

# SAP<sup>\*</sup> Solutions—High Availability on SUSE<sup>®</sup> Linux Enterprise Server for SAP Applications

All best practices have been developed jointly between Hewlett-Packard and Novell, as well as with the following hardware and software providers:



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# Executive Summary

SAP\* Business Suite is a sophisticated application platform for large enterprises and mid-size companies. Many critical business environments require the highest possible SAP application availability. SUSE® Linux Enterprise High Availability Extension, running on the modern x86-64 hardware platform, satisfies this requirement.

Modern SAP systems, running critical workloads, have to meet the highest standards for availability of their SAP services. SAP already comes with some basic redundancy mechanisms out of the box. However, for a full high availability, SAP relies on third-party high-availability cluster solutions, that are designed to cover all components in the SAP solution stack, that could fail and cause an interruption of the SAP services. The protected components include for example the SAP NetWeaver\* software, SAP databases, the network, server hardware and the underlying storage systems.

The goal of most businesses is to reach an availability of up to 99.999 percent. This is less than five minutes of service outage per year. This goal is attainable only when all single points of failure are eliminated and when takeover procedures happen reliably, smoothly and very fast in the event of an outage.

HP and Novell offer the right hardware and software technologies to run fully redundant, high-available SAP systems for critical SAP workloads.

HP delivers SAP-certified enterprise-class hardware such as the HP\* ProLiant\* blade servers and HP EVA\* storage arrays. Together with various management technologies, the

servers, blades and storage systems make up a proven platform for high-availability SAP systems of all sizes.

Novell delivers the SAP-recommended Linux\* operating system, SUSE Linux Enterprise Server 11. It is fully validated and certified by SAP for almost all SAP products. Together with the High Availability Extension, Novell offers a complete Software stack to make SAP systems high available. Third-party high-availability cluster solutions are no longer needed. SUSE Linux Enterprise Server for SAP Applications, which was developed specifically for SAP workloads, includes the operating system and the high-availability extension with the required SAP resource agents. No additional software is needed.

Once they have these hardware and software technologies, cluster architects need additional resources. High-availability SAP systems tend to be very complex, and individual requirements for storage replication, network connectivity and so on result in an enormous number of architecture possibilities for just one SAP cluster. Extensive resources would be needed to design, implement and test a cluster, that fulfills all individual requirements.

To minimize the planning, implementation and testing required, HP, Novell and several other hardware and software partners have developed a set of best-practices that describe the most common SAP high-availability scenarios at a detailed technical level. Cluster architects can use these best-practices as implementation guides and combine them as needed to setup their individual SAP high-availability clusters.

Each best-practice has been professionally designed, planned and tested by an interdisciplinary team of high-availability cluster and SAP experts. Each best-practice document focuses on a dedicated technical topic. Combined, these make up a powerful documentation collection that covers almost all high-availability requirements.

This white paper provides an overview of the best practices. For more details on each scenario please refer to the document collection at: [www.novell.com/saptechdocs](http://www.novell.com/saptechdocs)

## Introduction

### **SAP on Linux**

Novell and SAP have a strong partnership and cooperate on a wide range of technologies and solutions. Besides the Linux operating system layer, Novell and SAP work closely together to integrate identity and security management solutions from Novell with the SAP NetWeaver platform and business software applications.

Novell has multiple dedicated resources working at the SAP headquarters and the SAP Linux Lab to ensure maximum interoperability between our products and services.

SAP established the SAP Linux Lab back in 1999, to support SAP software on Linux. The Linux Lab assists other SAP departments with software development on the Linux platform, processes Linux-specific support problems and acts as an information hub to all SAP partners in the Linux ecosystem.

Linux enables customers to reduce their total cost of ownership (TCO). Linux distributors do not charge a license fee for Linux because it is open source, so customers need to pay only for support and services. Because Linux is supported on a very wide range of server hardware, customers now have the possibility to escape from vendor lock-in. In terms of administration, SAP customers

see little difference between Linux and proprietary UNIX\*-like operating systems. Linux is well accepted in all areas of data center computing. Through open interfaces and a wide range of supported applications, Linux is capable of providing all required services for standalone SAP workloads and integration in existing SAP environments.

### **SUSE Linux Enterprise Server for SAP Applications**

SAP recommends SUSE Linux Enterprise Server as a preferred Linux platform. Since the very beginning of SAP involvement with Linux, SUSE has been the number one Linux platform for SAP. SUSE Linux Enterprise Server has become the reference platform for SAP software development. SAP now actively suggests SUSE Linux Enterprise Server when customers want to run SAP workloads on Linux. Recently, SAP chose SUSE Linux Enterprise Server as the operating system for the fast-start program of its Business All-in-One solutions.

SUSE Linux Enterprise Server for SAP Applications is optimized to provide the best Linux platform for SAP software.

YaST®, the SUSE Linux Enterprise Server main installation and administration tool, provides an SAP software pattern that installs the prerequisites needed for running SAP software. Also, some system parameters are fine-tuned in preparation for the SAP workload.

### **Support and Certification**

For SAP customers, Novell offers a priority support service link to [www.novell.com/docrep/2007/05/4611143\\_f\\_en.pdf](http://www.novell.com/docrep/2007/05/4611143_f_en.pdf) that provides customers with a single point of contact for support, from the operating system through the application. This offering is valid in combination with SUSE Linux Enterprise Server or SUSE Linux Enterprise Server for SAP Applications.

SAP and Novell are working together to ensure that SUSE Linux Enterprise Server service packs always match the certification of the respective product. In fact, SAP recommends always using the latest available service pack.

Novell provides at least five years of general support for platform and operating system products, including its revisions, starting at the date of a product's general availability. When general support ends, Novell offers extended support for a minimum of two years. This gives SAP customers long product life, ensuring a low total cost of ownership.

### **SUSE Linux Enterprise High Availability Extension**

Your data is the most valuable asset that you have. It is what your business depends on. Robust, scalable and manageable storage is a top priority for your IT department. High-availability storage, applications and services are critical for your business to be competitive. But even as data grows, you can lower storage management costs and still benefit from an easy-to-manage, high-availability storage foundation that scales as needed.

The SUSE Linux Enterprise High Availability Extension, a featured addition for SUSE Linux Enterprise Server 11, satisfies these needs. It includes high-availability service and application clustering, file systems and clustered file systems, network attached storage (NAS), network file systems, volume managers, storage area network (SAN) and drivers, and the means to manage of all these components working together. The SUSE Linux Enterprise High Availability Extension 11 is included in the SUSE Linux Enterprise Server for SAP Applications product from Novell.

Unlike proprietary solutions, SUSE Linux Enterprise High Availability Extension keeps costs low by integrating open source, enterprise-class components. The key components of the extension are:

- *OpenAIS, a high availability cluster manager that supports multinode failover*
- *Resource agents to monitor availability of resources, including SAP instances and SAP databases*
- *Oracle\* Cluster File System 2 (OCFS2), a parallel cluster file system that offers scalability*
- *Cluster Logical Volume Manager (cLVM2), a logical volume manager for the Linux kernel, which provides a method of allocating space on mass storage devices that is more flexible than conventional partitioning schemes*
- *Distributed replicated block devices (DRBD8), which provide fast data resynchronization capabilities over a LAN and replicated SAN semantics, allowing customers to use cluster-aware file systems without additional SANs*
- *High-availability GUI and various command-line tools*

Availability is a result of the interaction of cluster software with application services on the front side and the operating system and hardware resources on the other side. Following this basic idea, cluster software like OpenAIS could not increase the availability on its own. It needs a lot of modules, such as services, resource agents, a messaging layer, network and file system availability, and a stable Linux kernel designed and configured for productive server systems in data centers.

SUSE Linux Enterprise High Availability Extension integrates these open source technologies and enables you to support line-of-business workloads traditionally reserved for UNIX and mainframe systems.

### **SAP Resource Agents**

The SAP Instance Resource Agent is responsible for starting, stopping and monitoring the services in an SAP instance. The resource agent monitors the following services: disp+work, msg\_server, enserver, enrepserver, jcontrol and jstart.

The SAP Instance Resource Agent can be used to manage the following SAP instances:

- *SAP WebAS ABAP Release 6.20–7.30*
- *SAP WebAS Java\* Release 6.40–7.30*  
(For 6.40 please also read SAP note 995116.)
- *SAP WebAS ABAP + Java Add-In Release 6.20–7.30* (Java is not monitored by the cluster.)

The purpose of the SAP database resource agent is to start, stop and monitor the database instance of an SAP system. Together with the relational database management systems (RDBMS) it will also control the related network service for the database. As with Oracle Listener and the xserver of MaxDB, the resource agent expects a standard SAP installation and therefore needs fewer parameters to be configured. The monitor operation of the resource agent can test the availability of the database by using SAP tools such as R3trans or jdbccconnect. This ensures that the database is accessible for the SAP system.

The SAP database resource agent supports the following databases in an SAP installation:

- *Oracle 10gR2 and 11gR2*
- *DB2 UDB for Windows\* and UNIX 9.x*
- *SAP-DB / MaxDB 7.7*

The resource agents are part of the SUSE Linux Enterprise High Availability Extension.

## **HP Hardware**

### **HP ProLiant Systems**

HP ProLiant systems offer simplicity, manageability and flexibility to ideally position them for SAP Business Suite environments. The broad range of SAP applications cover the full range of business solutions, including a middleware stack. HP ProLiant servers meet such sometimes complex IT infrastructures by offering the industry's broadest range of infrastructure solutions. The ProLiant server range comprises the ML, DL and BL blade

series, which offer customers the possibility to deploy either two-, four- or eight-CPU rack-mounted or standalone machines. The DL series is density optimized for flexibility and manageability and ideal for multiserver SAP deployments, while the ML series is suitable for standalone systems that require maximum internal storage capacity. HP BladeSystem infrastructures offer a highly flexible and scalable environment that enables enterprises to embrace change while dramatically reducing their total cost of ownership. HP also offers a set of software tools called ProLiant Essentials that extends server functionality for dynamic resource optimization, automated and intelligent management, and continuous, secure operations. HP BladeSystems\* and some ProLiant Essentials modules make up the infrastructure that supports both the SAP Adaptive Computing concept and the HP Virtual Infrastructure Solution for SAP Business Suite.

### **HP StorageWorks\* 6400/8400 Enterprise Virtual Array (EVA)**

The HP StorageWorks 6400/8400 Enterprise Virtual Array (EVA) family is an enterprise-class storage array system designed to aggregate and automate array management tasks to manage more storage capacity with fewer resources. The EVA family is designed specifically for customers in the business-critical, enterprise marketplace and is a scalable, highly available and highly reliable virtual-array storage solution. The EVA 6400/8400 saves time, space and costs compared to traditionally architected storage. It is supported by a powerfully simple suite of management software, making it easy for users to provision storage and to achieve the highest level of productivity. The HP StorageWorks 6400/8400 Enterprise Virtual Array family is designed for the data center where improved storage utilization and scalability are critical needs. The EVA meets application-specific demands for transaction I/O performance for midrange and enterprise customers. It provides easy capacity expansion, instantaneous replication and simplified

storage administration. EVA products combined with HP StorageWorks Command View EVA software provides a comprehensive solution designed to simplify management and maximize performance.

## Find the Right Best Practices for Your Requirements

Following is a set of best practices that we developed to cover as many of the most-common scenarios as possible. We do not expect one best practice to fit all customer needs. While each best practice focuses on a specific scenario, most of these best practices can be combined to fit your more complex situation.

Depending on the scenario you want to implement, you can select one or more of these best practices from Novell. To help you decide which best-practice matches your preferred architecture and system management principles, we describe each of the best practices in a short top-level view. This will help you implement the optimal infrastructure for running SAP NetWeaver on SUSE Linux Enterprise Server 11 with the SUSE Linux Enterprise High Availability Extension.

The following best-practices have been developed together with customers, partners and our consulting experts:

- *Simple stack high availability with two SAP systems active/active*

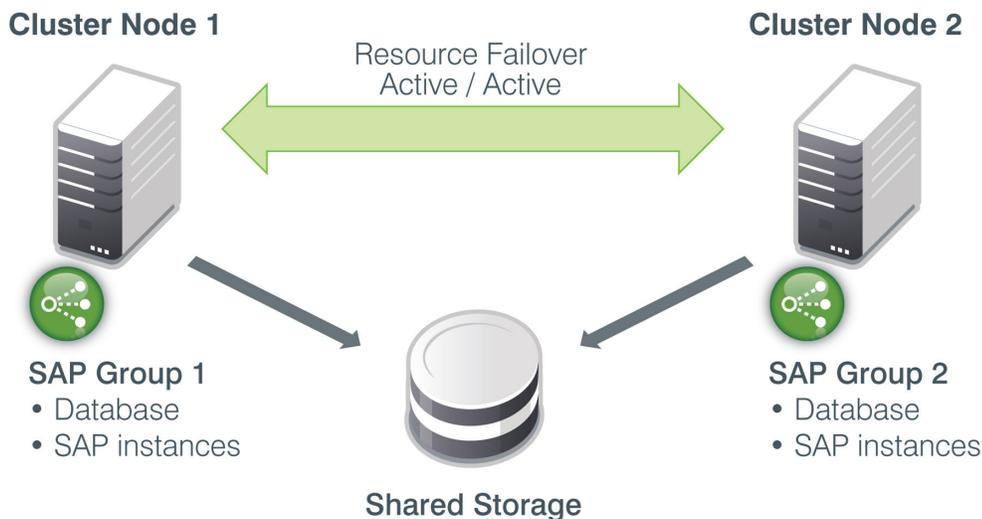
- *Enqueue replication high availability active/active*
- *DRBD data replication high availability active/active*
- *Storage mirror with HP CLXEVA*
- *High-availability NFS server and SAP within one cluster*
- *Dedicated high-availability NFS server*
- *Virtual environments—support of Xen\*, KVM\* and VMware\**
- *Virtual environments—cluster-in-cluster setup*

The best-practices described in this white paper will be published online in the near future. They will be available at: [www.novell.com/saptechdocs](http://www.novell.com/saptechdocs)

## Best Practices Explained in Detail

### ***Simple Stack High Availability with Two SAP Systems Active/Active***

This best practice defines an entire SAP system, including the database and all cluster-controlled instances, on a single cluster node running within a single resource group. The cluster uses shared storage devices such as SAN devices to provide the data to all cluster nodes. However, to minimize cluster complexity, the file systems are mounted by one cluster node at a time. This gives you the free choice of using any supported Linux standard file system such as ext3, reiserfs and xfs.



**Figure 1.** Simple Stack High Availability with Two SAP Systems Active/Active

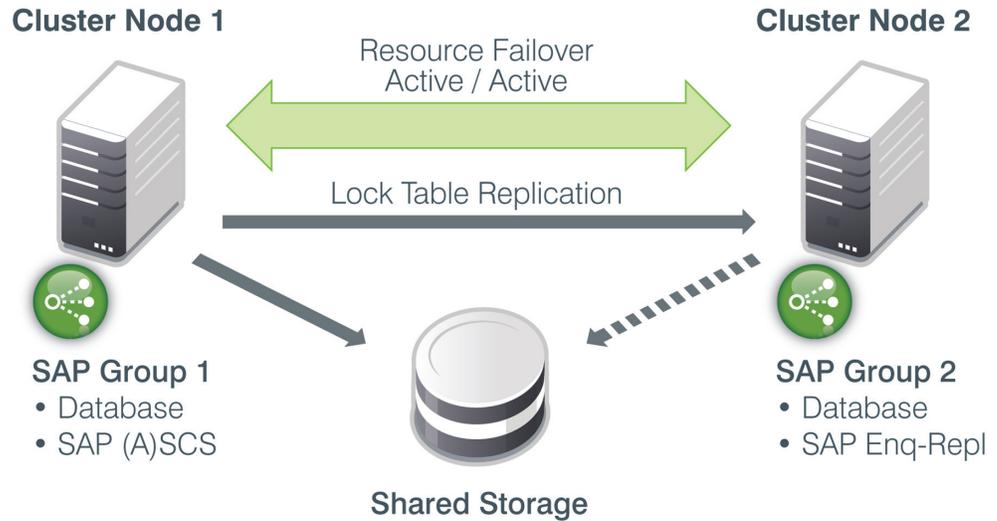
The advantages of this cluster model include:

- *Less complex cluster design*
- *Easy to expand with additional SAP systems*
- *Avoids domino effects, if running a single SAP system in the cluster*

To learn more about the architecture, technical details and how to implement this high-availability scenario, please read our document *SAP on SUSE Linux Enterprise—Best Practices for Running SAP NetWeaver on SUSE Linux Enterprise Server 11 with High Availability Simple Stack* at: [www.novell.com/saptechdocs](http://www.novell.com/saptechdocs)

### **Enqueue Replication High Availability Active/Active**

The best practice Enqueue Replication High Availability supports running an entire SAP system balanced on both cluster nodes. The master/slave mechanism of the SAP instance resource agent for the SCS/ASCS instances allows it to run the enqueue replication server. This increases the availability of the SCS/ASCS instances by providing a replication of the central locking table. In the case of a cluster failover, the SCS/ASCS instances are able to take over the replicated locking table. This mechanism improves the availability of the SAP system.



**Figure 2.** This best practice runs an entire SAP system balanced on both cluster nodes.

The advantages of this cluster model are:

- Locking table replication using the enqueue replication server improves availability of the SAP system
- Load balancing (database/instances) over both cluster nodes
- You can also run the database on a separate cluster if you want to spread the workload

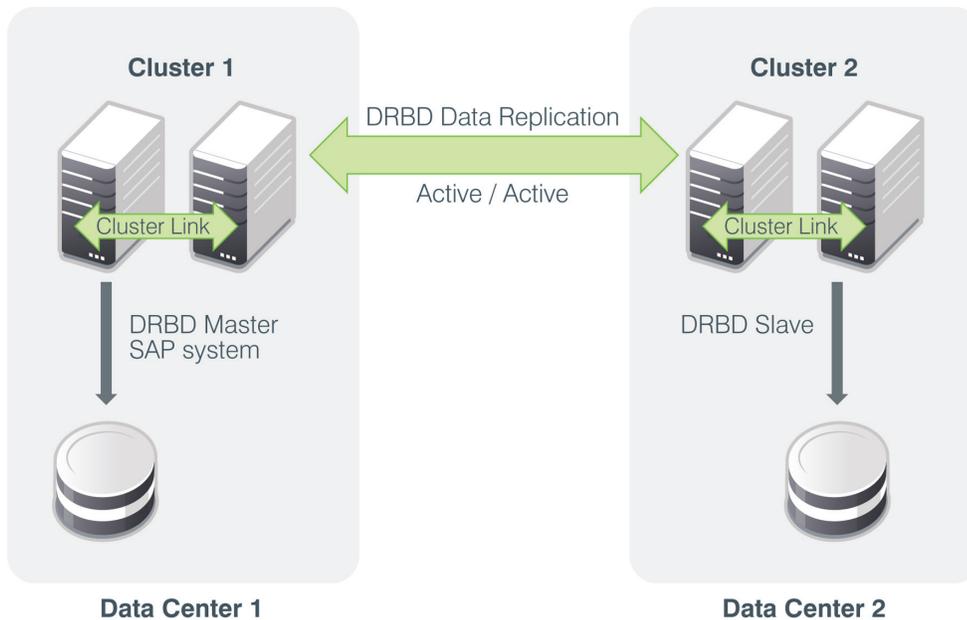
To learn more about the architecture, technical details of this solution and how to implement this high-availability scenario, please read our document *SAP on SUSE Linux Enterprise—Best Practices for Running SAP NetWeaver on SUSE Linux Enterprise Server 11 with High Availability—Enqueue Replication High Availability Active/Active* at: [www.novell.com/saptechdocs](http://www.novell.com/saptechdocs)

### **DRBD Data Replication High Availability Active/Active**

The best practice DRBD Data Replication High Availability Active/Active supports two separated data centers and host-based storage replication from one data center to the other. One of the key cluster techniques is the distributed replicated block device

(DRBD). This technique is included in the product SUSE Linux Enterprise Server for SAP Applications 11 SP1 and SUSE Linux Enterprise High Availability Extension 11. DRBD allows you to transparently mirror data from one node to another via the network. DRBD can be understood as network-based RAID 1.

The example configuration described in the best practice below comprises four SAP nodes spread across two distinct sites, with two nodes per site. The nodes in each site form an OpenAIS/Pacemaker high-availability cluster. This architecture assumes that both sites provide a local SAN with fully meshed fibre channel connectivity. In the example, the cluster nodes are assigned to two SCSI logical units (LUNs) spread across two different shared storage devices. Each cluster node has access to both LUNs with redundant, multipath connectivity and uses Linux software RAID (MD) for host-based mirroring. For replication between sites, a DRBD device is layered on top of the RAID mirror. Thus, asynchronous storage replication between sites requires no SAN connectivity—simple IP connectivity is sufficient.



**Figure 3.** DRBD Data Replication High-availability Active/Active.

The advantages of this cluster model are:

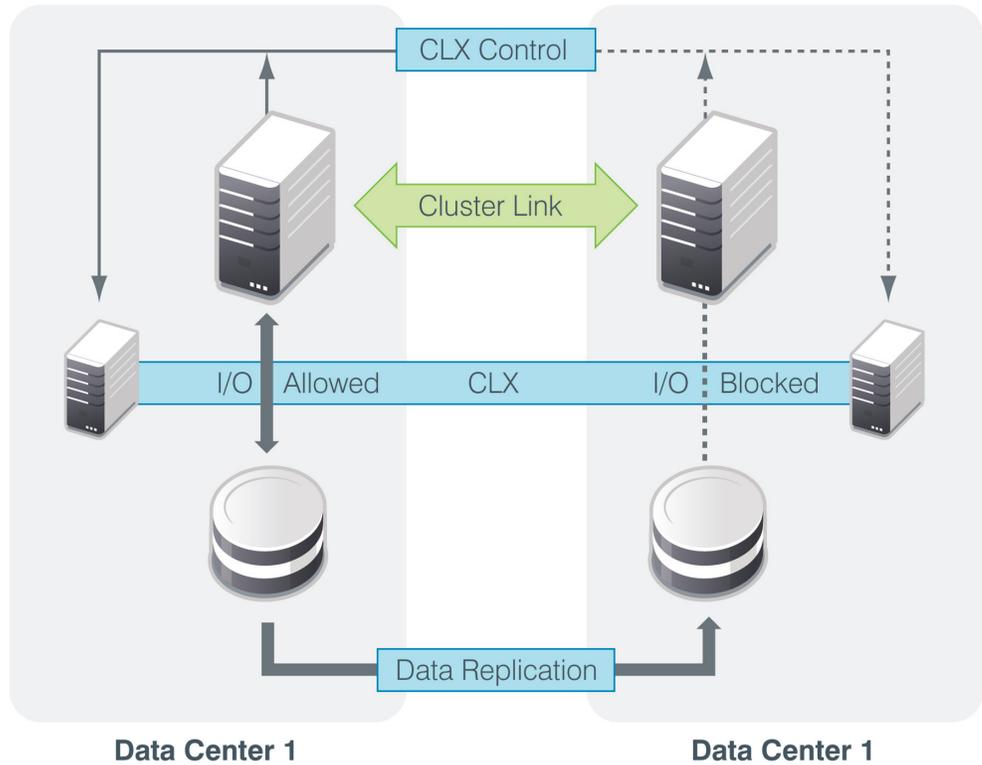
- Data replication from one data center to another
- Supports a wide area cluster
- The remote site (Data Center 2) can be either a standalone or a second cluster
- The solution could also be extended scenarios where the data centers run different SAP systems

To learn more about the architecture, technical details of this solution and how to implement this high-availability scenario, please read our document *SAP on SUSE Linux Enterprise—Best Practices for Running SAP NetWeaver on SUSE Linux Enterprise Server 11 with High Availability—Storage Mirror with DRBD* at: [www.novell.com/saptechdocs](http://www.novell.com/saptechdocs)

### Storage Mirror with HP CLXEVA

The high-availability cluster setup requires two redundant storage systems, either an HP EVA or a P9000/XP storage system. Both storage systems must be connected to a redundant, configured SAN, which connects one cluster node redundantly via a multipath with exactly one storage system.

HP StorageWorks Continuous Access is used to do the hardware-based data replication. It supports most HP EVA and P9000/XP storage systems. HP EVA Cluster Extension (CLX) software is used to integrate control of the data-replication into the high-availability cluster. It is an integrated solution that provides protection against system downtime with automatic failover of application services and read/write enabling of remotely mirrored storage. CLX adapts in real time to real-life situations, providing protection via rapid site recovery. CLX requires no server reboots or LUN presentation/mapping changes during failover, so if the human storage administrator is unable to respond, CLX delivers true hands-free failover/failback decision making. CLX integration provides efficiency that preserves operations and delivers investment protection because it monitors and recovers disk pair synchronization on an application level while offloading data replication tasks from the host. Implementation of a CLX solution ensures the highest standards of data integrity and protects your valuable information against the threat of downtime, whether planned or unplanned. HP provides proven strategies, services and technologies to reduce your exposure and vulnerability.



**Figure 4.** This setup requires two redundant storage systems connected to a redundant configured SAN.

HP StorageWorks CLX software protects valuable information against the threat of downtime and makes operations resilient regardless of external or internal events. The CLX software provides disaster tolerance to keep information accessible and available through adverse events. The CLX software offers protection against application downtime from fault, failure or site disaster by extending a local cluster between data centers over metropolitan distance. CLX reinstates critical applications at a remote site within minutes after an adverse event and integrates with the operating system clustering software and HP StorageWorks Continuous Access software on EVA to automate failover and failback between sites. This dual integration enables the cluster service to verify the status of the storage as well as the server cluster, thus allowing the correct failover and failback decisions to be made. Thus the CLX software

can help customers achieve zero recovery point objectives (RPO) and recovery time objectives (RTO) in minutes or seconds.

The advantages of this cluster model are:

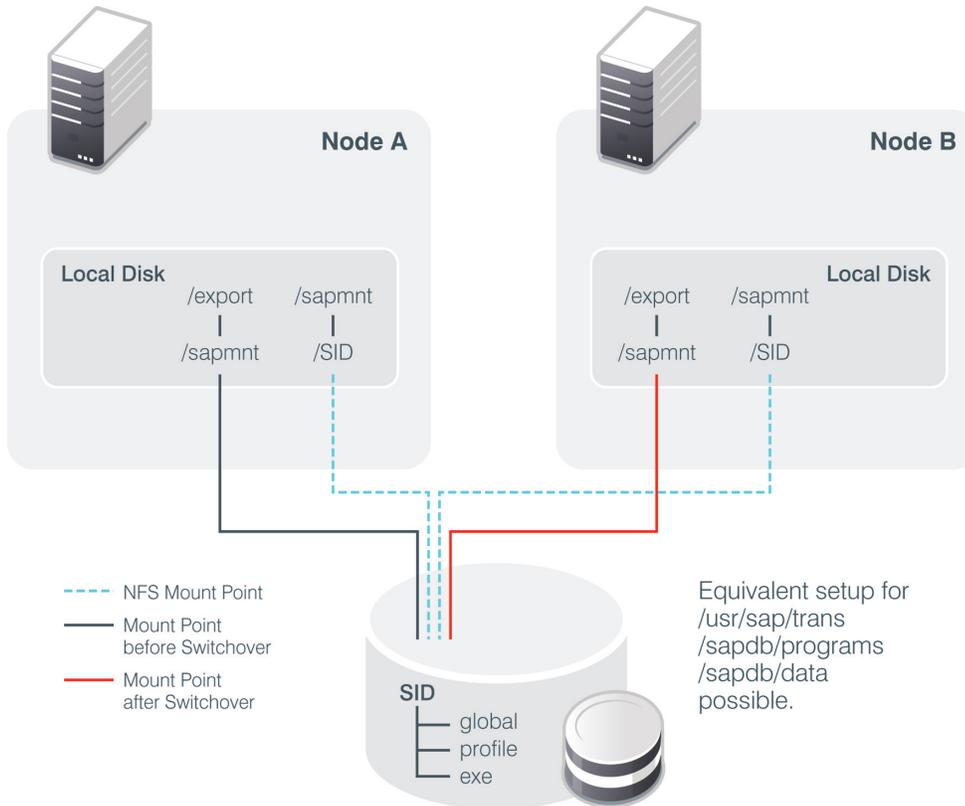
- Data replication from one data center to another
- Storage-based mirroring
- I/O fencing via CLXEVA functionality

To learn more about the architecture, technical details of this solution and how to implement this high-availability scenario, please read our document *SAP on SUSE Linux Enterprise—Best Practices for Running SAP NetWeaver on SUSE Linux Enterprise Server 11 with High Availability—Storage Mirror with HP CLX EVA* at: [www.novell.com/saptechdocs](http://www.novell.com/saptechdocs)

**High-availability NFS Server and SAP within One Cluster**

This best practice describes how to set up a cluster with SAP and an embedded NFS server, which shares the directories needed by all SAP instances. You no longer need an external NFS server for sharing SAP profiles, software and transport area.

This cluster setup includes the resource dependencies between the SAP system and the NFS server. The detailed best-practice document explains how to configure the NFS server and client correctly to avoid cyclic dependencies between the NFS server and the NFS client running on the same node.



**Figure 5.** In this case an embedded NFS server shares directories used by all SAP instances.

Another topic of the best practice is the detailed file system layout to be used for this setup to match the SAP expectations and recommendations. Figure 5 shows the mount points before and after a switchover. To simplify the graphic only one of the file systems has been illustrated. The design is flexible and can cover multiple separated file systems to be provided by the NFS server and to be used by the SAP system.

The detailed best-practice document also explains the takeover of the NFS server resource after a node failure without restarting the SAP instances on the other cluster node.

The advantages of this cluster model are:

- *Load balancing (database/instances) over both cluster nodes*
- *An embedded NFS server reduces total cost of ownership*
- *Extremely flexible design—this best practice can be combined with other best practices such as enqueue replication*

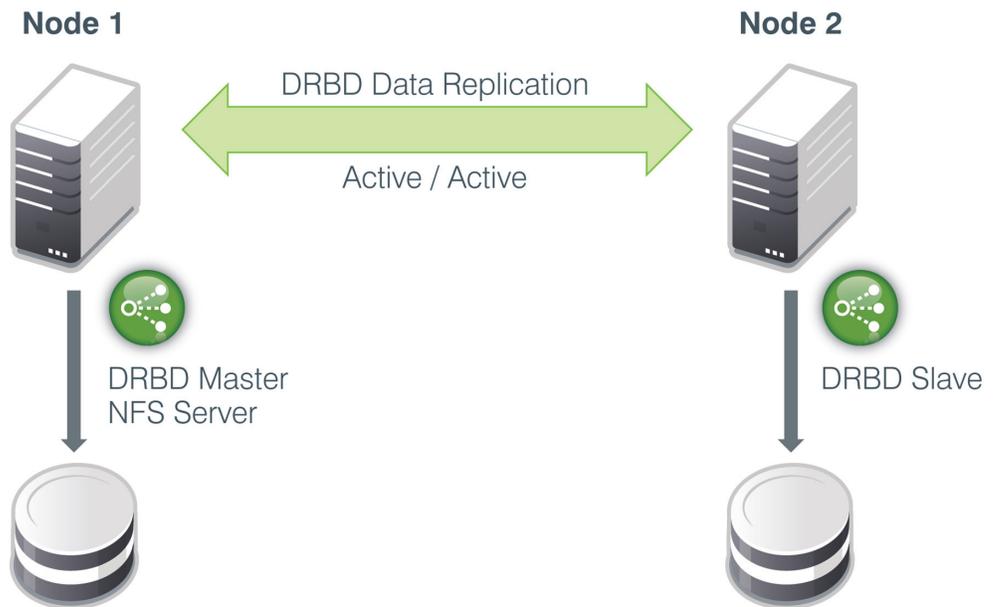
To learn more about the architecture, technical details of this solution and how to implement this high-availability best practice, please read our document *SAP on SUSE Linux Enterprise—Best Practices for running SAP NetWeaver on SUSE Linux Enterprise Server 11 with High Availability—NFS Server and SAP in one Cluster* at: [www.novell.com/saptechdocs](http://www.novell.com/saptechdocs)

### **Dedicated High-availability NFS Server**

For nearly every high-availability SAP installation, a dedicated external high-availability

NFS server is required. Since dedicated external NFS appliances can be quite expensive and may not fit in the architecture of a homogenous SAP landscape, we have developed two alternatives. The first one is the NFS reimport concept, where the NFS server is located on the same cluster nodes as the SAP application servers. However, this best practice should only be used for low-access files systems such as /sapmnt. This concept has been described in the previous section “High-availability NFS Server and SAP within One Cluster.”

The second alternative is to set up a high-availability NFS server based on SUSE Linux Enterprise Server 11 SP1 and the SUSE Linux Enterprise High Availability Extension, or SUSE Linux Enterprise Server for SAP Applications. This solution integrates perfectly with SAP high-availability clusters and can be used even for performance-critical file systems such as for database data files.



**Figure 6.** In this best practice, a high-availability NFS server is based on a SUSE Linux Enterprise product.

Details and features are as follows:

- *Two-node high-availability NFS server based on HP ProLiant servers and blades*
- *Local disks or SAN storage can be used as data storage*
- *The SUSE Linux Enterprise High Availability Extension with Pacemaker is used as cluster software*
- *Supports NFS v3 and NFS v4*
- *Synchronous data replication between both cluster nodes is based on distributed replicated block device (DRBD)*

In addition to comparably low costs, the main advantage of this solution is the very high I/O throughput that can be achieved without losing availability or functionality.

This solution uses DRBD to replicate data synchronously between the local disks or SAN LUNs of the cluster nodes. DRBD is a block-based replication mechanism that uses the TCP/IP network to replicate data in a fast and efficient way. DRBD is included in the SUSE Linux Enterprise High Availability Extension and is fully supported by Novell.

The NFS server software comes with SUSE Linux Enterprise Server. We are using the Linux kernel NFS server, which exports the filesystems via NFS v3 or NFS v4, mirrored by DRBD.

This concept has been proven to be stable and reliable under all circumstances. It is in use with various SAP landscapes of various customers.

To learn more about the architecture, technical details of this solution and how to implement this high-availability scenario, please read our document *SAP on SUSE Linux Enterprise—Best Practices for running SAP NetWeaver on SUSE Linux Enterprise Server 11 with High Availability—Dedicated High-availability NFS Server* at: [www.novell.com/saptechdocs](http://www.novell.com/saptechdocs)

### **Virtual Environments—Support of Xen, KVM and VMware**

More and more often SAP IT architects decide to use virtualization technologies such as Xen, KVM and VMware as part of their SAP landscapes concepts. Virtual SAP systems offers a lot of advantages over SAP system running as workloads on physical machines.

- *Hardware resources can be more efficiently utilized*
- *Several SAP systems and SAP databases can run as separate virtual machines on a single server*
- *The load-balancing mechanism can balance virtual workloads among several physical servers*
- *Live migration ensures maintenance windows for hardware maintenance*

On the other hand, hypervisors and virtual machines don't improve the availability of the SAP system. To achieve real high availability requires running a classic high-availability cluster in the virtual machines. Even if an external high-availability cluster is used to control the virtual machines, we strongly recommend you use an internal high-availability cluster with application-specific resource agents. You can achieve 99.999-percent availability only when the cluster manager controls the application through resource agents. A simple virtual-machine-based failover mechanism is sufficient where availability requirements are lower. In these cases, you must be able to tolerate interruptions and service outages until failover occurs.

We have implemented and tested all SAP high-availability cluster scenarios described in this white paper on virtual machines running on several virtualization technologies. These include Xen, KVM and VMware. As a result, we can confirm that all described solutions can be applied in virtual environments.

Since an SAP high-availability cluster stack involves a lot different technical components, certification and your ability to support the stack are very important. Therefore, we have verified the supportability of the SUSE Linux Enterprise Server for SAP Application operating system and all components such as the SUSE Linux Enterprise High Availability Extension cluster stack, the SAP software, databases and virtualization technologies. The following support matrix gives an overview of our findings.

## High-availability Cluster (Pacemaker) Inside Virtual Machines

SUSE Linux Enterprise Server for SAP Applications				
	KVM on SUSE Linux Enterprise Server	Xen (full-virtualized)	Xen (para-virtualized)	VMware
SAP NetWeaver	Official SAP certification expected Q1 / 2011	OK	OK	OK
MaxDB	Official SAP certification expected Q1 / 2011	OK	OK	OK
Oracle	Not supported	Not supported	Not supported	Restricted

**Table 1.** This solution supports Xen, VMware and KVM.

Our best-practice document “SAP on SUSE Linux Enterprise—Best Practices for Running SAP NetWeaver on SUSE Linux Enterprise Server 11 with High Availability—Virtual Environments,” available at [www.novell.com/saptechdocs](http://www.novell.com/saptechdocs), describes example configurations for Xen, KVM and VMware, including VMware fault tolerance, which integrate well in common IT infrastructures. The Virtual Environments document provides detailed descriptions of the test setups, covering the virtual machine, storage, network setups and integration of virtual resources into the internal virtual machine high-availability clusters.

### Virtual Environments—Cluster-in-Cluster Setup

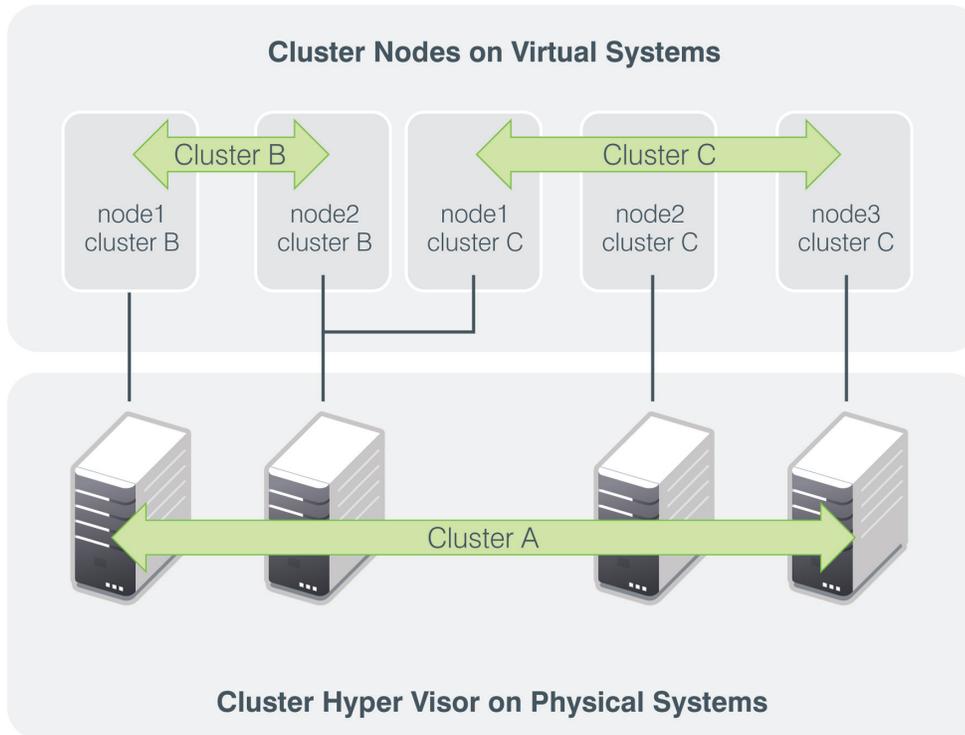
HA clusters running inside virtual machines can be smartly combined with high-availability clusters running outside of the virtual machines. Internal clusters usually control the applications such as SAP, SAP databases and all associated resources such as virtual IP addresses or filesystems. External clusters control the virtual machines themselves,

providing load-balancing services and basic availability in the case of hardware failures.

External clusters usually don’t achieve real high-availability with rates up to 99.999 percent, or five minutes of downtime per year, as they are often required to do by critical SAP systems. They are not aware of the application status and health as well as the status of any other resources running inside a virtual machine. In case of a hardware failure, they have to start the whole virtual machine on another node, which is comparably slower than an application failover.

On the other hand, they can extend the cluster functionality with load balancing, for example; provide automatic or manual live-migration; and improve overall scalability.

The best-practice document *Virtual Environments* describes how externally running high-availability clusters can be combined with high-availability clusters running inside the virtual machine. This document provides the architectural concepts as well an overview of the technologies that can be used.



**Figure 7.** External high-availability clusters can be combined with clusters running inside the virtual machine.

The advantages of this cluster model are:

- *Load balancing by placing virtual cluster nodes strategically*
- *Horizontal scalability*
- *Abstraction of application layer from the physical hardware*
- *Extremely flexible design—this best practice can be combined with other best practices such as DRBD and enqueue replication*

To learn more about the architecture, technical details of this solution and how to implement this high-availability scenario, please read our document *SAP on SUSE Linux Enterprise—Best Practices for running SAP NetWeaver on SUSE Linux Enterprise Server 11 with High Availability—Virtual Environments* at: [www.novell.com/saptechdocs](http://www.novell.com/saptechdocs)

## Conclusion

HP and Novell provide all the required hardware and software components to successfully set up and run high-availability SAP workloads—in physical and in virtual environments.

HP provides with the ProLiant server and blade solutions a powerful platform for SAP workloads of all sizes. HP EVA storage arrays provide the optimal SAN back end to safely store critical SAP business data. Combined with the CLX extension for HP EVA storage systems, HP significantly improves the redundancy of and thus the availability of SAP data stored in the SAN.

Novell provides SUSE Linux Enterprise Server for SAP Applications, the most interoperable platform for mission-critical computing.

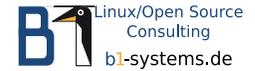
SUSE Linux Enterprise Server for SAP Applications enhances SUSE Linux Enterprise Server with additional functions and services, such as the SUSE Linux Enterprise High Availability Extension, which are tailored for SAP in the data center. They come with all necessary components to run the SAP Business Suite applications as well as SAP certified databases in high-availability clusters. SUSE Linux Enterprise Server 11 is certified for almost all SAP products.

Using SUSE Linux Enterprise Server for SAP Applications together with our comprehensive set of best practices, IT architects get a powerful tool box to design and implement even very complex and customized high-availability SAP clusters that fit individual business and IT infrastructure requirements.

Novell and HP worked together with several hardware and software partners, as well as with customers, to develop solutions that reflect real-world SAP scenarios rather than just theoretical setups. All described topics have been carefully chosen based on specific customer demands. The developed best-practices have been planned, implemented and tested on the same hardware, that is commonly used in data centers running critical SAP systems.

## Credits

All best practices have been developed jointly between HP and Novell, as well as with the following hardware and software partners:



To address the demands of our customers and to develop customer-proven solutions, we worked closely together with the following customers:

- *BASF IT Services*
- *HP Hosting Services*

We would like to thank our partners and customers for their committed engagement. We would especially like to thank our team members from seven different companies for their hard and successful work. We believe that brilliant solutions have their origin in the minds of brilliant people.

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**Novell, Inc.**

404 Wyman Street  
Waltham, MA 02451 USA



**Novell.**