



**White Paper:
High Availability**

High Availability for SAP Solutions

2007

SAP AG
Neurottstraße 16
69190 Walldorf
Germany
T +49/18 05/34 34 24
F +49/18 05/34 34 20
www.sap.com

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Typographic Conventions

Type Style	Represents
<i>Example Text</i>	Words or characters that appear on the screen. These include field names, screen titles, pushbuttons as well as menu names, paths and options.
Example text	Emphasized words or phrases in body text, titles of graphics and tables

Icons

Icon	Meaning
	Caution
	Example
	Note
	Recommendation
	Syntax

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Introduction

To gain additional competitive advantage, enterprises must now work more closely together and integrate their current IT solutions with those of other organizations, such as partners, customers, or suppliers. The availability of these solutions is therefore essential. The number of areas that are critical to enterprises is increasing. SAP provides open, scalable, and available solutions to meet these requirements effectively.

There are the following main availability classes, depending on the degree of availability required:

- Standard availability – achievable availability without additional measures
- High availability – increased availability after elimination of single points of failure
- Error tolerance – highest availability, which even overcomes the failure of an entire production site

With SAP solutions, SAP and its partners support all availability classes.

SAP offers a number of solutions to:

- Avoid unplanned downtime and optimize the support of system administration
- Reduce the effect of planned maintenance work on availability
- Restore production operation quickly

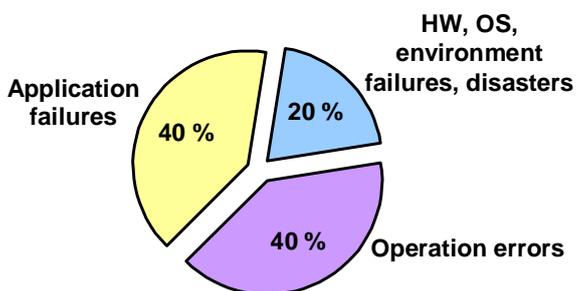
Additional hardware and software solutions are used to increase availability. This requires close collaboration between SAP and its partners.

Avoiding Unplanned Downtimes

It is estimated that approximately 20% of **unplanned downtime** is due to hardware, system software, and infrastructure failure as well as disasters. You can achieve increased availability especially by eliminating single points of failure (SPOF). The Enqueue Replication Server eliminates the only SPOF that has not yet been avoided in the SAP architecture.

Causes for Unplanned Downtimes

Source: Gartner Group



- 80% of unplanned downtime (caused by "human errors") to be addressed with improved system, change and problem management processes

- Hardware, OS, environment failures, disaster impact to be avoided by eliminating Single Points of Failure (SPOF)

A further 40% of unplanned downtime is due to operator errors. You can avoid this by using tools and services to support system operation. SAP provides coordinated system management solutions and a service portfolio to ensure stable operation and identify possible weak spots in advance. SAP also provides change management tools for this purpose.

Avoiding Single Points of Failure with the SAP NetWeaver AS

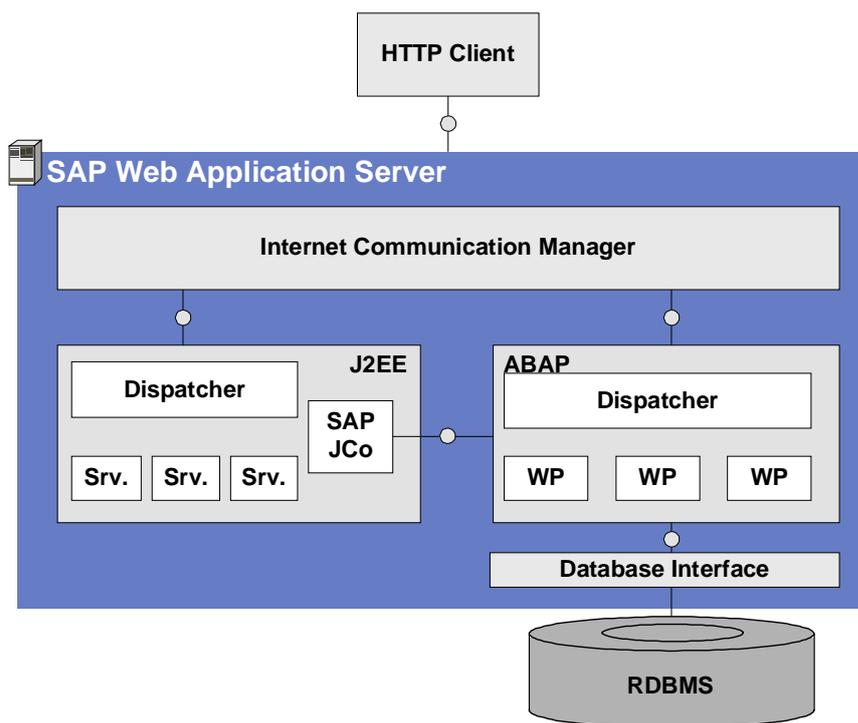
With SAP NetWeaver Technology, SAP provides a proven, scalable, fault-tolerant, multi-tier architecture. The individual components can be protected either by horizontal scalability – that is, the use of multiple components that tolerate the failure of individual components – or by cluster and switchover solutions. All SAP hardware partners provide their own proven solutions, which enable SAP applications using additional software and hardware to achieve high availability.

With the SAP NetWeaver Application Server (SAP NetWeaver AS), SAP enables web applications to be directly supported by the application server for the first time and combines ABAP and J2EE in one infrastructure.

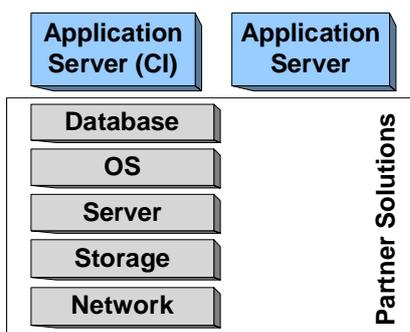
The Internet Communication Manager has also been implemented as another new process in the application server framework. It enables communication between the SAP NetWeaver AS and external partners using Internet standard protocols such as HTTP, HTTPS, SMTP, SOAP, and the Java Communication Services.

The SAP Java Connector (SAP Jco) enables method calls between Java applications and ABAP applications.

Architecture of SAP NetWeaver Application Server



The following levels need to be protected against single points of failure:



The layers below the business applications are generally transparent to these applications. However, in the event of errors, they can affect the availability of the business applications and you must therefore protect them. Partners offer a number of proven solutions for this purpose. The most important mechanisms are described briefly below.

Network

To operate SAP applications in networks, additional components (for example, routers, switches, firewalls, load balancers) are required, which can also be single points of failure. These components are provided by partners. Note especially the following basic measures:

Provider Connection

When you are offering services that extend beyond an intranet, you normally have to use the network connections of internet providers. These connections must be executed redundantly. When choosing Internet service providers, make sure that as many potential customers as possible are also connected with these providers (which increases the likelihood of high throughput) and that peering between the chosen providers is possible, which avoids sudden performance problems due to the failure of one provider.

Router and Firewall

When routers are used, you have to build in redundancy (for example, through appropriate network design). You should also design redundancy into firewalls used to protect a demilitarized zone (DMZ), so that you can avoid any single points of failure.

Network Load Balancing

Load balancing allows the requests to one server to be distributed to a number of servers of the same type. For example, web switches can be used for this purpose, for example. Consequently, load distribution – the web switch enables the servers to be addressed as a virtual server – and failover are possible. To achieve high-availability solutions, you can build failover into redundant web switches so that the web switch itself is not a single point of failure.

Redundant Server Networks

When using the main current switching technologies to design a server farm, you need to take into account the redundancy of the components used. Servers operated in such redundantly designed networks require redundant network connections and IP address transfer. You can develop such solutions by using specific network cards or cluster products.

Other Network Services

Services to be designed with high availability can also use other network services, which in turn also have to be designed with high availability. Examples include DNS, e-mail, domain controllers, and directory servers.



You can find more information on network high availability for SAP applications in the documentation *SAP High Availability*, which you can find in the SAP Library

Storage

Disk storage is particularly important for high availability. It stores important data that needs to be called quickly and reliably. Also, as a component with mechanical parts, it is exposed to wear and tear.

Using technology based on a **Redundant Array of Inexpensive/Independent Disks (RAID)**, you can distribute data redundantly to different disks to achieve both high availability and high performance. This is mostly implemented using special controller hardware. Besides hardware-based solutions, there are also software-based solutions for increasing the availability of disk systems. You can implement strategies using hardware-based RAID solutions (that is, mirroring and striping) together with the software-based solutions.

In the last few years, there has been a trend away from storage units that are connected directly to local computers towards storage systems at network level. A **Storage Area Network (SAN)** is a high-speed network of shared storage systems. SANs are intended for block-oriented input and output. They are normally accessed using fiber channels and are suitable for large environments with high performance and scalability requirements.

A **Network Attached Storage (NAS)** device is a server that has the sole task of providing disk space. NAS enables storage systems to be provided and extended flexibly, without affecting the servers using them. NAS devices are intended for file-oriented input and output and are normally accessed from IP networks.

Features depend on the attributes of the respective devices and implementations. You can obtain more information from the relevant partners.

Note that none of the critical components of storage devices are single points of failure.



You can find more information on how to make use of split-mirror features of storage devices for SAP Systems at:

service.sap.com/split-mirror

Server

You can increase the availability of a server by using multiple components on different servers. This is particularly worthwhile if the applications running on the server are single points of failure.

The following features can increase the availability of servers:

- Redundant resources, such as boards, space, power supply, bus
- Uninterrupted power supply
- Error-correcting memory (ECC memory)
- Mirrored disks
- Hot-plug compatible components
- Partitioning of server resources

The solutions provided by SAP hardware partners include all these features.

Operating System

You should make sure that resources managed by the operating system (for example, host name, IP address, disk storage, processes) are set up so that applications can continue using them

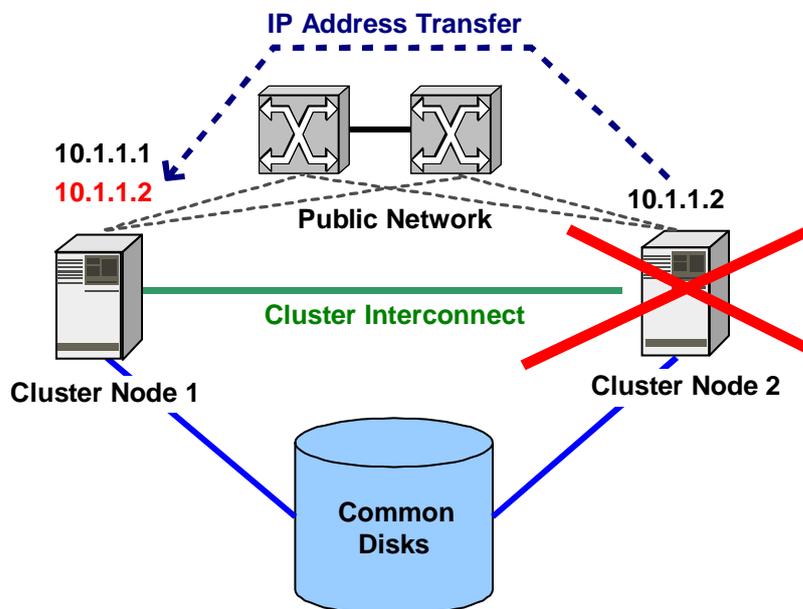
transparently if the underlying hardware fails. To achieve this, multiple layers of hardware can be used with controlling cluster software, which appears externally as one unit. A switchover mechanism ensures that the resources assigned to a node in the cluster are automatically reassigned to another node in the cluster in the event of the first node failing. The affected resources remain available, except at switchover time.

There are the following cluster types:

- A **Shared Nothing Cluster** is a cluster in which each node has its own tasks but also, in the event of another node failing, takes on the tasks of the failed node. Also, in the event of server resources failing, nodes are assigned other server resources.
- A **Shared Everything Cluster** is a clustering model in which each server can have simultaneous read and write access to all common data.

You can obtain information about the exact attributes of a cluster solution from the relevant partner.

Switchover in a Cluster



You can find more information on SAP Systems in cluster environments in the Technical Infrastructure Guide, available from service.sap.com or in the relevant installation guide.

Database

The database is a central building block in the SAP component. Since the data is crucial, not only do you have to make sure that the database is safeguarded against failure, but you also have to regularly save the data itself and check that it can be recovered.

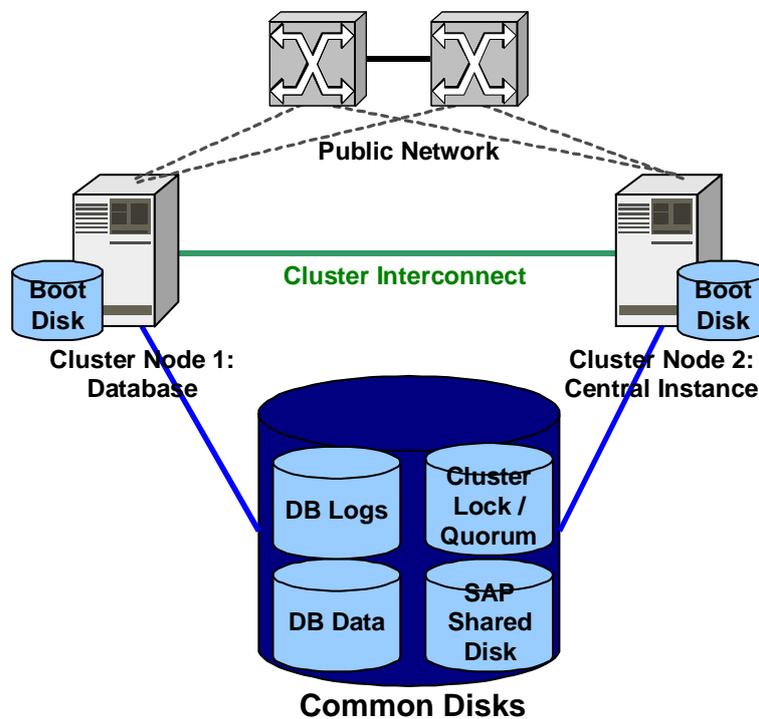
SAP supports nearly all important database systems. However, the database technology is not usually developed by SAP itself, with the partly exception of Max DB. As with SAP's own technology, the SAP partners also provide high-availability solutions for the databases supported by SAP. The additional software and hardware required for this can often also be used to ensure the availability of critical SAP components. There are different methods of protecting databases against failures.

One database	<ul style="list-style-type: none"> • Cluster • Parallel databases
Two databases	<ul style="list-style-type: none"> • Standby database with replication at database level • Standby database with replication at storage-system level

Protection at Server Level Using Clusters

For an SAP component, you can operate the database host and the central instance on two opposite nodes of a cluster, for example. If one of the nodes fails, its resources are transferred to the remaining node, so that the database host and the central instance then run on this remaining host. This normally results in a loss of information. When sizing your system, note that the remaining host now has to perform both tasks.

Server-Level Cluster using Shared Disks

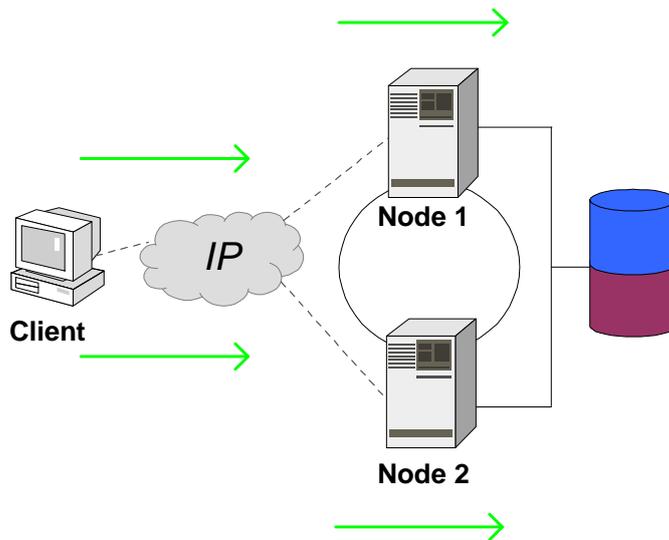


Protection Using Parallel Databases

Besides scalability of the database over multiple servers, **parallel databases** also increase downtime security, depending on the database type.

Parallel databases enable multiple database servers to work with the same set of data, while maintaining data consistency. Uninterrupted operation is guaranteed, even if a node fails.

Parallel Databases



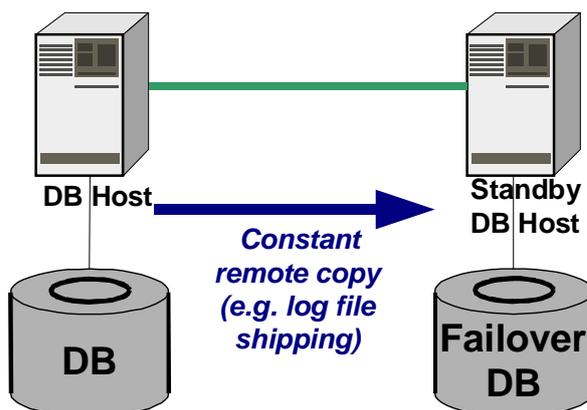
Protection Using a Replicated Database – Standby Database

Standby databases increase the availability of SAP components and overcome the single point of failure that an individual database represents. A copy of the primary database is replicated on a second database host and can be used if the primary database fails.

Protection at Database Level Using Replicated Databases

Database methods for replicating data are used. The type and method of implementation depend on the respective database platform. For example, the log files can be replicated so that, in the event of database failure, the standby database can be started up using the log files and a consistent status reached. However, in the case of asynchronous replication (for example, log-file replication), be aware that the standby database might have an older dataset than the original and that it takes longer to start up the database due to forward recovery.

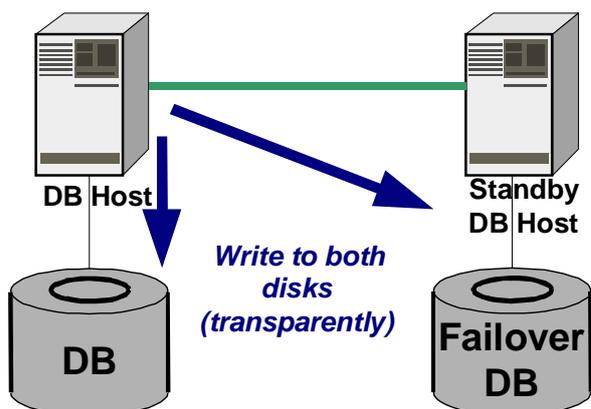
Replicated Database



Protection at Storage-System Level Using Mirroring

Modern storage subsystem methods use remote copying for extra protection. The storage subsystem writes data transparently and simultaneously to both a local and a remote copy. The write process is only complete after data transfer to both copies. The remote copy is write-protected during normal operation. Read/write mode is activated on switching.

Local and Remote Data Copies at Storage-System Level



Database Reconnect

SAP provides the **database reconnect** solution to enable work to be continued without failures after database work has been resumed or the standby database activated. The SAP work processes restore the connection to the database so that the user can continue working without loss of data.

SAP Web Application Server

An SAP application consists of one or more instances of an application server. Each instance can run on a separate server, but it is also possible to operate multiple instances on one host. An SAP instance can provide different service types. The standard SAP services that can be configured on all instances of the SAP component are dialog, batch, update, and spool. The failure of an SAP instance on which only these standard services are configured causes all the transactions processed on it to be terminated and rolled back. Database consistency is guaranteed at all times. Terminated transactions can be repeated on one of the instances still available.

Apart from the standard services, there are two other services that exist only once. They are supplied by the message server and the Enqueue server and are potential single points of failure. The SAP instance with both these services is called the sap central service instance (SCS).

In the SCS instance there is the standalone or Enqueue replication service, the Enqueue service is operated separately from the other SAP services and independently of the other application servers.

Since the message server in the SCS instance is also operated separately from the other application servers, both these critical components can be restarted faster than a complete application server, for example.

Enqueue Replication Service

The enqueue service is a critical component of the SAP system. It administers locking using objects within SAP transactions that can be requested by applications to ensure consistency within the SAP system.

Since the lock table is held in the main memory of the enqueue server, server failure without additional backup measures results in loss of the locks held. To maintain consistency, all open transactions are rolled back after the enqueue server is restarted.

The Enqueue Replication Server enables the lock table to be replicated on a second server, the replication server. A copy of the lock table is maintained on this server. If the Enqueue Server fails, a new Enqueue server is started on the Replication Server using a failover solution (cluster, partner solution) and this replication service creates a new lock table from the copy of the lock table. This enables the Enqueue server, and therefore the whole SAP component, to continue operating almost without interruption. If the Enqueue server fails, transactions are no longer terminated, so that work can be continued transparently.

The hardware partners provide the cluster technology for Enqueue Replication Server, which is required for the Enqueue Server to operate without interruption.

Message Server

To avoid the single point of failure with the message server, this server must simply be restarted quickly. It can be restarted automatically in a few milliseconds using cluster technology.

Logon Load Balancing

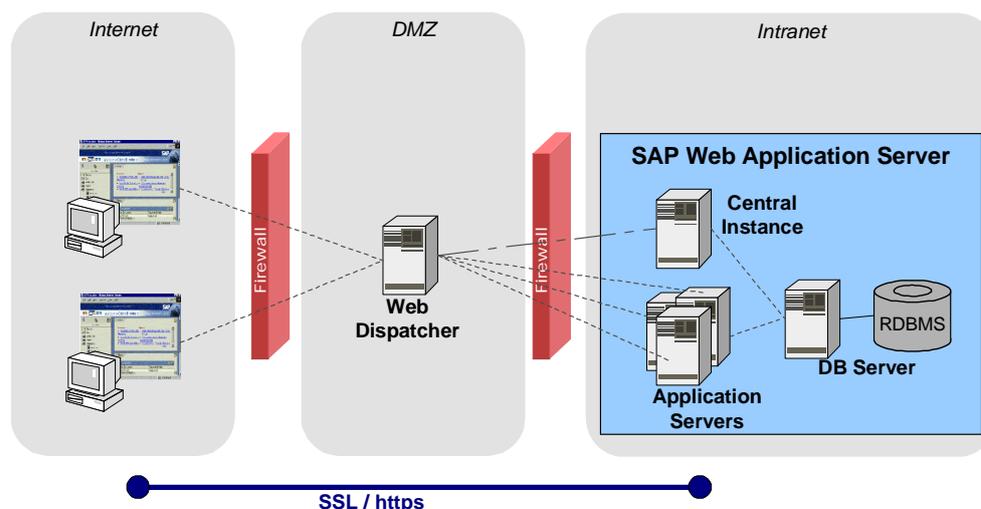
The assignment of user logons to application servers occurs during logon. Application servers can be combined in logon groups, whereby logon assignment depends on the load. In the event of application server failure, the user can log on to another application server in the logon group. However, the data from the user session on the original application server is lost.

The same procedure is also possible for linking systems by remote function call (RFC), where application servers can be combined in RFC groups.

Web Dispatcher

With SAP NetWeaver AS, SAP continues to provide its own technology for web load balancing, the **Web dispatcher**. Similarly to web switches, it enables load distribution of requests to multiple Web Application Servers. Configuration and load distribution are based on information that the Web dispatcher regularly receives from the message server.

Web Dispatcher and SAP Web Application Server



In contrast to message-server based load balancing (redirect), this setup has the advantage that only one address and one host name have to be known externally, for which bookmarks can be used. Also, separate, official IP addresses and server certificates do not have to be provided for each server. In the event of SAP NetWeaver AS failure, rerouting to an available web server occurs automatically.

In contrast to traditional web switches, configuration is simpler because the information from the message server is used automatically.

High Availability for System Landscapes and Scenarios

The measures described above remain important for comprehensive system landscapes. The concept of a group of different components and services only being as available as the individual components or services within it also applies here. You must also consider the interaction between the components in these system landscapes. The failure of one component can, for example, not only mean that the orders in this component can no longer be delivered, but also that they queue up in another component.

Besides the generic components described above, the SAP solutions also use specific components that are scalable and balanced with each other, and which can be used according to the current availability requirements.

SAP Technology enables you to implement comprehensive solutions using portals and an exchange infrastructure. As a result, access to the scenarios and the integration of their back-end systems has changed, resulting in specific availability requirements for both the portal infrastructure and the exchange infrastructure.

SAP CRM and SAP SCM scenarios are used in the following as examples to illustrate how you can achieve high availability in comprehensive system landscapes.

SAP CRM

SAP CRM is a comprehensive solution for maintaining the relationships that an enterprise has with its business partners and customers using many different communication channels – telephone, e-mail, fax, field service, or Internet. The complete customer life cycle (engage, transact, fulfill, service) from customer acquisition through order processing and delivery to customer service is mapped by SAP CRM.

High availability is a central criterion, particularly in the area of eSelling. A web shop has to be open for its customers 7x24 hours a week, without exception. Therefore, we use this example to illustrate the high-availability solutions that SAP offers.

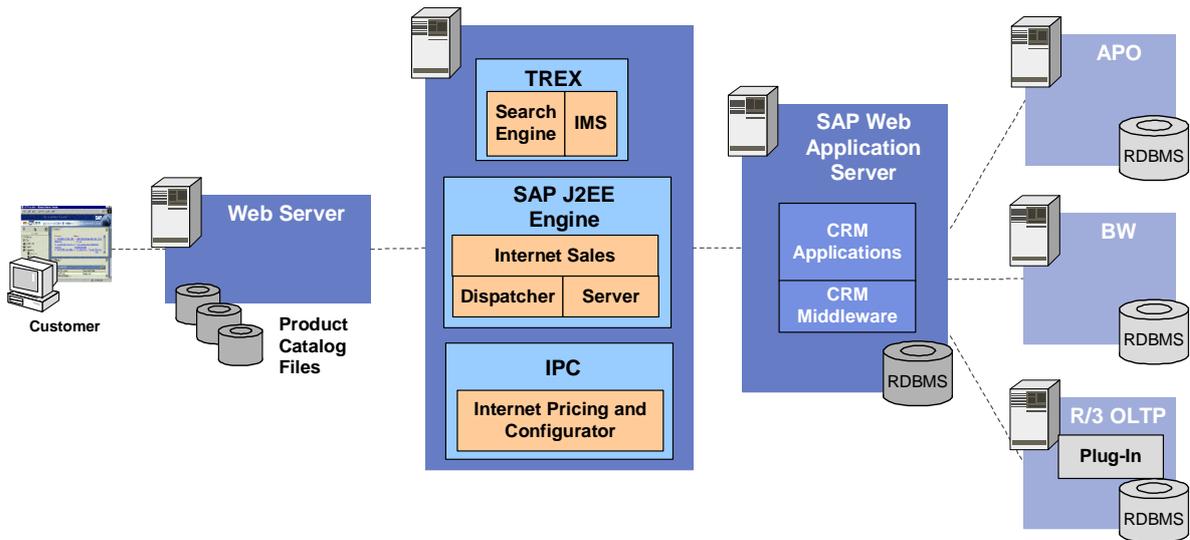
SAP CRM is based on the SAP NetWeaver AS. Therefore, you can use the options for ensuring availability described in the preceding sections for SAP CRM. The same applies to SAP APO, SAP BW, and the SAP OLTP system, which are started from an SAP NetWeaver system.

Internet Sales, the web shop in the SAP CRM solution, is a J2EE application that is based on the Java Functionality. The web shop is separate from the CRM server so that you can use firewalls to increase security. A firewall is recommended not only between the web server and the Java Engine, but also between the web shop and the CRM server.

The SAP Internet Pricing and Configuration (SAP IPC) solution is available for complex price determination and the configuration of products in the Web shop. The TREX search engine enables products to be found quickly in the web shop catalog.

All these components are designed so that they meet the high-availability requirements of a web shop.

Example of CRM Architecture – Internet Sales Scenario



IPC and IMS

The **Internet Pricing and Configurator (IPC)** is a standalone Java application. It consists of a dispatcher and one or more IPC instances. You should design the IPC dispatcher redundantly. Multiple IPCs can be operated in parallel to achieve scalability and prevent downtime.

The **Text Retrieval & Information Extraction Server (TREX)** consists of the index server (IS) and the TREX search engine. It is called by RFC to execute indexing.



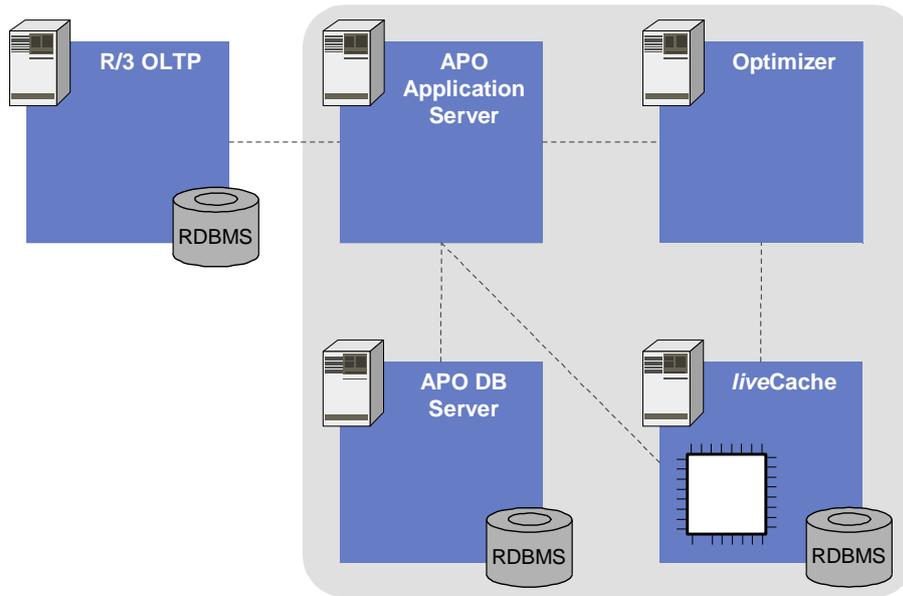
You can find more information on the technical implementation of CRM scenarios at the appropriate Masterguide

<http://service.sap.com/support> → *Release & Upgrade Info* → *Installation & Upgrade Guides* → *SAP Business Suite Applications* → *SAP CRM Your Release*

SAP SCM

SAP Supply Chain Management (SAP SCM) provides a user-friendly, efficient, competitive solution, which enables modeling and optimization of the entire logical chain. An independent SAP component with the SAP Advanced Planner and Optimizer (SAP APO) forms the basis of this solution.

SAP SCM Scenario



SAP APO is started from an SAP Basis system, which means that the measures for increasing availability described above can also be applied here.

Besides the APO database, the liveCache and one or more optimization servers can be used as additional components for SAP APO.

SAP liveCache technology

The SAP liveCache technology is based on [MaxDB](#) and ensures the high performance of SAP SCM. liveCache can be considered as both a second database of an SAP component, which works on an object-oriented basis, and as an additional application server, since business logic is executed in the SAP liveCache object management system. The same high-availability technologies used for [MaxDB](#) can also be used for SAP liveCache. SAP liveCache behaves as a standard database, enabling you to perform backup and recovery, and implement high-availability features. SAP liveCache executes its own object logging. A switchover solution is available for SAP liveCache as well as a hot-standby solution.

The hardware partners also provide the cluster solutions for standby databases and storage-system mirroring, as described in Database [page 12] above, for SAP liveCache and [MaxDB](#).

APO Optimizer

The APO modules SNP, CTM, PP/DS (DPS and SEQ optimizer), ND, and VSR use independent programs, called optimizers. Optimizers use simulations to solve optimization problems and are usually installed on separate servers. If an optimizer fails, the only effect is that the simulation has to be restarted. With regard to availability, optimizers are not classified as particularly critical, since they do not contain local databases and are not single points of failure. To achieve high availability, you can use and configure multiple optimizer servers in the APO.



You can find more information on SCM backup and recovery, SCM high availability, and the technical implementation of SAP SCM scenarios at:

service.sap.com/scm → *SAP SCM Technology*

Reducing Planned Downtime

Planned downtime is when the system is not available for production use due to planned maintenance tasks. The major causes for planned downtime are:

- Maintenance for network and hardware
- Maintenance for system and application software
- System upgrades
- Database reorganizations
- Database backups
- Archiving

Depending on the system scenario, you might be able to design your system so that you can perform necessary maintenance tasks without disturbing system operation. This becomes essential when the business scenario leaves insufficient time for maintenance.

Backups cause planned downtime when an offline backup is required, that is, when the backup requires exclusive access to the data.

To perform maintenance tasks on unique components that cannot be configured redundantly, such as databases, you might require other maintenance strategies.

The following SAP system tasks might require planned downtime:

- Profile parameter changes
- Import of transports requests (coding, structure definitions, and control data)
- Support Package imports
- Release upgrades of SAP software components
- Kernel patches
- Upgrades of middleware components
- Hardware and system software maintenance
- Database reorganizations

We discuss these in greater detail below.

Profile Parameter Changes

You can use profile parameters to configure SAP application servers. These parameters are combined in profiles.

You change parameters by changing the profiles. Previously, you had to restart the affected instances in the SAP system to activate parameter changes. Although restarting an instance is quick, all work processes with their associated user transactions fail, and buffered information is lost, which in turn impacts the performance of the affected instance.

All parameters are stored in the shared memory and can be accessed by all work processes of one application server. This is the prerequisite for online parameter changes. Each work process can now change profile parameters for the entire system. Therefore, you can now change most profile parameters online. An exception is the parameters for shared memory, because an online change might lead to addressing errors for the work processes.

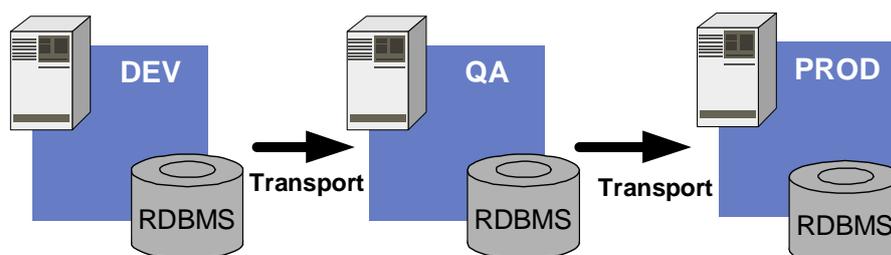
Transports and Software Logistics

SAP software is standard software that you first have to configure to meet your particular needs during the customizing phase. If you have more specific requirements, you can also extend and modify the application programs.

It is very risky to change a production system in this way without thorough prior testing. Therefore, we recommend using system landscapes with the following kinds of system:

- Development system
This is where you develop and customize for the first time. You test the function roughly. The stability of the system is not high.
- Quality assurance (QA) system
This is closer to the production system. You can test changes in a more stable environment.
- Production system
This is used for production and must be very stable.

You initially perform the changes once in the development system. To avoid manually applying changes in the QA and production systems, SAP provides a toolset to transfer changes automatically from the development to the production system. This toolset is called the **Change and Transport System (CTS)**.



All objects (both repository and customizing objects) to be changed are kept in the database of the SAP system. The changes to be performed are included in change requests. These are files that are created by the source SAP system and will later be imported into the database of other SAP systems.

CTS helps to implement changes within a system landscape and helps you avoid operation errors, which are in fact one of the main causes of unplanned downtime. Change management with CTS enables you to ensure quality and consistency for your SAP systems.

For large developments, SAP offers a service that lets you create add-on components instead of transport requests. Add-on components are more stable with controlled version management and also allow shadow import and inclusion into the upgrade. You can maintain add-on components using Support Packages and Note corrections.

Imports into Production Systems

You frequently need to import into a production system a number of change requests containing changes from a long development period. These requests usually contain multiple changes to some objects. Normally, these change requests are imported sequentially, with multiple changes being applied to some objects. You can consolidate these requests by using **merge transports**. This means that transport objects that are included in several change requests are imported once – that is, only the latest version is imported.

We strongly recommend you to test the consolidated change request in an identical copy of the production system – that is, a copy created using split-mirror technology. Merge transports can significantly reduce the required time for such multiple change requests, depending on the number and type of change requests and the duration of the development period. With this method SAP has seen downtime reductions of 30% to 70%.

Using add-on assembly to package your software developments, you can reduce import times even more by exploiting shadow repository import.

Corrections by SAP

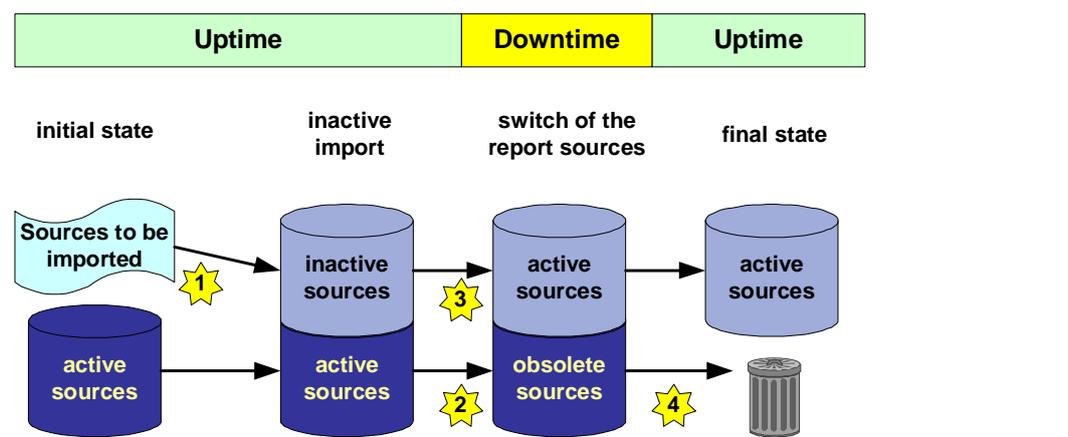
SAP provides corrections and changes to the SAP system by delivering Support Packages and kernel patches. To apply these corrections might cause some planned downtime. Corrections and changes of repository objects of the SAP system are delivered as **Support Packages**. Corrections of the SAP kernel are delivered as **kernel patches**.

Support Packages

You can decrease the planned downtime for the import of Support Packages by using 'downtime minimized' option of the Support Package Manager (SPAM) to **inactively import** for report sources, report texts, classes, and function modules of one or more change requests.

Inactive import means that these new objects are not detected by the runtime environment of the target system and exist in parallel to the old object versions that might already be in the database. The remaining objects are imported during the following import, which consists of DDIC import and main import. You can switch the previously inactive imported objects to an active state after the DDIC import, so that they become visible for the runtime environment.

The main benefit of this downtime minimized option is that you can import the majority of a Support Package during uptime without negatively affecting performance. This greatly decreases the time required for the remaining import steps. You can use this method to significantly reduce downtime, especially for large or multiple Support Packages.



Kernel Patches

Kernel patches contain corrections and enhancements of the SAP kernel. To change the kernel you have to stop the SAP-relevant services on an application server and replace the files of the old kernel with the files of the new kernel (for example, using a soft link to a new directory). You can then restart the application server, which now uses the new kernel files.

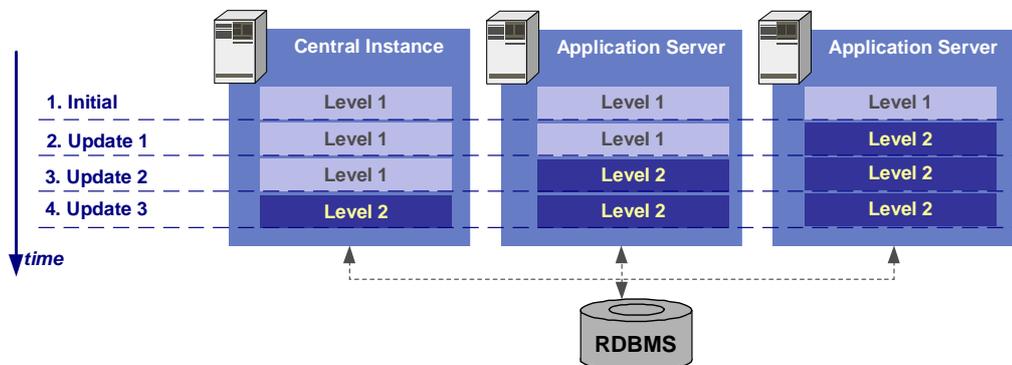
A kernel switch takes only a short time, but requires you to stop all instances of the SAP system, which in turn stops all active transactions. This is very inconvenient, especially for long-running jobs.

SAP plans to support **rolling kernel patch upgrades**.

A rolling kernel upgrade enables you to change the kernel of all application servers sequentially. It has the following requirements:

- The application server must not be a single point of failure. That means that the message server and the enqueue server have to be run separately, using a standalone enqueue server, and protected by a failover cluster.

- Rolling kernel upgrade is only possible for compatible kernels (compatibility is important for the message exchange between SAP instances and shared data structures in the database). SAP guarantees compatibility for kernels of the same patch level. You can only perform a rolling kernel upgrade for kernels of the same patch level with a higher patch number.
- Different kernel patch numbers are only allowed during the rolling kernel upgrade.
- We recommend you to test the rolling kernel patch before applying it in your production system.



Furthermore, there are tools to shut down an application server seamlessly. These tools are required to perform a rolling kernel patch transparently to the user (that is, no sessions have to be aborted). Such a **soft shutdown** is available from SAP NetWeaver AS 6.10. A soft shutdown terminates the work on an application server so that new requests are no longer accepted.

Release Upgrades

SAP releases are part of the product development process of an SAP system. They provide new and enhanced functionality developed by SAP on the basis of customer experience and requirements. As Support Packages contain a number of new repository objects, an SAP release upgrade provides a completely new and consistent SAP software component repository.

During migration to a new repository and during the required customizing steps, the SAP system is temporarily unavailable. Therefore, performing a release upgrade has more impact than importing a Support Package. An SAP release upgrade can also require other upgrade tasks, such as an operating system or database upgrade.

One of the major advantages of the SAP upgrade technology is that you can modify the SAP software for your own needs. During a release upgrade you can adjust these changes or continually modify them, but this requires extra effort.

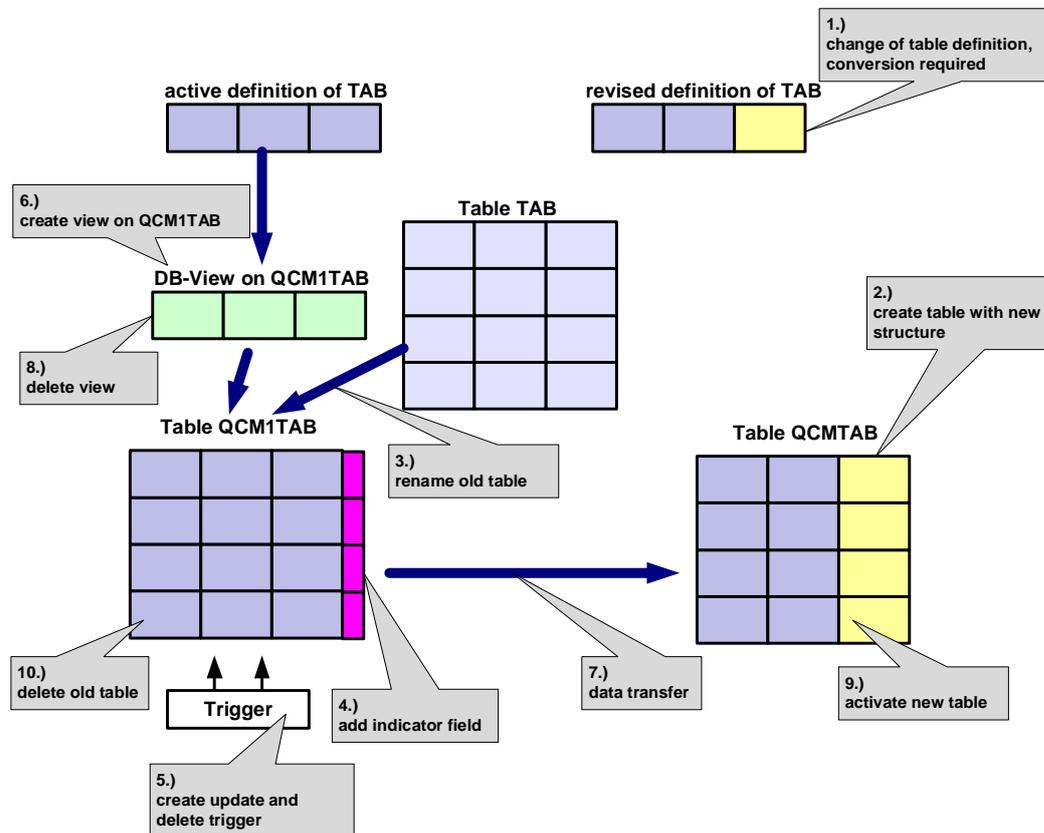
Optimization of the SAP Release Upgrade

A key goal of upgrade tool development is, besides robustness and streamlined user interaction, to minimize the planned downtime required for an SAP release upgrade. The required runtime of a release upgrade is in principle not related to the size of the database and depends mainly on the following factors:

- Hardware – CPU performance
- Operating system – 32- or 64-bit
- Disk configuration – I/O throughput
- Number of modifications
- Number of productive applications
- Number of SAP clients
- Upgrade strategy

Incremental Table Conversion

Release upgrades often lead to changes in the structure of database tables. Sometimes a full table conversion is required, affecting every row in the table. In former R/3 releases these conversions were part of the downtime phases of the release upgrade, contributing to the overall technical downtime. With incremental table conversion (ICNV), available from Basis Release 4.6B onwards, you can perform the conversions **before** the downtime phases of the upgrade (that is, while the system can still be used for production operation).



For upgrade of SAP components, the affected table is converted **before** the upgrade. The PREPARE tool detects which tables need to be converted and where ICNV should be applied. The best improvements are for large tables that would increase the upgrade runtime considerably during conversion.

For the table that has to be converted, a new shadow table containing the new structure is created. The old structure is renamed. Access to the data is handled via a database view. Update and delete operations are done by triggers. The fields of the old table are then copied in the background to the corresponding fields of the new structure. The conversion is complete when all records in the old table are tagged as converted. Finally, the old table can be deleted.

This ensures that the table can be transparently handled by applications although a table conversion is running. The system remains up and running. **Customer-Based Upgrade**

A Customer-Based Upgrade (CBU) is a special upgrade procedure to significantly reduce downtime when you upgrade a production system. This is achieved by creating an individual export at the customer site, which replaces the SAP-delivered standard substitution set.

This export already contains all customer-specific adjustments to the repository, which are normally made during or after the upgrade:

- Importing Support Packages for the target release
- Importing add-on updates and Conflict Resolution Transports (CRTs)

- Modification adjustment (transactions SPDD and SPAU)
- Adjustments to customer development objects
- Creating the corresponding ABAP loads for the customer applications

This customer-specific export removes the need for the following actions when you use a CBU for the production system:

- Dictionary activation
- Modification adjustment with transactions SPDD and SPAU
- Import of repository objects during downtime
- Import of customer transports after the upgrade, with the exception of Customizing
- ABAP load generation after the upgrade

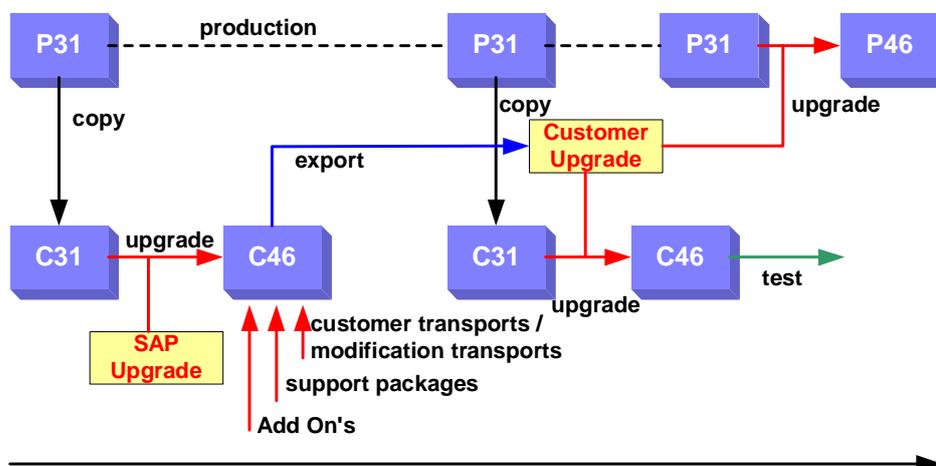
A CBU also offers the following advantages:

- Uses language exports and parallel language imports to reduce the runtime of the language import
- Critical or long-running database modifications (such as `DROP FIELD` actions or creating indexes) can be analyzed and avoided, if necessary

In general, the process flow of a CBU lets you plan the upgrade of the production system more precisely.

CBU has the following steps:

1. A copy of the production system is created. From here, no further development and transport to the production system are allowed until the upgrade is finished.
2. The copy is upgraded using a standard upgrade procedure. The modification adjustment is done here (or a transport from the development or QA system is used). Furthermore, development and delta customizing are transported. Support Packages and add-ons are imported.
3. From the new system, export CDs are created containing the customer-specific repository.
4. This CD set has to be validated. Therefore, you must perform a customer-based upgrade for testing on a new copy of the production system.
5. The production system is upgraded using the customer-based upgrade strategy.



To use CBU you need to:

- Have a method to create fast copies of the production system, such as split-mirror copies
- Make sure that the transports from the development system are ready for modification adjustment, adjustment of your own development objects, and release customizing
- Have Support Packages and add-ons available
- Have additional hardware for the test upgrade

You get maximum benefit from CBU when you:

- Have to import a large number of Support Packages
- Have a SAP system with IS solutions or add-ons
- Have to adjust a lot of modifications
- Have to import a lot of transports after the upgrade
- Expect long adjustment and activation phases

System Switch Upgrade

The System Switch Upgrade is available for upgrades to SAP Components that are based on SAP Web Application Server 6.10 or higher. The System Switch Upgrade ensures short downtime especially for upgrades of heavily modified systems and upgrades including a large number of Support Packages.

During the upgrade, a second instance, the "shadow instance," is installed in parallel with the production system into the same database. This means that:

- During production operation and before the upgrade starts, the shadow instance adjusts the delivered target release software to the requirements of customer modifications and Support Packages. This shadow system contains all the software of the target release and is used to integrate Support Packages and add-ons that are included in the upgrade, and customer modifications into the target release while the system is still live.
- You can perform modification adjustment for DDIC objects during uptime in the shadow system. You can then restore the referential integrity of the DDIC objects using the mass activation program.
- Former restrictions based on having to use source release upgrade tools and programs are eliminated.

The System Switch Upgrade offers the following strategies for differing customer needs:

- "Downtime-minimized" for production systems with high-availability requirements
- "Resource-minimized" for systems with limited hardware resources

The System Switch Upgrade replaces the Repository Switch Upgrade available for upgrades to releases based on SAP Basis Release 4.6D or earlier.

Description of Improvements

Modification Adjustment of DDIC Objects During Uptime

All version management functions are available in the shadow system, which enables you to perform the modification adjustment of the DDIC objects. You can create your own version of the objects or return to the SAP standard version.

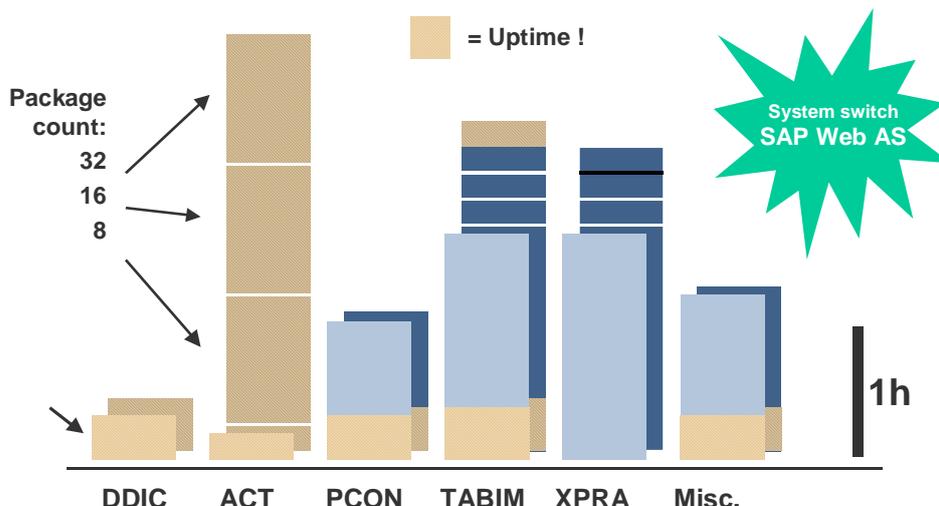
Activation and Distribution During Uptime

You need to activate all DDIC objects (as well as all their dependent objects) changed by Support Packages in the delivered release, as well as objects that you have modified or created. When there are a large number of integrated packages or add-ons, or where systems have been greatly modified, this procedure can take several hours.

The distribution program then calculates how to achieve the transition from the source release structure of a database object to the target release structure.

Since both procedures can be executed during uptime, downtime during the upgrade is largely independent of the number of Support Packages and add-ons included in the upgrade.

No significant downtime extension caused by Support Packages/Add-Ons included in the upgrade!



System Operation During the Upgrade With a Consistent System

The system uses the version of programs that matches the ABAP Dictionary and the state of the database. This avoids the problems of the previous procedure, namely that integrated packages tend to destabilize the upgrade.

Use of Target Release Tools for the Upgrade

Programs belonging to the target release calculate the actions that are required to go from source release structure to target release structure (activation and distribution), and then perform these actions. This removes restrictions that are caused by using source release tools.

Extension of the Shadow Import

Using the shadow system to calculate the target release status of a table before the beginning of downtime lets you import data into more tables in advance. This is because you can already create the shadow tables in the final structure during uptime. Until now, you were only able to do this for new tables and substituted tables.

Specific Use of the ICNV

You can also increase the number of candidates for ICNV, since the amount and target structure can be calculated at the customer site. Therefore, ICNV can also be used for modified tables, that is, modified by customers, add-ons, or Support Packages. The number of tables, together with their structure, is currently limited to a fixed, delivered release.

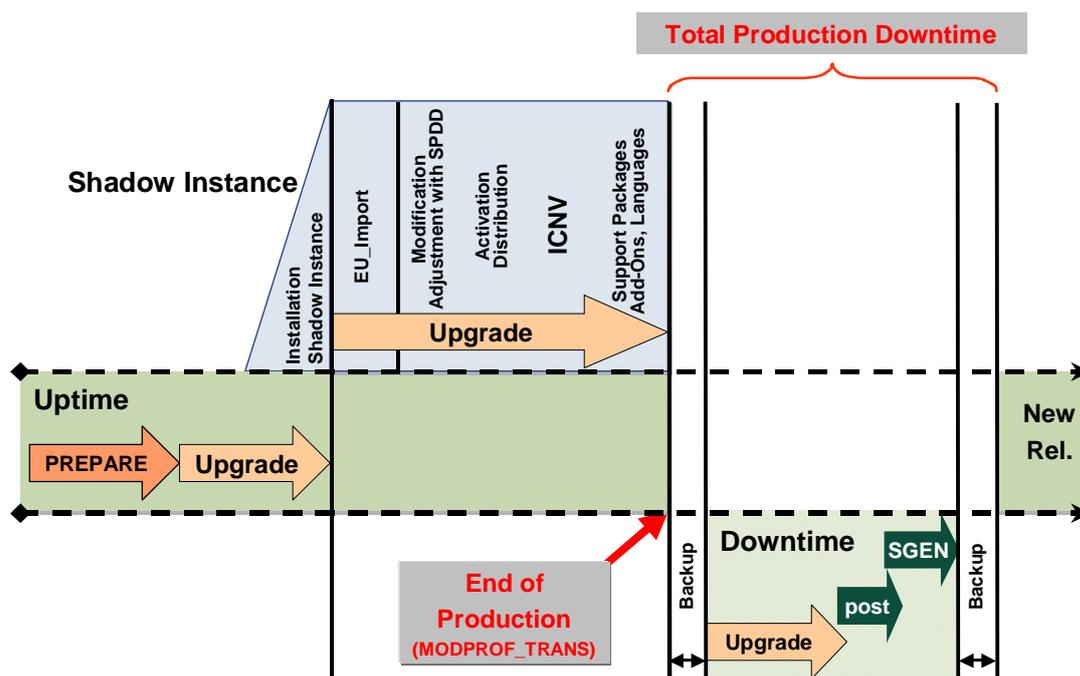
This improvement is particularly noticeable in the shorter downtime in upgrades that include one or more add-ons.

Reducing Upgrade Times

To determine the expected total time to upgrade your production system, it makes sense to test an SAP system upgrade with a similar set of data. A system copy of your production system is best for this.

If you have special requirements for the availability of your SAP system, adjust the process and the length of the upgrade to fit the required period of downtime.

Timing Diagram for Upgrade Strategy Downtime-Minimized



During the upgrade, various actions are performed by and in the shadow system.

- Creation of the shadow repository – EU_IMPORT phases
- Import of additional software packages such as languages, Support Packages, and add-ons – phase SHD_IMP
- Adjustment of modifications to the ABAP Dictionary objects – use transaction SPDD
- Mass activation and distribution
- Incremental conversion of tables – transaction ICNV

The runtime of these actions depends on various factors, including your chosen upgrade strategy, and is specific to each SAP system.

If you use the **resource-minimized** upgrade strategy, these phases take place during downtime. You can influence, among other things, how long these phases take by the number of import processes.

If you have chosen the **downtime-minimized** strategy, you can continue to use your SAP system productively during these activities. You can reduce downtime if you make sure that all the activities that the shadow instance performs to deal with objects are finished before the scheduled start of downtime (phase MODPROF_TRANS). Therefore, start the upgrade in good time. If you finish the activities before the scheduled start of downtime, you can stop the upgrade before the MODPROF_TRANS phase.



You can find more information on SAP release upgrades at:

service.sap.com/upgrade

Changes to Middleware Components

Several SAP business scenarios use additional middleware components where changes might have to be applied. Try rolling changes (similar to rolling kernel upgrades) to mask downtimes of single components.

The SAP Internet Transaction Server (ITS) is included in the SAP correction and transport management system. Changes can be deployed using the IACOR service. The benefit is that you can prepare the changes centrally and deploy them consistently to all ITSs.

Maintenance of Hardware and System Software

Maintenance tasks on hardware or system software might have an impact on the application software and can cause restarts and downtime.

We recommend you to reserve an adequate period for maintenance. Combine several tasks to minimize the impact on the production systems. Be sure to have appropriate change management procedures in place to plan, perform, and test changes – and also possibly roll them back.

If you do not have enough time for adequate maintenance periods, another approach is to set up redundant configurations that can mask maintenance tasks on a single component.

Database Reorganizations

Database reorganizations optimize performance and recover disk space by cleaning up database tables and files, so eliminating fragmentation.

The main causes for database reorganizations are:

- **Tablespace overflow**

The free space within a tablespace can overflow due to unexpected data growth. Be sure to increase the tablespaces in time to avoid this problem (most databases can do this automatically). When the tablespaces can be extended automatically, disk size becomes the limiting factor.

- **Database file fragmentation**

When data is inserted and deleted very frequently (for example, after archiving), this can lead to fragmentation of the data files, which increases disk space requirements. However, this does not normally impact performance and can often be tolerated when availability is the priority.

- **Index fragmentation**

A fragmented index can decrease performance significantly, so that a reorganization is required. The main causes are incorrect parameter settings or frequent insert, update, and delete operations.

When you reorganize a database, you create new database objects and convert the data from the old objects to the new objects. The new objects are not fragmented because they are newly created.

You always have to decide whether to reorganize, which might impact the availability of your system, or to live with the performance or space constraints.

SAP and some database suppliers provide tools for online reorganization without downtime. Check whether such tools exist for your database.

Summary and Outlook

Unplanned downtime can hinder critical business processes and so slow down business activities. By using the SAP solutions with appropriate partner solutions, you can react to this problem by eliminating single points of failure with improved setup of essential components. The resulting high-availability solutions are not only better protected against failure, but they also facilitate gradual growth with increasing customer requirements.

You can integrate SAP Technology with various partner products in high-availability solutions. You can choose from a variety of partner solutions in the following areas:

- Infrastructure
- Network
- Hardware
- Databases
- System management
- Services

The implementation partner creates a complete solution from these and is responsible to the customer.

Besides the prevention of unplanned downtime, you must also consider adequate data backup, as well as possible options for data recovery after logical errors (for example, accidental deletion). Note that the measures described above offer no protection against **logical** errors.

To protect against the effects of the failure of an entire production site, you must set up an alternative production site for disaster recovery. You can use SAP components with appropriate partner products to meet this requirement.

In addition to preventing unplanned downtime, SAP is also striving to further reduce planned downtime and limit the effect of system maintenance on availability. Important features in this area are rolling maintenance procedures, which can be used in multiple components, and improved SAP upgrade procedures, which reduce downtime at release upgrade.

The following checklist shows the most important aspects in a high-availability SAP solution, and can be used to determine suitable partner solutions.

Checklist for HA Solutions

Problem Area	Solution	Suitable Product
Data center infrastructure	Uninterrupted power supply	
	Emergency power backup	
	Failsafe air-conditioning	
	Secure storage for backup media	
Network	Redundant network components	
	Redundant provider connection	
	Redundant network services	
	Network load balancing	
	Redundant network services (mail, directory services, domains, ...)	
Server	Redundant components	
	Error-correcting memory	
	Hot-plug compatibility	
	Cluster technology	
Storage	RAID technology	
	Hot-plug compatibility	
	Split mirror technology	
	Remote copy	
Databases	Standby database	
	Parallel database	
	Cluster	
	Backup and recovery concept	
SAP	Multiple application servers with logon load balancing	
	Cluster-compatible message server	
	Replicated enqueue server	
	Multiple ITSs with WGate and AGate load balancing	
	Multiple CRM Middleware components	
	High-availability liveCache	
System management	System management monitoring tools	
	CCMS and solution manager	
	Defined measuring points for service level agreements	
Services	Proactive and reactive services	
	Consulting services	

	Co-location services	
	Best practices	
	GoingLive, EarlyWatch	
	Hosting services	

The SAP partners can provide you with more information on partner products. For more information on:

- SAP partners, see service.sap.com/partner
- SAP partner products chosen for high availability, see service.sap.com/ha or the SAP Library [page 43]

Glossary

ABAP	See Advanced Business Application Programming .
ABAP Dictionary	<p>A central redundancy-free information repository for all application and system data in the SAP System.</p> <p>The ABAP Dictionary (also known as DDIC) describes the logical structure of application development objects such as tables, views and data types, as well as their representation in the structures of the underlying relational database. Data redundancy is eliminated because all runtime environment components such as application programs or the database interface get information about these objects directly from the ABAP Dictionary. The ABAP Dictionary is an active data dictionary and is fully integrated in the ABAP Workbench.</p>
ABAP load	ABAP code is not executed directly. An intermediate code is generated from the ABAP sources and loaded into the program buffers of the SAP instances that can be executed by the SAP Kernel.
Advanced Business Application Programming (ABAP)	A programming language developed by SAP for application development. All R/3 applications are written in ABAP.
Availability	<p>A service is regarded as available when it can fulfill the tasks it has been designed for. A service is either available or unavailable (there is nothing in between).</p> <p>Since a business scenario consists of a lot of single processes that each consist of chains of single services, the availability of a scenario can only be considered for a particular process. When one service fails, only one process might be affected, although all other processes remain available.</p> <p>Availability can be calculated as follows:</p> $\text{Availability} = (\text{uptime}) / (\text{expected uptime}) * 100\%$
Backup and Recovery Concept	<p>A backup and recovery concept, which is essential for high availability.</p> <p>It describes what data has to be backed up as well as the procedures for backup and recovery. It should also contain procedures for restore tests on a regular basis.</p>
CBU	See Customer-Based Upgrade .
CCMS	See Computing Center Management System .
Checkpoint	A point in time where typically the buffers of a database are synchronized with the data files on disk.

Cluster	<p>A cluster is a set of computers that work together to provide a joint service.</p> <p>Clusters are used to scale up the performance or to achieve a transparent failover between computers in the cluster (that is, cluster nodes).</p>
Co-Location Services	<p>Co-location services mainly use an alternative data center location to build up a disaster recovery site. Specialized vendors offer such services, so that a company does not need to build its own disaster recovery site.</p>
Computing Center Management System (CCMS)	<p>An integrated suite of tools for monitoring and managing SAP R/3 systems and independent SAP business components, with which operations such as resource distribution and managing SAP databases can be automated.</p>
Conflict Resolution Transport (CRT)	<p>Adjusts a Support Package to a certain Add-On.</p> <p>Conflict Resolution Transports (CRTs) are used only in Add-Ons (IS-IS or IS-OIL, for example).</p>
Customer- Based Upgrade (CBU)	<p>A special upgrade procedure that aims to reduce downtime significantly when a customer upgrades a production system.</p> <p>This is achieved by creating an export at the customer site, which replaces the substitution set that is imported in the EU_IMPORT phases.</p>
Database Log File	<p>Databases can be operated to write modifications to log files.</p> <p>Database log files contain the database log. Using the database files and the log files, a database can be recovered to a given point in time.</p>
Database Reorganization	<p>During the work of a database, fragmentation within database files and indexes can occur.</p> <p>This fragmentation can lead to space and performance losses. Database reorganization aims to move the affected parts into new areas of the database in order to overcome the fragmentation. Generally, such reorganizations require database downtime.</p>
Demilitarized Zone (DMZ)	<p>An area that exists between two networks that allows connections between the networks without sacrificing unauthorized access to the systems located within the networks.</p> <p>Example</p> <p>A company typically sets up a DMZ between the company's local intranet and the Internet. The DMZ contains the company's firewalls and routers, which allow Internet protocol connections such as HTTP or FTP into the DMZ. Within the DMZ, these connections are controlled and routed so that the company's intranet is not directly accessible to the Internet.</p>
Disaster Recovery	<p>A method by which an installation recovers its computing services after a severe</p>

disabling event, such as fire.

In a disaster, critical components in the SAP environment become unavailable and service cannot be resumed quickly.

DMZ	See Demilitarized Zone .
Domain Name Service (DNS)	A hierarchical name service in the Internet and TCP/IP based networks, that maps hostnames to IP addresses.
ECC Memory	<p>ECC = Error Correcting Circuits, Error Correcting Code, Error Correction Code</p> <p>Detects multi-bit errors and corrects single-bit errors transparently.</p> <p>To achieve this, a special algorithm is used to create redundant information that helps to detect and correct errors (using the Hamming code principle). It takes 7 additional bits to protect 32 bits and 8 bits to protect 64 bits.</p> <p>Modern servers are mostly equipped with ECC RAM. This ensures that all memory errors can be detected and even the most errors can be corrected.</p>
Emergency Power Backup	Device to generate power independently of the normal electricity grid in the case of a power failure.
Enqueue Service	<p>A transaction that administers the lock table in a distributed R/3 System.</p> <p>The enqueue service (also known as the lock service) runs on the central instance. When an application running on an instance other than the central instance requests a lock, the lock request is sent through the local dispatcher to the message service and then to the dispatcher on the central instance.</p> <p>This dispatcher passes the request to the enqueue work process, which then looks in the lock table to determine whether this request conflicts with a lock that has already been set. If so, the request is denied. Otherwise the lock is set and an entry is added to the lock table.</p>
Enqueue Replication Server	<p>A high-availability solution for the Enqueue Server by SAP.</p> <p>The Enqueue Server replicates changes to its lock table to a remote replication service. When the Enqueue Server fails, the replica table is used to rebuild the lock table when the Enqueue Server is restarted on another node in a cluster. This means that transactions do not have to be rolled back in the event of an Enqueue Server failure.</p>
Enterprise Java Beans	<p>Java architecture for component-based programming of enterprise applications.</p> <p>Enterprise Beans are components of distributed transaction- oriented enterprise applications written in Java. They typically contain business logic that operates on the enterprise's data.</p>
eXtensible Markup Language (XML)	<p>A subset of the Standard Generalized Markup Language (SGML) developed for use in the World Wide Web.</p> <p>XML documents consist of entities that contain either analyzed (parsed) or unanalyzed (unparsed) data. The XML 1.0 specification was created by the XML working group of the World Wide Web Consortium (W3C) and adopted as a</p>

recommendation by W3C in 1998. You can find this specification at www.w3.org. A large number of standards for specific tasks have been (and are being) developed on the basis of XML (such as XLink, XPointer; XSL, XSLT; DOM).

Failsafe Air-Conditioning

Provides defined working temperatures.

Powerful computers have to be operated in a specific temperature range, which is regulated by air-conditioning. If the maximum temperature is exceeded the computer might crash. Therefore, air-conditioning should be failsafe.

Firewall

A special server in computer networks that prevents unauthorized penetration (dialling in) of external people and/or unauthorized data transfer.

A firewall is a type of digital protection wall that, for example, shields an internal network (that is, an intranet) from the Internet.

High Availability

A property of a service or a system to remain in production operation for a large proportion of the time.

High availability for an SAP System means that unplanned and planned downtime is kept to a minimum. Well-managed system administration plays a key role in this.

Hot-Pluggable

Feature of modern computer components.

A hot-pluggable component can be replaced during the normal operation of the computer. This does not require a planned downtime.

Hot-Standby

Feature of redundant components.

Hot-standby components can take over the tasks of a failed component immediately because they have basically the same state as the failed component before the failure (e.g. the application is already running and has the same state as the failed application).

HyperText Transfer Protocol (HTTP)

An application protocol of the World Wide Web (WWW).

HTTP controls the communication between the Web browser (HTTP client) and the Web server (HTTP server).

HyperText Transfer Protocol with SSL (HTTPS)

A connection that provides for encrypted communications between the client and the server.

In addition, server-side, client-side, or mutual authentication are also supported. When accessing Internet sites that are protected with SSL, you use the prefix HTTPS: in the URL instead of HTTP.

IACOR Service

A tool for publishing Internet Transaction Server (ITS) files such as service files, HTML templates, flow files, language resources and MIME files directly from the SAP System to the ITS (AGate) and the Web server.

The IAC Object Receiver (IACOR) enables automatic update of the ITS and the Web server whenever the SAP System is updated by a transport. In the case of a dual-host installation, you have to install the IACOR on the ITS server and the Web server. The IACOR is implemented as a Windows NT service.

Incremental Conversion (ICNV)	A process that changes the structure of a table (conversion) during production operation.
Java 2 Platform, Enterprise Edition (J2EE)	<p>J2EE defines the standard for developing multitier enterprise applications.</p> <p>J2EE simplifies enterprise applications by basing them on standardized, modular components, by providing a complete set of services to those components, and by handling many details of application behavior automatically, without complex programming.</p> <p>The Java 2 Platform, Enterprise Edition, also takes advantage of many features of the Java 2 Platform, Standard Edition, such as "Write Once, Run Anywhere" portability, JDBC™ API for database access, CORBA technology for interaction with existing enterprise resources, and a security model that protects data even in internet applications.</p> <p>Java 2 Enterprise Edition adds full support for Enterprise JavaBeans components, Java Servlets API, JavaServer Pages and XML technology. The J2EE standard includes complete specifications and compliance tests to ensure portability of applications across the wide range of existing enterprise systems capable of supporting J2EE.</p>
Java Database Connectivity (JDBC)	JDBC technology is an API that lets you access virtually any tabular data source from the Java programming language. It provides cross-DBMS connectivity to a wide range of SQL databases.
Java Server Pages	<p>JavaServer Pages technology is an extension of the Java Servlet technology.</p> <p>Servlets are platform-independent, 100% pure Java server-side modules that fit seamlessly into a Web server framework and can be used to extend the capabilities of a Web server with minimal overhead, maintenance, and support.</p> <p>Unlike other scripting languages, servlets involve no platform-specific consideration or modifications. They are Java application components that are downloaded, on demand, to the part of the system that needs them.</p>
Jco	<p>A middleware component that facilitates the development of SAP-enabled components and applications in Java.</p> <p>The SAP Java Connector (JCo) supports communication with the SAP server in two directions:</p> <ul style="list-style-type: none">• Inbound (Java calls ABAP)• Outbound calls (ABAP calls Java) <p>SAP JCo can be deployed with desktop and (Web) server applications.</p>
JDBC	See Java Database Connectivity .
Kernel	<p>Central module of an operating system.</p> <p>The kernel is the part of the operating system that loads first. Since it remains in main memory, it should be as small as possible, yet still be able to provide all the essential services required by other parts of the operating system and applications. The kernel is typically responsible for memory management,</p>

process and task management, and disk management.

Load Balancing	<p>Mechanism that distributes server requests across any number of application servers.</p> <p>Load balancing ensures that an Internet page remains available, even with a large number of users and a high load. It recognizes when a server is down within seconds and ensures that that server is not reused until the system becomes available again.</p> <p>In the SAP system, load balancing is performed by the message server when users log on.</p> <p>In the case of HTTP requests made to the SAP Web Application Server, the SAP Web Dispatcher performs load balancing.</p>
Lock Table	<p>A table stored in the main memory of the enqueue server containing entries for the current locks in the system.</p> <p>Each lock includes the owner of the lock, the lock mode, and the name and the fields of the locked table.</p>
Message Service	<p>An independent program that lists all the servers in the SAP System.</p> <p>The message service:</p> <ul style="list-style-type: none">• Decides which server a user logs on to• Handles communication between the application servers (not RFC/CPI-C) such as transport a lock request to the Enqueue service or transport update requests <p>An SAP System always has one message service.</p>
Modification Adjustment	<p>Follow-up actions on Repository objects during a SAP release upgrade.</p> <p>This function compares Repository objects before the upgrade (old version) with their state after the upgrade (new version).</p>
SAP CRM	<p>A SAP solution that focuses primarily on the value relationship between an enterprise and its end customers.</p> <p>SAP CRM is closely related to and connected with the other SAP solutions.</p>
SAP SCM	<p>The solution that enables companies to network their supply chains and create business value.</p> <p>SAP SCM integrates extended supply chains, allowing companies to participate in collaborative, self-organizing, and value-added trading communities. The solution transforms supply chain management from a linear, sequential process into a collaborative community that enables businesses to network, plan, execute, and coordinate with customers, suppliers, and partners throughout the entire life span of the product or service.</p>
Network Attached Storage (NAS)	<p>A NAS device is a server dedicated for file sharing that can be accessed using a LAN.</p>

Online Transaction Processing System (OLTP System)	<p>The APO system generally works in connection with an OLTP system. This system supplies the APO system with the necessary data relevant for planning. The APO system transfers the planning results back to the OLTP system. In the OLTP system, if necessary, planning is completed and the production and planning is started, confirmed, and so on. The OLTP system can be an R/3 system or another system.</p>
Parallel Database	Database system where all nodes in a cluster have access to one database.
Platform	Operating system and database platform.
Profile Parameter	A parameter to control the behavior of a SAP Basis or SAP NetWeaver AS system.
Redundant Array of Independent Disks (RAID)	<p>A hardware-based technology that supports disk redundancy by using disk mirroring.</p> <p>RAID systems contain an array of disk spindles sharing a common controller that distributes data on the disks in a way transparent to the user. Most RAID systems include internal error checking to keep data available even if single disks fail. There are different RAID levels, characterized by the methods of distributing data (and check bits) on the disks in the system.</p> <p>Another technique to achieve disk mirroring is the software-based LVM technology (Logical Volume Manager).</p>
Remote Copy	<p>A function of storage devices or storage management software that apply changes of a local disk or volume simultaneously to a remote device.</p> <p>This feature can be used for disaster recovery.</p>
Remote Function Call (RFC)	<p>A SAP interface protocol based on CPI-C used to simplify the programming of communication processes between systems.</p> <p>RFCs enable you to call and execute predefined functions in a remote system, or in the same system. They manage the communication process, parameter transfer, and error handling.</p>
RFC	See Remote Function Call .
Round Robin	<p>A method of managing requests by distributing these requests across multiple equivalent servers (that is, containing identical content).</p> <p>Round robin works on a rotating basis. It passes a request to one server and moves the server to the end of the list. It then passes the next request to the next server on the list, moves the server to the end of the list, and so on through the list of servers. This continues in an endless loop.</p> <p>Round robin is different than load balancing. Load balancing distributes connection loads across multiple servers, giving preference to those servers with the lowest load. For round robin, server distribution rotates rigidly, with one server strictly being assigned to one user.</p>

Router	<p>A device to connect networks.</p> <p>The coupling is done on the network layer of the OSI reference model. Routers have implemented features to lead network traffic through meshed networks.</p>
SAN	See Storage Area Network .
SAP Advanced Planner and Optimizer (SAP APO)	Component of SAP CRM.
SAP Business Information Warehouse (SAP BW)	Component of SAP BI.
SAP Kernel	<p>A part of the SAP Basis System.</p> <p>The SAP kernel is responsible for:</p> <ul style="list-style-type: none">• Executing applications• Managing user processes• Distributing tasks to work processes• Memory management• Database accesses• Communicating with other applications• Managing the SAP System <p>The SAP kernel is the interface between the underlying operating system and SAP applications and is an independent process (disp+work) underlying every SAP instance.</p>
SAP Solution Manager	The SAP Solution Manager is a platform that provides the integrated content, tools, and methodologies that you need to implement, support, operate and monitor your enterprise's SAP solutions.
Scalability	<p>Scalability is the feature of a solution to be made suitable to changing (growing) requirements. Satisfying performance is impossible without availability. On the other hand it might happen that the performance is so low that a service is regarded as unavailable. Many measures to improve performance also help to increase availability. Non-scalable components often impose a single point of failure.</p> <p>Horizontal scalability means to use several components that are configured identically. The workload can be distributed among these components. When the workload grows, new components can be added. In a failover situation the remaining components can take over the tasks of the failed components.</p> <p>Vertical scalability means that the component itself has to be scaled for higher workload and to be protected against failures. We strongly recommend protecting even the hardware of such components that have to be scaled vertically (for example, database servers).</p>
Secure Storage for Backup Media	Backup media should be stored remotely from the production site, protected by special safes that are protected against fire, and so-on.

When the production site is damaged, the backup media need to be accessible on the disaster recovery site.

Server Certificate An attachment to an electronic message used for security purposes.

The most common use of a digital certificate is to verify that a user sending a message is who he or she claims to be, and to provide the receiver with the means to encode a reply.

The most widely used standard for digital certificates is X.509. Companies use X.509 certificates to implement SSL in their Web servers and browsers.

Servlet An applet that runs on a server.

This usually refers to a Java applet that runs within a Web server environment. Java servlets become more popular as an alternative for CGI programs.

Session Persistence A feature of load balancing devices.

It means that all requests of a session have to be handled by the same server because they need a session state that is stored only on this particular server. Session persistence has to be ensured by the load balancing technology.

Shadow Import An import of upgrade transport requests, including any Support Packages and add-ons, into the shadow repository tables, and into the new tables in the target release.

You can perform the import during production operation of the system, since the imported tables are not used by the source release.

Shared Everything Cluster A cluster where all nodes have concurrent access to the same resources.

The cluster has to resolve access conflicts using a distributed lock management. Parallel databases are often called shared everything clusters.

Shared Nothing Cluster A cluster where a single cluster node has exclusive access to a defined set of resources.

In the case of a node failure, these resources are re-assigned to a surviving node that can restart the failed applications.

A shared nothing cluster is often called fail-over cluster.

Simple Object Access Protocol (SOAP) A method for a program running in one kind of operating system (such as Windows NT) to communicate with a program in the same or another kind of an operating system (such as Linux) by using the World Wide Web's Hypertext Transfer Protocol and its Extensible Markup Language as the mechanisms for information exchange.

Simple Object Access Protocol specifies exactly how to encode an HTTP header and an XML file so that a program in one computer can call a program in another computer and pass it information. It also specifies how the called program can return a response.

Simple Mail A protocol for sending e-mail messages between servers.

Transfer Protocol (SMTP)	Most e-mail systems sending mail via the Internet use SMTP to send messages.
Single Point of Failure (SPOF)	<p>A hardware or software service that, if it fails, causes the entire system to fail, leading to unplanned downtime.</p> <p>It is often advisable to use additional hardware and fault-tolerant software so that the service can continue operating. This enables uninterrupted system operation if a single component fails.</p> <p>Example</p> <p>Disk drives might be a hardware single point of failure (SPOF). Disk mirroring reduces the likelihood of failure and can effectively eliminate the SPOF.</p>
SMTP	See Simple Mail Transfer Protocol .
SOAP	See Simple Object Access Protocol .
Split-Mirror technology	<p>Feature of storage management solutions.</p> <p>Split mirror means that a mirror of disks or volumes is created within very short time. This mirror can be used independently from the original (for example, for system copies, non-impact backup, and so on).</p>
SPOF	See Single Point of Failure .
Standby Database	<p>An identical copy of the production database on a standby database host.</p> <p>The secondary (that is, standby) database service can be used if the primary database fails, so providing a continued service with minimal data loss. Typically, the secondary database is located at a remote site (connected by a network) and is kept up to date with the primary by the shipping of the transaction log records generated on the primary database.</p>
Storage Area Network (SAN)	<p>A high-speed subnetwork of shared storage devices.</p> <p>A storage device is a machine that contains nothing but a disk or disks for storing data. A SAN makes the storage available to all connected computers.</p>
Switch	<p>A network device that couples networks on the OSI data link layer.</p> <p>Most switches operate similarly to bridges in that they forward frames according to the destination MAC (media access control) address. However, frame and cell switches are much faster and use temporary virtual connections that link source to destination port.</p> <p>These dedicated connections provide more available bandwidth to network users than do shared network devices.</p>
Switchover	Process of moving resources from on cluster node to another.
Table conversion	Conversion of an existing database table to a changed structure.

Example: when the length of a field changes, the table has to be converted.

TCP/IP

See **Transport Control Protocol / Internet Protocol**.

Text Retrieval and information Extraction (TREX)

Knowledge Management functions and services for information retrieval and document classification.

Transaction

A logical R/3 process.

From the user's point of view, a transaction is a self-contained unit such as an address change for a customer or executing a program.

From a dialog programming point of view, a transaction is a complex object that consists of a module pool and screens, and is called by specifying a transaction code.

After logon, there are the following distinct levels in the SAP System: R/3 level, work area level, application level.

A transaction is an application at application level. To go to the initial screen of an application, you can either navigate through the menus by choosing the appropriate menu options or enter the appropriate four-character transaction code in the command field. Using the transaction code saves time and takes the user directly to the initial screen.

Transport Control Protocol / Internet Protocol (TCP/IP)

Combination of communication protocols used by host computers to exchange information between applications (and their processes) on a local (LAN) or wide area network (WAN).

TCP/IP has become the accepted world-wide standard and is used for the Internet.

TCP is a connection-oriented transport protocol that enables a full duplex point-to-point connection. It recognizes transmission errors and corrects them to a certain extent. For this reason TCP is considered relatively slow and is only used if large amounts of data need to be transmitted reliably.

IP is a connection-independent network protocol. Information is transmitted between two separate components without establishing a path or a connection.

TREX

See **Text Retrieval and information Extraction**.

Uninterruptible Power Supply (UPS)

Means of ensuring the continuity and raising the quality of electricity supplied to a computer system.

UPS comes in many different varieties but the aim is always to protect the system against complete failure or undesirable power fluctuations in the mains electricity supply. UPS is an important element in safeguarding the R/3 System against unplanned downtime.

If UPS cannot continue to supply electricity (for example, because the battery backup is exhausted), it should ensure a graceful shutdown of the system as it nears the end of its power. This greatly reduces recovery time when the power supply is finally restored.

Upgrade

The switch from an older software version to a new version.

Typically, both the server component of a system landscape and other

components are upgraded. Several different technical upgrade procedures are used to upgrade the server component, such as the Repository Switch upgrade or the System Switch upgrade.

UPS

See **Uninterruptible Power Supply**.

Web Switch

Host that serves as the entry point for requests from the Web and forwards the requests to a Web server for processing.

A Web server can process only a limited number of requests at any one time. To ensure that even busy websites can process all requests without any major delays, the Web content can be spread over a number of servers, and load balancing functions can forward the data traffic in the most efficient way possible to the various servers. Load balancing is one of the essential tasks of a Web switch.

Web switches examine TCP/IP data within the HTTP header, and use layer 7 information, such as URL or cookie information, to distribute the load as efficiently as possible. Web switches also ensure the necessary level of persistence on connections being used for shopping basket transactions.

Work Process

A process that processes a particular SAP request.

To process SAP requests from several front ends, an SAP application server has a dispatcher, which collects the requests and forwards them to work processes for execution.

There are the following types of work process:

- Dialog – for executing dialog programs
- Update – for asynchronous database updates
- Background (batch) – for executing background jobs
- Enqueue – for executing lock operations
- Spool – for print formatting
- Work processes can be assigned to dedicated application servers. In the service overview (SM51), you can see which work process types are provided by the individual servers.

SAP Library

For more information on the SAP Web Application Server, access the SAP Library from any of the following:

- An SAP system if you have installed the documentation:
 - i. Choose *Help* → *SAP Library*
 - ii. In the browser, choose *SAP Technology Components* → *SAP Web Application Server*.
- The SAP Help Portal at help.sap.com:
 - i. Choose *SAP NetWeaver* → *Your Release* .
 - ii. Select the required language.
 - iii. Choose *Technical Operations Manual* → *High Availability* → *SAP High Availability Documentation*.
- The help files on the online documentation CDs

If you want to view the help files in HTML-Help format from the online documentation CDs, you need a PC running Microsoft Windows to install the HTMLHelp Viewer.



To find the high availability documentation, add the following to the above path:

Computing Center Management System → *SAP High Availability (BC-CCM-HAV)*