise Server for SAP Applications are approved by SAP and SUSE.
- **Extended service pack overlap support** – SAP customers receive 18-month service-pack support, a 12-month extension from the standard period.
- **Optimization for business continuity** – The included SUSE Linux Enterprise High Availability Extension allows you to build both physical and virtual HA Linux deployments.

SUSE Linux Enterprise Server for SAP Applications is the only operating system optimized for all mission-critical SAP NetWeaver software solutions and appliances.

Hypervisors

Dell and SUSE Linux Enterprise Server are hypervisor agnostic, allowing you to choose the hypervisor you prefer. SUSE Linux Enterprise Server comes with both Xen and Kernel Virtual Machine (KVM), allowing you to deploy virtual machines with no additional hypervisor expense. SUSE Linux Enterprise Server also works with vSphere, for those familiar with that popular hypervisor.

Reference Architectures

Small (10-100 Users)

This small architecture is appropriate for organizations that expect between 10 and 100 high-level concurrent users on their SAP application. In this example, all the component parts of a SAP NetWeaver deployment would run on individual virtual machines within a single Dell PowerEdge T620 tower server.

- Application server instances (AS) handling user load
- The central services instance (ASCS) coordinating the system

- The database (DB) holding all system and user data

Figure 1: Small Conceptual View

The goal with a deployment of this size is to have a standalone server for simplicity and cost. You can also separate this deployment's component parts in to rack or blade servers with external storage. This separation would allow further growth and more flexibility with availability options.

For most organizations with a deployment of this size, we recommend a standalone system using internal storage, such as the T620, with its flexibility of I/O and media options and the number of drives available.


Rack format
R620

Tower format
T620

A physically smaller solution that also provides a large number of internal drives would be a rack server such as the PowerEdge R720xd, with 26 available drive slots.

The drive count is an important factor in maintaining the I/O speed required (IOPS), especially when using regular spinning SAS media. Organizations are increasingly using solid state media to provide greater throughput, though the ratio of some SAP write activities require a write-intensive media. Typically the system's IOPS requirement determines the number of drives.

Networking

Many organizations building a system of this size will already have a basic networking infrastructure in place. Typically this will be based on 1Gbps Ethernet. The server connects to this through a bonded pair of LAN connections, providing the option for a highly available LAN connection. Nowadays, a 1Gbps connection can often be limiting, especially if your organization is moving towards the use of iSCSI for storage. Many organizations are switching to 10Gbps LAN connections.
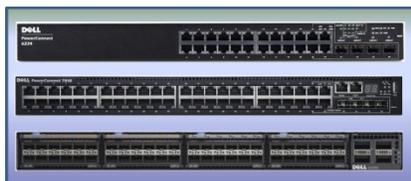
Dell offers a wide range of award winning networking choices, ranging from basic 1Gbps switches up through Force10 switches, such as the S5000, with 10Gbps and 40Gbps port capabilities.

Figure 2: Small Deployment
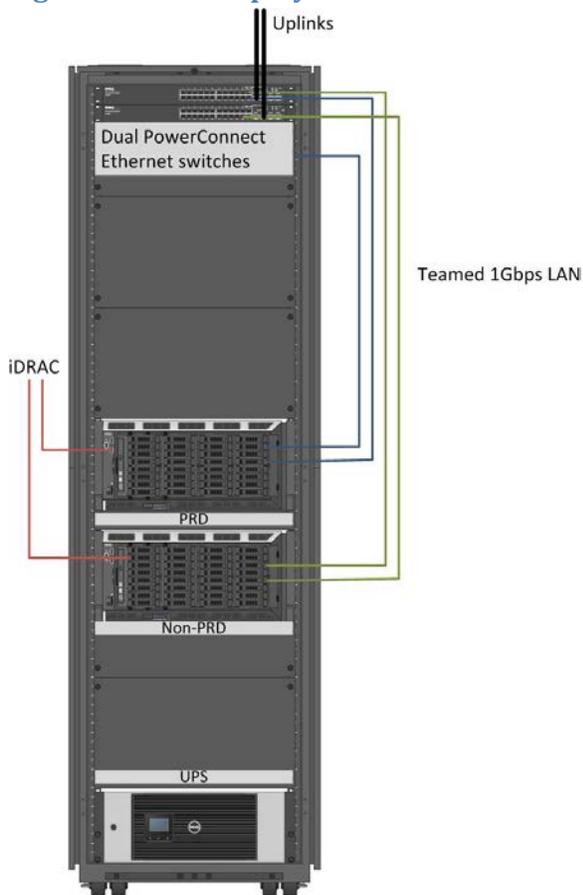
This figure shows a rack-mounted version in a standard 42U rack, rather than the standalone T620, so we can illustrate the necessary wiring. In addition to the production unit, there is a second unit for non-production landscapes such as Development, Quality Assurance and Testing.

If you have not already deployed SAP's Solution Manager, you would likely place this within the non-production instances.

Both servers are connected through bonded network interface cards (NICs) to a pair of top of rack (TOR) Dell PowerConnect 7024 switches. These switches then use 10Gbps uplinks. The switches feature 24Gb Ethernet ports for wire-speed switching and up to four 10Gbps uplink ports.

This configuration could also be built using an R720xd rack server with external storage, such as direct-attached or a Dell EqualLogic iSCSI SAN.

Shown at the bottom of the 42U rack is an uninterruptable power supply (UPS), available from Dell in various power configurations based off load and desired run time.

Note that though Dell PowerEdge servers themselves have many availability features, this small implementation does not include full application high availability (HA). Often customers' smaller implementations do not require HA. If yours does, know that Dell offers various options to add this capability.

Medium (100-500 Users)

This medium architecture is suited for organizations that expect 100 to 500 concurrent users on their SAP application. As with the other examples here, we've illustrated a deployment for only one SAP NetWeaver solution. When you are deploying multiple solutions, such as SAP ECC and SAP CRM, they can typically share the deployment platform. The load of the various systems would be aggregated, and the platform resources shared, while providing sufficient dedicated capacity for each solution's needs.

In this example, the application server instances (AS) and the services instance (ASCS) run on individual virtual machines on two Dell PowerEdge R620 rack servers. The deployment uses two servers to provide high availability.

The database runs on SUSE Linux Enterprise Server for SAP Applications on two Dell PowerEdge R720 rack servers. Again, we use two servers for high availability. When deploying across rack servers, the R720 is often used for databases because it has more I/O slots than the R620. The application tier has no need for I/O beyond its LAN connections for data and hypervisor use. We use a separate database server here to minimize any core-based licensing.

Note you can build a blade variety of this configuration using M620s to replace both the R620s and the R720s.

Figure 3: Medium Conceptual View
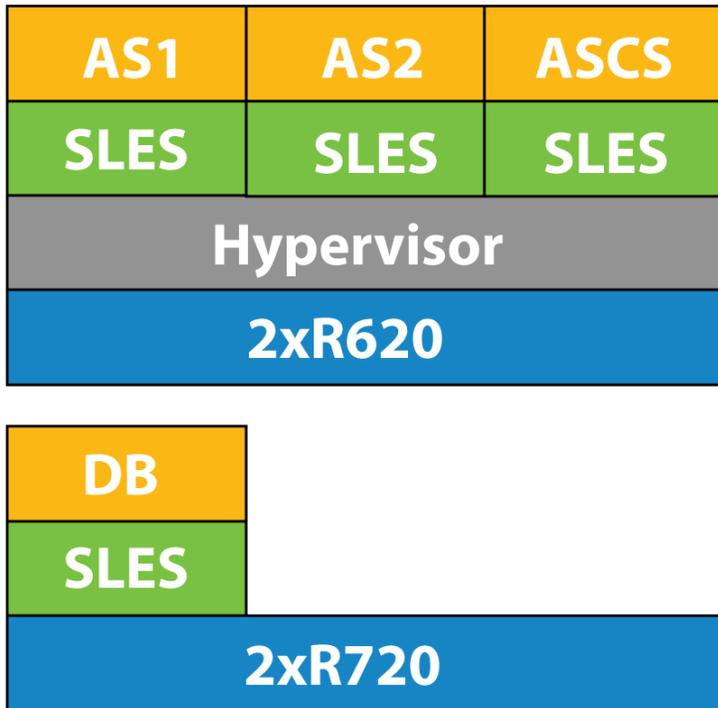
High Availability

In addition to the availability options designed in to the system's components, for application high availability you will need to protect the three parts of your NetWeaver deployment.

- The application servers can use SAP's inherent load balancing when deployed across multiple servers.
- SUSE Linux Enterprise Server for SAP Applications includes features which can provide HA for the ASCS instance.
- HA for the database is provided by mirroring the instance across two servers.

Storage

The system is connected over iSCSI to storage in the form of Dell EqualLogic iSCSI SAN. EqualLogic virtualized IP storage is built on an advanced, peer storage platform. It provides you with a flexible, high performance and reliable solution for block and file-level data.

Dell offers many configurations to meet your capacity and IOPS needs. A typical system for a medium deployment might be the EqualLogic PS6110XV with 10Gbps LAN interfaces and 15,000rpm SAS media.

With 24 of the 146GB/15,000 drives the system would provide 3.5 terabytes (raw), or 7.2 terabytes (raw) with the 300GB drives. Solid state drives are also available to increase the system's IOPS capacity.

Networking

Obviously your networking infrastructure will extend beyond this one solution and would be shared across your applications. As the load increases on your network, you will likely want to switch to a 10Gbps based network if you've not already done so. If you're not yet able to put 10Gbps switches into place, you can use dual-port 10BASE-T NICs in the servers, connecting to your current 1Gbps switches. These NICs will negotiate down, but be able to support the full 10Gbps once you update your switches. By using a 10Gbps link you can divide it to provide adequate allocations for various needs such as iSCSI, user connectivity, the hypervisor and so on.

For this size example we recommend Dell Force10 S4820 switches over full 10Gbps ports with multiple 40Gbps uplinks. They are available with either SFP+ or 10BASE-T connections.

The servers, storage and networking can then fit in to a standard rack, as show in Figure 4.

Figure 4: Medium Deployment
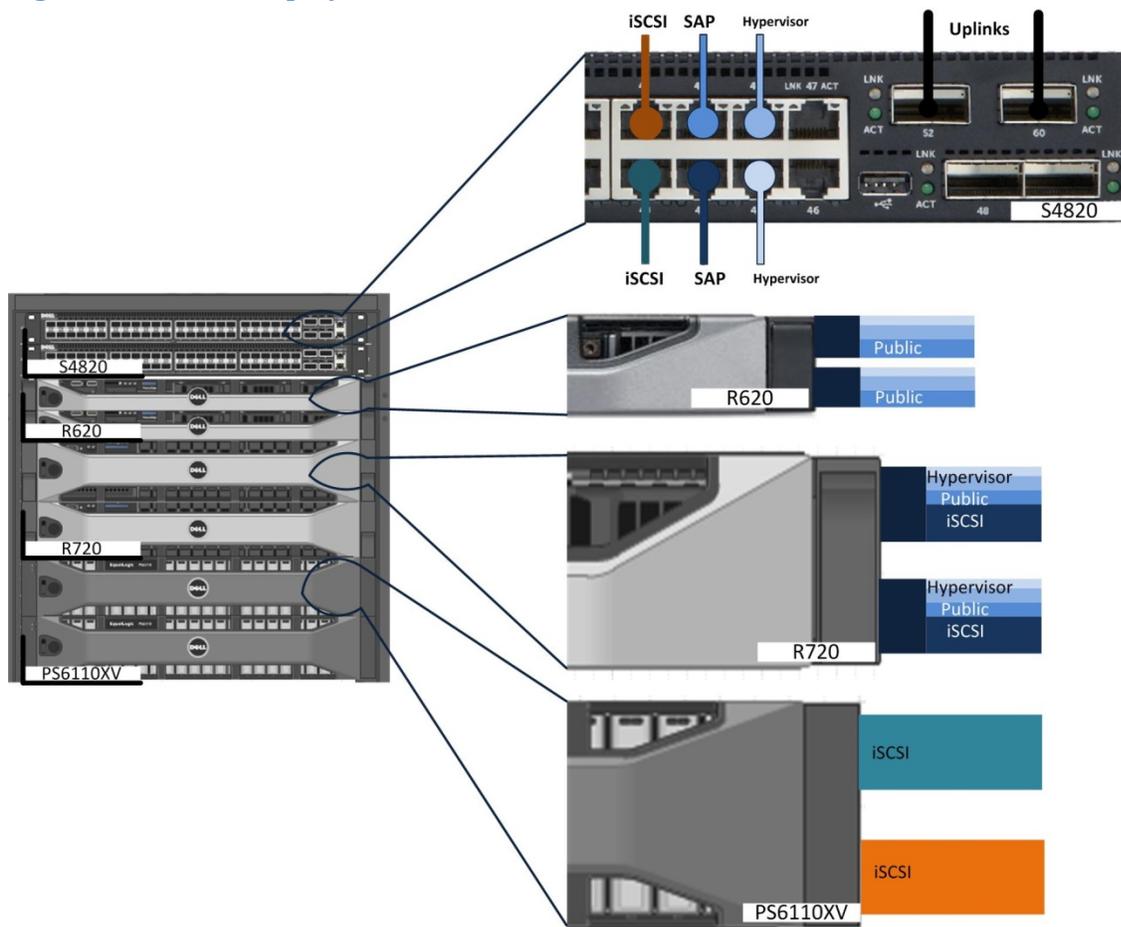
Large (1000 Users)

This large architecture is appropriate if you expect more than 1000 concurrent users on your SAP application. This architecture can be expanded as needed for organizations expecting 2000, 5000 or more users, and for use across multiple SAP applications. In this architecture, the application server instances (AS) and the services instance (ASCS) run on individual virtual machines. These run on five Dell PowerEdge M620 blade servers. Each server making up the virtualized pool uses a hypervisor to host multiple application server instances – potentially from different SAP solutions.

The database runs on SUSE Linux Enterprise Server for SAP Applications on two Dell PowerEdge M820 blade servers.

Figure 5: Large Conceptual View
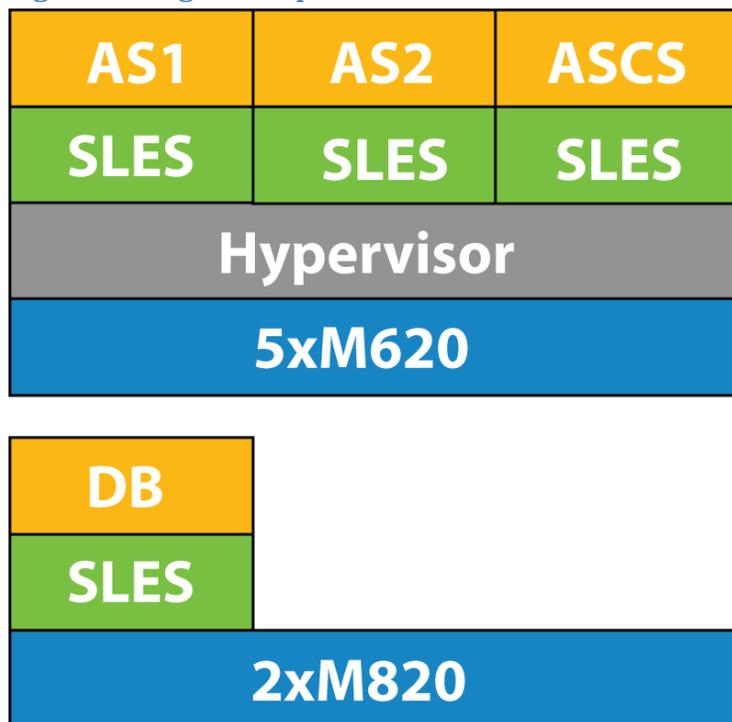
High Availability

We use the same availability architecture here as for the previous medium-sized example, where the AS benefit from SAP's inherent load balancing, the ASCS is protected by the HA features in SUSE Linux Enterprise Server for SAP Applications and the DB instances are protected through mirroring. For HA, you should distribute the AS instances across multiple physical servers.

As an individual solution's load grows, or as the load from multiple solutions increases, the application tier pool would grow. Once you are supporting multiple solutions, you can share the database servers through virtualization or by means of multiple DB instances on the physical server. You can also add additional servers to the database tier as needed and distribute the applications' loads across them.

Storage

The large architecture uses Dell Compellent storage. Part of the Dell Fluid Data architecture, Dell Compellent Storage Center is a virtualized storage platform designed for high scalability, advanced intelligence, centralized management and flexible configuration options.

The Compellent storage system uses redundant controller systems for availability. You can connect these to your servers through iSCSI or Fibre Channel connections.

The system then uses a series of drive shelves, with you basing your drive choice off both your capacity and IOPS requirements. In this example we show a shelf of 24 300GB/15,000rpm drives. Alternative configurations, including all flash-based storage, are also available.

Chassis and Power Supply

The systems used in this large configuration are blade-based, though you could implement it through rack-based servers if you prefer. These blades are held in the Dell M1000e chassis, which offers many redundancy features in areas such as power, cooling and system management.

The chassis can contain up to 16 M620 half-height servers, or up to eight M820 full height servers, or a mix of the two.

It offers management connections front and rear, along with redundant remote out-of-band management connections.

The rear of the M1000e shows:
- Redundant, out-of-band management
- Redundant, hot-swappable power and cooling
- Six I/O bays
    - Three I/O independent paths
    - Redundant power and cooling
    - Multiple 1Gbps, 10Gbps, FC and Converged options

Networking

From the range of options available, we've chosen to build this example with the Dell MXL switch. It provides 1/10GbE connectivity on server-facing ports for up to 32 M-Series blade servers equipped with the latest KR-based 10GbE network daughter or mezzanine cards. For SAP installations, up to 16 servers will make use of the switch for all traffic within the chassis—minimizing transit delays associated with transitioning out to a TOR switch.

We use two of the MXL switches for redundancy.

One option would be to have storage traffic across this switch also, but in this example we've already included a separate Fibre Channel SAN with chassis-based switches.

Figure 6: Large Deployment (front)

The M1000e chassis, with the half height M620s, and full height M820s.

These then use the switches in the rear of the chassis to connect to the two Compellent storage controllers, making use of the SAS based storage shelves.

Figure 7: Large Deployment (back)

The I/O switches are visible in the rear of the chassis. You can see how using the MXL for switching internal to the chassis greatly simplifies the cabling you need to do. With the MXL you can connect the 40Gbps uplinks to a TOR switch, or a four-way 10Gbps splitter.

Similarly the Fibre Channel traffic is consolidated with a pair of Brocade 5424 Fibre Channel switches that sit within the M1000 chassis. These then route to the SC8000 Compellent array.

40 Gbps, or multiple 10Gbps uplinks
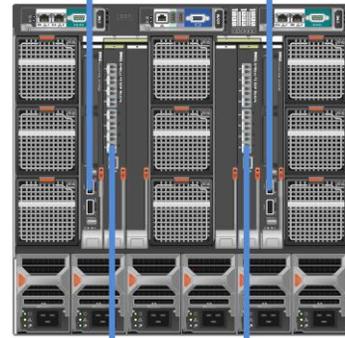
8Gbps FC SAN connections

Compellent FC connected storage

Glossary

1U, 2U, etc. – This shorthand refers to a standardized rack unit, or the size of a server or other rack component. So a 2U server takes up two spaces in a standard rack.

10BASE-T – Twisted-pair Ethernet wire

DIMMs – Dual In-line memory modules.

I/O – Input/Output

IOPS – Input/Output operations per second. A common performance measurement used to benchmark computer storage devices.

iSCSI – Internet small computer system interface. An Internet-Protocol-based storage networking standard.

KR-based – a type of backplane Ethernet

NICs – Network interface controllers (or cards). The connection between a computer and the network.

RAID-1 – A data storage technology.

SAN – Storage area network. A dedicated network providing block-level data storage.

SAPS – SAP Application Performance Standard. A hardware-independent unit of measurement that describes the performance of a system configuration in the SAP environment.

SAS – Serial attached SCSI

TOR – Top of rack. A type of networking switch that sits on top of a server rack, rather than within it.

UPS – Uninterruptable power supply