Applies to:
SAP landscapes running on the IBM i database and operating system.

Summary
The document *SAP on IBM i Reference Architecture* is giving an overview of how SAP landscapes are implemented on the IBM i platform. In its first part, this document provides an introduction to the SAP and IBM components that are used to build SAP landscapes. It shows SAP solution scenarios based on SAP Business Suite applications. The implementation of the solution scenarios is then shown as three reference architectures. The architectures leverage the specific benefits of the IBM i platform and demonstrate different high availability options.

Based on the components described in the first part of the document, the second part describes extended SAP on IBM i scenarios. It explains the integration of further SAP components like Adobe Document Services and the SAP BusinessObjects BI platform, as well as more virtualization scenarios. The section *Further Topics and References* contains links to other topics regarding SAP on IBM i that were not described in detail in this document.

This document represents the current state of both IBM and SAP product availability as of October 2017. As this may change in the future when new components become available, this document will also be updated.

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Introduction to SAP on IBM i

Today almost any enterprise relies on information technology to run its business operations. SAP, the world market leader in business software offers software solutions that fit most company sizes in any kind of industry. The SAP Business Suite offers a set of applications that can be selectively installed to fit companies’ needs. In order to run SAP solutions, an SAP certified operating system and database are required. One of the operating systems certified by SAP is IBM i, formerly known as OS/400 and i5/OS, with its integrated database Db2 for i. IBM i running on an IBM Power server offers a highly scalable and virus resistant architecture with a proven reputation for exceptional business resiliency. Running applications based on IBM i has helped companies over many years to focus on innovation and delivering new value to their business rather than managing their data center operations.

IBM i integrates a trusted combination of relational database, security, Web services, networking and storage management capabilities. It provides a broad and highly stable database and middleware foundation for efficiently deploying business processing applications like those from SAP. IBM develops, fully tests and preloads the core middleware components of IBM i when the system is manufactured. On other platforms, operating system, database and middleware integration is done after the hardware is installed in the customer data center. The pre-integration and testing of IBM i is a key factor in enabling companies to deploy applications faster and maintain them with fewer staff. Virtualization and workload management are also built into IBM i to enable running multiple SAP applications and components together on the same system, driving up system utilization and delivering a better return on IT investments for the SAP landscape.

In September 1995, SAP released its SAP R/3 Enterprise Resource Planning software for OS/400 for the first time. Since then, IBM i has established itself as a proven and reliable platform for SAP. All core SAP components, including SAP NetWeaver and its Java application server, have been released for the IBM i platform since then. All new IBM i releases since the original release of SAP on IBM i have been certified by SAP within a very short time period after their general availability. That is why SAP on IBM i customers can immediately benefit from new and improved OS and DB functionalities of a new IBM i release. Since IBM i 7.1, IBM is releasing Technology Refreshes (TRs) twice a year and along with them Db2 PTF Groups to enable new functionality between release cycles even faster. A development team located at SAP Germany with members from both IBM and SAP is enabling and optimizing SAP applications on IBM i, with close collaboration from the IBM i development team at IBM in Rochester, Minnesota. Support functions from both IBM and SAP are tightly integrated with the development team, making SAP on IBM i a thoroughly integrated solution spanning hardware, software and support.

Like the SAP software, the IBM i platform is suitable for any size of business ranging from a dozen to thousands of users. The SAP on IBM i reference architectures shown in this document are not representing a system sizing guideline. Information about how to size systems for SAP applications can be obtained from the experts at the IBM SAP International Competence Center (ISICC) by sending an e-mail to isicc@de.ibm.com and asking for assistance.
SAP Components
This section provides an overview about solution scenarios offered by SAP and then introduces the SAP components that are viewed as a precondition for a discussion of any implementation of SAP solutions.

SAP Solution Scenarios
This section provides a high-level overview of SAP solution scenarios and their application components. More detailed information can be found in dedicated SAP publications, for example at https://www.sap.com/products/enterprise-management-erp.html.

The compilation of various solution scenarios reflects the fact that, depending on their size and business, companies have different requirements regarding solution completeness and flexibility on the one hand and different potential in terms of handling complexity on the other.

All presented scenarios can be viewed as subset of the complete SAP Business Suite. Therefore, this solution and its components will be described first and in some detail in order to serve as a reference for the simpler scenarios like Basic SAP ERP later on.

SAP Business Suite
SAP Business Suite software is a comprehensive family of applications that support industry-specific business requirements for finance, human resources, procurement, product development, marketing, sales, service, supply chain management, and asset management. SAP Business Suite supports integrated, comprehensive business processes that transcend organizational, departmental, and geographic boundaries for all industries. New SAP Business Suite applications can be added without expensive replacements or upgrades.

SAP Business Suite serves as the foundation for many SAP solutions, serving the needs of customers in more than 25 major industries. The suite can be configured and deployed quickly to address specific industry requirements and processes.

SAP Business Suite is available in modular building blocks that combine software, support for best practices, and services to help your organization benefit from SAP business expertise. Each of the core applications within SAP Business Suite is based on the SAP NetWeaver technology platform.

Core applications building the SAP Business Suite

SAP Enterprise Resource Planning (ERP)
SAP ERP includes comprehensive functionality for accounting and financials, sales and service, procurement and logistics, inventory management, human capital management, product development and manufacturing, corporate services, and reporting and analytics.

SAP Customer Relation Management (CRM)
SAP CRM allows managing all aspects of customer relationships, from marketing to sales to service.

SAP Product Lifecycle Management (PLM)
SAP PLM provides customers with a 360-degree-support for all product-related processes – from the first product idea, through manufacturing to product service.

SAP Supplier Relationship Management (SRM)
SAP SRM automates, simplifies, and accelerates procure-to-pay processes for goods and services. With SAP SRM, customers can reduce procurement costs, build collaborative supplier relationships, better manage supply bases, and improve your bottom line with innovative offerings and a faster time to market.
**SAP Supply Chain Management (SCM)**

SAP SCM can help transform a linear, sequential supply chain into a responsive supply network – in which communities of customer-centric, demand-driven companies share knowledge, intelligently adapt to changing market conditions, and proactively respond to shorter, less predictable life cycles. SAP SCM provides broad functionality for enabling responsive supply networks and integrates seamlessly with both SAP and non-SAP software.

![Figure 1: Components of the SAP Business Suite](image)

**Technology Platform SAP NetWeaver**

Like many other SAP solutions, SAP Business Suite is powered by the technology platform SAP NetWeaver. It includes a comprehensive set of components and tools. With application servers for running ABAP and Java based applications, it provides a highly scalable and solid middleware foundation for SAP Business Suite applications such as SAP ERP. Other components provide advanced integration capabilities for business intelligence and collaboration. A few of the prominent components are:

* **The SAP NetWeaver Business Warehouse (SAP NetWeaver BW) component:**
  SAP NetWeaver BW enables a scalable enterprise data warehouse.

* **The SAP NetWeaver Process Integration (SAP NetWeaver PI) component:**
  SAP NetWeaver PI allows connecting applications and data sources to integrate processes. SAP intends to replace SAP NetWeaver Process Integration with Process Orchestration (PO) in the future. SAP Process Orchestration is based on SAP NetWeaver Java only and consists of Advanced Adapter Engine Extended (AEX) and Business Process Management (BPM).

* **The SAP Enterprise Portal component:**
  SAP Enterprise Portal allows providing role-based views that span the customer’s enterprise, enabling everyone to take full advantage of information resources.
SAP ERP Foundation rapid-deployment solution

This preconfigured solution enables you to quickly and affordably implement functionality for predefined business scenarios that are crucial to your company. The solution is flexible in scope – so you can start small, lay the foundation for growth, and expand your footprint later on. With reasonable, predetermined costs and implementation services, you can set realistic expectations and meet your budget requirements. For more information, see https://www.sap.com/services/rapid-deployment/erp-foundation.html.

SAP Industry Solutions

SAP Business Suite serves as the foundation for every solution portfolio SAP offers, serving the needs of customers in more than 25 major industries. The suite can be configured and deployed quickly to address specific industry requirements and processes.

Often SAP Industry Solutions are delivered as add-ons to general-purpose applications, particularly to SAP ERP. Some industry-specific applications may run stand-alone, and others require SAP ERP or other SAP Business Suite software.

Development, Test and Production System Landscapes

An SAP system consists of a logical database, one or more application server instances (ABAP and/or Java), central services (such as a message server and enqueue server), and in some cases, optional components. An SAP system is identified by its SAP system ID (SID), which consists of three letters or digits (e.g. PRD or P01).

An SAP recommended landscape for a single component always includes three individual SAP systems: the development system (DEV), the quality assurance system (QAS) and the production system (PRD). This way, customizations to SAP delivered components, support packages, SAP kernel etc. can be implemented and tested in the DEV and QAS systems before they are deployed into the PRD system.

The separation of the development and test systems from the production system in terms of hardware and operating system enables implementation and test of OS and DB patches before doing this on the production server.

The three-system SAP landscape is in principle then replicated for each SAP application.

Technology Stacks ABAP and Java

A specific SAP system is identified by a system ID (SID), whereas processes belonging to one particular SID are grouped into instances. Instances may be categorized into certain types according to their underlying technology and the corresponding characteristics in terms of resource consumption and workload.

SAP’s traditional workload runs on ABAP instances. Those are powered by a C/C++ based kernel that ensures abstraction from OS platform and database peculiarities at the application level. At the kernel level, platform optimization is a permanent effort taking advantage of new features and capabilities of the underlying operating system and database.

In addition to the ABAP stack, there are SAP products utilizing Java technology compliant with the Java EE standards.

In contrast to single stack systems with pure ABAP or Java instances, so-called “dual-stack” systems were allowed for some time. Most of these are no longer allowed and the stacks must be separated. A few dual-stacks, such as the Solution Manager, have remained.

Proper isolation of systems with concurrent workload will be one basic requirement to ensure stability of each solution.
2-tier, 3-tier Landscapes

Scalability is a key requirement for business applications. SAP systems can scale by increasing the number of work processes in an instance, adding additional local instances or using the concept of 3-tier landscapes.

In Figure 4, the left-most box shows a 2-tier configuration where the central instance or primary application server instance and database are both residing in the same partition on a server. The right boxes show a 3-tier architecture where the database and application server instance are on different partitions or even on different servers. As scaling requirements increase, additional resources and/or servers can be added. However, with Db2 on IBM i a central instance or primary application server instance is always needed on the database server to install or upgrade the SAP system.

![Figure 4: 2-tier landscape with database and work processes on one host versus 3-tier landscape with remote host for the work processes](image)

Older SAP ABAP systems own a singular central instance, which also provides a set of unique services. In Java and newer ABAP systems, these services are externalized into one particular central services instance. The maximum capacity of an SAP system can be extended by adding hardware resources to the same server or by adding application servers. To make use of these additional hardware resources, application server instances may be added. The capacity of an individual SAP instance can be scaled by increasing the number of work processes.

Because of platform and database abstraction, an additional application server is not necessarily hosted on the same platform as the central instance. In the context of Db2 for i, Windows and IBM i are supported as operating systems for additional application servers.

SAP Solution Manager

The SAP Solution Manager was introduced by SAP as a central system to manage an SAP business landscape. Meanwhile SAP has made it mandatory for all customers; hence it needs to be included in any SAP implementation.

The SAP Solution Manager basically is an SAP system with ABAP and Java stack. It has a connection to SAP as well as connections to all single systems existing in the local landscape.

Solution Manager fulfills different tasks such as:

- Central system repository (for example SLD – System Landscape Directory)
- Business process management
- Lifecycle management – manage software updates, upgrades, etc.
- Central monitoring system
- Entry point for SAP support
- Enablement of new additional SAP system installations
Figure 5: Solution Manager managing systems of a basic business landscape

Stand-alone Engines (ADS, SAP NetWeaver Enterprise Search, SAP APO Live Cache, …)

For different reasons, some SAP components are relying on third party services or on particular processor architectures. Consequently, not every single component may be supported natively on every platform. Examples are Adobe Document Services (ADS), SAP NetWeaver Enterprise Search or the SAP Advanced Planning and Optimization (APO) Live Cache, which are described later in the context of the SAP Business Suite reference architecture. These components can be integrated into an IBM i based solution as stand-alone engines. How this can be achieved, is part of the section Extended Scenarios.
IBM i and Power Systems Components

This section discusses the key features of IBM i and IBM Power Systems which are often used within SAP environments.

PowerVM LPARs and Shared Processor Pools

The IBM PowerVM dynamic logical partition (LPAR) functionality enables the separation of one physical machine into several logical systems. Each LPAR is running a single operating system image. Using LPARs is an efficient way to achieve the separation of the development, test and production workload. LPARs also provide a very efficient way to maximize the utilization of available hardware resources. The processors available in a system can be assigned directly to individual partitions or placed into one or more shared processor pools. Processing capacity from a shared pool can be assigned to individual LPARs that are members of that pool. It is possible to assign a minimum processing capacity to each LPAR and let the remaining capacity be dynamically assigned between LPARs in the pool as needed. It is also possible to place priorities on each LPAR in a shared pool, and to restrict the maximum processing capacity for each LPAR to make sure no LPAR is given too many or too few resources.

A Virtual I/O Server (VIOS) LPAR can be used to share certain HW resources between LPARs, such as ethernet and fibre channel adapters. VIOS is required to access certain external disk hardware and it is required to implement Live Partition Mobility.

IBM i Work Management

The IBM i operating system provides flexible concepts for managing workload, which are widely used by the SAP implementation.

The most obvious implication is that every instance of an SAP system is running in its own subsystem. Subsystems are an IBM i unique feature and provide advantages in terms of resource management and isolation when running multiple SAP systems within the same OS image.

SAP on IBM i customers regularly take advantage of the benefits of sharing a single large memory pool within a partition for multiple SAP applications, where the OS is managing the usage of the pool by all the subsystems that are sharing it. In some cases, dedicated memory pools may be used when ABAP and Java stacks coexist within an LPAR because these stacks show significant differences in memory management. For example, isolating a Java instance into its own memory pool can ensure that it is not impacting other instances when it needs to perform Java garbage collection functions.

Implementing the SAP landscape on IBM i gives enterprises the full advantages of workload management and virtualization capabilities offered by the IBM i operating system and the IBM Power Systems hardware.
IBM i Operating System Options

The IBM i fully enabled OS license 5770-SS1 includes full entitlement to Db2 for i. This should be used for the DB servers of most SAP systems.

IBM i Application Server entitlement 5770-SSB is a lower cost OS license meant for use by application server types of workloads as opposed to DB intensive workloads. In addition to being used for true 3-tier application servers attached to a DB server, this OS license can be used for partitions hosting the SAP Solution Manager, SAP Enterprise Portal or SAP NetWeaver Process Integration solutions. Note that the SS1/SSB distinction is only made when ordering. The OS code is the same, only the terms and conditions are different.

IBM i OS features and Licensed Program Products

IBM Backup, Recovery & Media Services (BRMS) for IBM i is the most commonly used solution for planning and managing the backup of SAP on IBM i partitions. BRMS (available as LPP 5770-BR1) provides support for policy-oriented setup and execution of backup, recovery, archive, and other removable-media-related operations, so that customers can implement a backup strategy tailored to specific business requirements.

Db2 Symmetric Multiprocessing (SMP, option 26 of IBM i) extends the capabilities of Db2 for i to allow a single database operation to run on multiple CPU threads in parallel. While SMP is not required for any SAP application, using multiple CPU threads can greatly improve the performance of complex SQL queries like those used in SAP BW and SAP Core Data Services (CDS) based applications. Most simple OLTP queries do not see a benefit from SMP. Db2 can only take advantage of SMP when CPU resources are available to the partition.

Db2 Multisystem (option 27 of IBM i) can be a useful feature when dealing with very large tables as it allows table partitioning on a single system. Table partitioning allows a table to hold much more data and contain many more rows than a non-partitioned table. In an SAP environment, table partitioning can be the only option when a table is approaching a database limit and it is not possible or desired to reduce the amount of data in the table. Partitioning can also enhance performance and manageability in SAP BW environments. Partitions can be used to quickly delete sets of records grouped in a partition rather than processing individual rows of a large nonpartitioned table. New (empty) partitions can be quickly added as old ones are dropped.

IBM Power Systems Server Options

The implementation of an SAP on IBM i solution can run on any IBM Power model that is capable of running IBM i. The servers can consolidate multiple workloads through their high scalability. With direct attached internal storage, the server models allow building an integrated and simple solution running in only one server, resulting in minimal administration efforts.

Capacity Backup models are available to reduce the cost of High Availability/Disaster Recovery solutions. These models are meant to be used as failover systems – usually idle, but fully enabled in case the primary system goes offline for any reason.

IBM i Solution Edition for SAP

The IBM i Solution Edition for SAP is a special offer for optimizing IT costs when implementing an SAP on IBM i solution. The Solution Edition includes an IBM Power Systems hardware model, operating system, database and maintenance. The IBM i Solution Edition for SAP is available for new hardware purchases in conjunction with a new or upgraded SAP license purchase. For the available options and more information, see the IBM website (https://www.ibm.com/systems/power/hardware/solutioneditions/ibmi/index.html) or an IBM sales representative.

IBM System Storage Options

Traditionally, IBM i based systems used direct attached internal storage. Internal storage provides advantages in terms of maximized integration and performance with minimal administration.
Externally attached storage offers additional flexibility when implementing more complex solutions. Heterogeneous environments, some high availability options, solutions involving flash copy and highly virtualized configurations often depend on external storage. Some storage configurations may require a PowerVM Virtual I/O Server (VIOS). All IBM i solutions related to external storage, including those requiring VIOS, are compatible with SAP applications.

**Solid State Disks and Flash Storage Systems**

Solid State Disk (SSD) drives and Flash Storage Systems can be used to replace spinning disk drives to reduce space and energy requirements while maintaining or improving overall I/O performance for SAP applications. SSDs can be used for IBM i in either internal or external disk configurations. Flash Storage Systems are only available as external configurations.

With hierarchical storage management provided by IBM i, the most active data can be automatically placed on SSDs making it easier to get the benefit from faster I/O response times.

**IBM Easy Tier**

Available on several IBM external storage devices, IBM Easy Tier is a built-in function that automatically balances data between SSD and HDD drives based on the data access pattern. Data that is read frequently is placed on SSD drives to decrease read response times and improve I/O throughput, while infrequent accessed data is placed on the slower HDD drives.

**Disk Compression with IBM Storwize Family and SVC**

The IBM Storwize Family of external storage systems or the IBM SAN Volume Controller (SVC) may be used to enable IBM Real-time Compression (RTC) on a logical disk volume basis. IBM RTC improves efficiency by storing significantly more data in the same physical disk space without significant impact to the I/O response time for most workloads. Compression ratio for a typical SAP ERP system is between 50 and 70 percent. RTC can be used together with IBM Easy Tier. Further information about IBM Real-time Compression is available at [http://www.redbooks.ibm.com/abstracts/tips1083.html](http://www.redbooks.ibm.com/abstracts/tips1083.html).

**Business Continuity with High Availability**

This section summarizes several options that are available to minimize any downtime scenarios, which may occur in SAP environments.

**SAN Boot**

Storage Attached Network (SAN) Boot is a simple but efficient method to recover from a hardware failure. It requires that there is a second server system available and that the data resides on an external storage device. When the main system fails due to a hardware error, the external storage is attached to the backup system and the backup system is then booted with those disks. Using this solution, the production system can be back online within half a day.
Figure 9: SAN Boot requires two servers and external storage

Logical Replication

The logical replication approach is based on IBM i object journaling technology. Changes and updates to objects are applied to the secondary server by replaying the journal entries from the source server. Logical replication does not require an independent ASP (IASP) or external storage. Logical replication is best suited for systems running only a few SAP systems due to the administration effort. For systems running many SAP systems in one IBM i partition, an IASP based HA solution is preferable.

Figure 10: Logical Replication: journal entries are replayed on the backup system
IBM PowerHA IASP based High Availability Options

The hardware replication technologies within the PowerHA SystemMirror product are based on the independent auxiliary storage pool (IASP) technology provided by the IBM i operating system. The IASP is a set of disks than can be dynamically configured in and out of an IBM i system and therefore can be easily replicated or moved between systems. Most commonly, the IASP is replicated using the Geographic Mirroring, Metro Mirror, or Global Mirror technologies. When the IASP is configured on an external storage device, it can also be switched between physically separated systems, called LUN-level switching. The switched disk technology can also be used with an IASP on internal storage, but then it can only be switched between logical partitions of the same machine. SAP is fully enabled to make use of an IASP configuration. A new SAP system can be installed to an IASP directly, or an existing system can be moved into an IASP with tools delivered by SAP.

To enable automatic failover scenarios, all PowerHA options also require a cluster configuration. The IBM i cluster technology provides the tools to create and manage a cluster of two or more IBM i systems. One system in the cluster is configured as the primary node running the production workload. All other systems in the cluster are secondary nodes. The cluster configuration is then monitored, and if the primary cluster node fails, an automatic switchover to the next in line secondary system is initiated. The switchover moves the IASP to the secondary system which then can run the production workload.

The LUN-level switching and switched disk options allow recovery from a system hardware failure within a few hours but do not protect the system against data loss due to a storage failure. To prevent data loss, the following mirroring solutions can be implemented on top of the IASP based cluster.

PowerHA Geographic Mirroring

Geographic Mirroring is creating a copied image of an IASP that is attached to a second server system. The connection between the primary and the secondary system is established over an IP network, which allows the geographically distant placement of the secondary system. The actual mirroring of the data is performed on data segment basis. Data segments from the primary server are sent to the secondary server either synchronously or asynchronously. In synchronous transmission mode, a writing job on the primary server must wait for the secondary system to acknowledge the successful receipt of the data segment before it is allowed to continue. Depending on the bandwidth and distance of the network connection, this can cause a noticeable performance impact on the primary server. In asynchronous transmission mode, the writing job on the primary server can continue once the data segment has been sent but not necessarily received and written to disk. This reduces the performance impact on the primary server due to network latency, but potentially affects performance due to other system resources, such as processor and memory. Since the replication is done by IBM i, Geographic Mirroring supports internal or external disk, either attached natively or virtually.

PowerHA Metro Mirror and Global Mirror

Metro Mirror and Global Mirror work in the same way as Geographic Mirroring, except that the data copy is handled by an external storage device. Therefore, the system CPU is not occupied with the data copy process. The synchronous mode is called Metro Mirror, the asynchronous mode is called Global Mirror.
because the asynchronous mode allows greater distances between the storage devices. PowerHA currently supports the DS6000, DS8000, Storwize family, and SAN Volume Controller (SVC) storage devices.

![Figure 12: Metro Mirror / Global Mirror: replication handled by external storage device](image)

**Figure 12: Metro Mirror / Global Mirror: replication handled by external storage device**

**PowerHA with SAP Application Resiliency**

The SAP application itself is also able to provide resiliency by using a configuration that does not have a single point of failure.

![Figure 13: PowerHA with SAP Application Resiliency](image)

**Figure 13: PowerHA with SAP Application Resiliency**

The white paper *High Availability Options for SAP Using IBM PowerHA SystemMirror for i* is available on IBM Techdocs and contains a detailed description of how to enable SAP application resiliency. See [http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP102130](http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP102130) for more information.

[SAP Note 1635602](https://www.sap.com/community.html) contains the most current configuration guidelines as well as a detailed setup guide for SAP High Availability on IBM i.

## High Availability Options Summary

The following table gives an overview over the described high availability options in order to allow a quick assessment which option meets given requirements:

<table>
<thead>
<tr>
<th>Option</th>
<th>Estimated Recovery Time*</th>
<th>Protection Against</th>
<th>Supported Storage Configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB Reload</td>
<td>½ day</td>
<td>Hardware fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Storage fail</td>
<td>External</td>
</tr>
<tr>
<td>SAN Boot</td>
<td>½ day</td>
<td>Hardware fail</td>
<td>External</td>
</tr>
<tr>
<td>Logical Replication</td>
<td>½ - 2 hours</td>
<td>Hardware fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Storage fail</td>
<td>External</td>
</tr>
<tr>
<td>Geographic Mirroring</td>
<td>½ - 2 hours</td>
<td>Hardware fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Storage fail</td>
<td>External</td>
</tr>
<tr>
<td>Metro Mirroring</td>
<td>½ - 2 hours</td>
<td>Hardware fail</td>
<td>External</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Storage fail</td>
<td></td>
</tr>
<tr>
<td>Global Mirroring</td>
<td>½- 2 hours</td>
<td>Hardware fail</td>
<td>External</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Storage fail</td>
<td></td>
</tr>
<tr>
<td>PowerHA with SAP</td>
<td>10 min. for appl. failure</td>
<td>Hardware fail</td>
<td>Internal</td>
</tr>
<tr>
<td>application resiliency</td>
<td>2 hours for DB failure</td>
<td>Storage fail</td>
<td>External</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Application fail</td>
<td></td>
</tr>
</tbody>
</table>

* Recovery times may vary depending on system configuration, size and type of failure.
**SAP on IBM i Reference Architectures**

SAP solution scenarios can be successful with IBM i at the center of the environment. IBM i runs the core SAP technology stacks (ABAP, Java) natively, providing the foundation for SAP NetWeaver, SAP Business Suite and all the SAP Industry Solutions.

Most SAP on IBM i customers prefer 2-tier architectures for their simplicity and because they scale very well without requiring a separate application server. Due to the efficiency of IBM i subsystems, it is very common for customers to run multiple SAP systems within a partition, especially for development, test and QA. It is also fairly common to see multiple production SAP systems within a partition. Customers also may take advantage of IBM i subsystems to run non-SAP applications in the same IBM i partition with SAP systems. Nearly all customers take advantage of IBM PowerVM partitioning technology to some degree, most often to separate non-production from production workloads.

Most SAP on IBM i customers implement some sort of High Availability or Disaster Recovery solution, either a third party logical replication solution or an IBM PowerHA solution. Some of the PowerHA solutions will take advantage of IBM i IASP technologies or external storage functionality. SAP applications can run equally well with either internal or external disk. SAP applications can often benefit from using SSD or Flash technology when higher levels of I/O are expected.

3-tier architectures are rarely necessary for scaling reasons. However, some SAP components that do not run natively on IBM i may require them. Other stand-alone SAP components that need to connect to core SAP technology stacks running on IBM i may do so via standard SAP APIs over the TCP/IP network. There are no SAP Business Suite components that cannot be used in some way with an IBM i centered SAP implementation. In some cases, SAP may have created a dependency on the SAP HANA database for a particular solution. SAP HANA can run in a Linux LPAR on the same Power hardware where your IBM i LPARs are running the rest of your SAP Business Suite environment. IBM i LPARs may also be used to run the application servers of an SAP system based on the SAP HANA database.

In addition to taking advantage of IBM i subsystems and IBM PowerVM, IBM hardware and IBM i software acquisition costs can be reduced by taking advantage of the IBM Solution Edition models, Capacity Backup models or the IBM i Application Server entitlement. Also, many of the components that do not run on IBM i can run in AIX, Windows or Linux environments that can be either hosted by IBM i or be on the same Power machine with the IBM i partitions.

The following reference architectures are reflecting the considerations above and show examples how to implement SAP Business Suite application based landscapes on IBM i.

**Basic SAP ERP**

The reference architecture for an SAP ERP solution on IBM i is implemented as a simple integrated single server configuration. The server runs two partitions, one for the production and one for the development and test workload. This setup ensures that the production system can run undisturbed from the development and test activities. Using multiple LPARs also allows flexible and dedicated resource assignments, ensuring the production system is not constrained by resources used from DEV and QAS systems.

The SAP Solution Manager is not resource demanding and is therefore also installed into the development and test partition. The availability of the SAP Solution Manager is usually not critical for the production systems.

Of course, variations of this setup are feasible. It is also possible to install development and test instances of the SAP Solution Manager when required. It is not recommended to run test and production systems in the same partition, because with such a configuration you could not test enhancements to the operation system and database (PTFs or a new release) prior to installing them on your production system.
SAP ERP with additional SAP products

The following example for a SAP solution on IBM i consists of three SAP Business Suite applications: SAP Enterprise Resource Planning (SAP ERP), SAP NetWeaver Business Warehouse (SAP NetWeaver BW) and SAP Customer Relationship Management (SAP CRM) applications. The SAP ERP application covers the essential functionality that an enterprise requires to run its business, including financial, human resources and sales and distribution modules. To optimize business decisions, an enterprise requires the capability to analyze data that is stored within the IT systems and applications it is running. This functionality is provided by a business intelligence solution like SAP NetWeaver BW. SAP NetWeaver BW integrates information from internal and external sources and transforms it into valuable business information for decision making. Increasing the efficiency of communication with its customers is another requirement an enterprise is facing. The SAP CRM application is offering solutions to manage all aspects of customer relations like marketing, customer interaction, distribution and service.

The example implements an IASP based high availability concept to ensure high availability of the SAP ERP and SAP CRM applications. The SAP ERP and SAP CRM applications run in one partition on the production server. With dedicated memory pools defined for the subsystems, the ABAP and Java workloads can safely run in the same LPAR.

The decision, which of the available IASP based mirroring solutions to use, depends on the individual needs of the enterprise. To learn more about the available options, see the section Business Continuity with High Availability.

The backup server system is not only used for providing a partition for the stand-by SAP ERP and SAP CRM applications. It is also used to run partitions for the BW production system and the development and test systems for all SAP applications. Development and test systems usually have a different workload distribution and are not as resource demanding as production systems. That is why multiple DEV and QAS systems can easily share resources and run in the same LPAR.
The SAP Solution Manager is also installed into the development and test partition because it is not resource demanding as well. Running the SAP NetWeaver BW production system in its own partition allows flexible resource provisioning and ensures that there will be no performance issue during peak usage of the SAP NetWeaver BW application.

![SAP Solution Manager diagram](https://www.sap.com/community.html)

**Figure 15: SAP example reference architecture with an IASP based mirroring solution**

**SAP Business Suite**

The SAP Enterprise Resource Planning (SAP ERP), SAP Customer Relationship Management (SAP CRM), SAP Supply Chain Management (SAP SCM) and SAP Product Lifecycle Management (SAP PLM) components are building the base of the SAP Business Suite reference architecture for IBM i. SAP Supplier Relationship Management (SAP SRM) is not shown in the figure 16, but it could be added in the same way as the other components.

The production systems of the SAP Business Suite components are located in an IASP of one partition. This enables the mirroring of the production systems to a backup server with one of the options described in the section [Business Continuity with High Availability](https://www.sap.com/community.html).

The SAP NetWeaver Enterprise Portal (EP) and SAP NetWeaver Process Integration (SAP NetWeaver PI) components are installed in a separate partition. Due to the workload characteristics of those components, the partition can be run with IBM i Application Server entitlement rather than the standard IBM license. If one or both of these components are business critical, for instance when the portal is running an online-shop, the EP and PI systems should also be mirrored to the backup server like the core SAP Business Suite components.

The SAP SCM Business Suite component is extended with the SAP SCM LiveCache module to boost the performance of supply chain planning. The SAP SCM LiveCache server can be installed into a Linux on Power or AIX partition running on the same server machine as the other production systems. Alternatively, the SAP SCM LiveCache server can be installed on a separate x86 based server as well.

The backup server machine holds the stand-by partition for the core SAP applications, the SAP NetWeaver Business Warehouse (SAP NetWeaver BW) production system and the development and test systems for all SAP applications in their own LPARs. The SAP Solution Manager is installed to the development and test LPAR.
Figure 16: SAP Business Suite reference architecture implements business continuity of a complete solution portfolio leveraging integration capabilities of IBM i.
Extended Scenarios

This section describes selected IBM and SAP technologies which may be of interest. They are not always required, but appear often enough or are unique enough to justify mentioning where they may fit in an IBM i centered SAP solution landscape.

SAP Landscape Optimization with IBM i Application Server entitlement

IBM i Application Server entitlement is allowed for partitions hosting SAP Solution Manager, SAP Enterprise Portal (EP), SAP NetWeaver Process Integration (PI) and SAP NetWeaver Composition Environment (CE) systems. It can also be used for 3-tier application servers attached to a DB on some other system or partition. The full IBM i license entitlement is required for any IBM i partition where business data is stored, not just metadata that supports the application.

Although the IBM i code is exactly the same, the IBM i Application Server entitlement cost is significantly less than the full IBM i license. Therefore, running Solution Manager, EP, PI or CE systems in a partition using IBM i Application Server entitlement can reduce OS license costs for an SAP landscape. In 3-tier landscapes, license costs for additional application servers can also be optimized by taking advantage of the IBM i Application Server entitlement, but one must realize that there is some response time increase from using a 3-tier instead of a 2-tier configuration.

Furthermore, SAP EP, PI and CE license costs can be based on the number of CPU cores available for these systems. When choosing such a license model, it is recommended to run those SAP systems in their own LPAR with dedicated CPU resources.

During the ordering process, 5770-SS1 is used for the full IBM i license entitlement and 5770-SSB is used for IBM i Application Server. However, the OS command WRKLICINF will always show 5770-SS1 with Install ID #5051 for the IBM i fully enabled license and Install ID #5053 for the IBM i Application Server entitlement.

Figure 17: Example for License Cost Optimization

Figure 17 shows on the left a landscape running a PI and EP systems in the same LPAR as an ERP system. In this case, even though the available CPUs will be mostly occupied by the ERP workload, all CPUs need to be licensed for the PI and EP systems. As shown in figure 17 on the right, placing the PI and EP systems in their own LPAR allows licensing of only the CPUs really needed for these systems. Since most customers use one or fewer CPUs for these applications, it can make sense to combine them.

PowerVM Live Partition Mobility for IBM i

Since IBM i 7.1 Technology Refresh 4 (TR4), IBM i is enabled to perform LPAR migrations from one physical Power server to another without interruption. SAP states support for Live Partition Mobility (LPM) in SAP Note 1102760, meaning that LPM can be performed with running SAP systems. Prerequisites for LPM are...
POWER7 or higher servers with PowerVM Enterprise Edition and a fully virtualized system setup using Virtual I/O Server and external storage.

**PowerVM IBM i Hosted Disks**

IBM i has the ability to host disk storage for other platforms within an IBM i partition by using IBM i objects called network server storage spaces (NWSSTG). Hosting the disk of other platforms allows a very tight integration of SAP components that are not running on IBM i directly, like Adobe Document Services or SAP Business Objects components; it also offers some interesting options since an IBM i partition can host the disk for a different IBM i partition.

IBM i network server storage spaces can be thought of as virtual disk drives that IBM i makes available to other partitions or servers – either AIX or Linux partitions, or Windows environments. These storage spaces can be allocated on the hosting IBM i partition from its system storage pool (ASP), a user storage pool or an independent user storage pool.

IBM i commands can be used to backup entire hosted environments by simply backing up the virtual disk drives (storage spaces). This provides a disaster recovery backup of the server, since the entire image of the hosted server can be recovered quickly by simply restoring the server's virtual disk drive objects to the host partition.

Even other IBM i partitions can be hosted by an IBM i. This can be useful for multiple sandbox, training or testing scenarios. For example, it is possible to set up an SAP system on a network server storage space and save the image right after the installation. After the system was used, it can be easily restored to its original state in one simple step by restoring the saved image.

![Figure 18: Integration of heterogeneous components utilizing hosted disks](image)

There is no restriction to what type of application can be run in a hosted environment. For SAP on IBM i, the most suitable applications are the stand-alone engines that do not natively run on IBM i. Some of them are described in more details in the following section.

**SAP Stand-alone Engine Scenarios**

Stand-alone engine scenarios refer to a set of SAP components that run as specialty appliances. For various reasons, these components do not run on all SAP NetWeaver platforms, or may only run on one platform. It is always the case that there is a way to incorporate these components into an IBM i-centric SAP solution because they are integrated within SAP landscapes using standard industry or SAP protocols.
SAP Adobe Document Services

The SAP Adobe Document Services (ADS) enhance the document handling capabilities of the SAP applications. The main idea is to replace the cost intensive manual document handling by a complete digital document handling which is fully integrated into the SAP processes. Especially globally acting companies with locations all over the world handling documents in different languages appreciate the ability to reduce the amount of costly paper based processes. This also applies to national companies which have a lot of remote branches or consultants with only loose contact to the headquarters. ADS enable all SAP applications (either ABAP or Java) to use the full range of the Adobe Acrobat document software. This functionality is provided by the so-called SAP INTERACTIVE FORMS by Adobe which are saved in the file format PDF (Portable Document Format). The main functions are:

- Derive dynamic PDFs from data within an SAP system
- Readout data from forms and put it directly into an SAP system
- Enable users to sign PDFs digitally
- Provide interactive forms that look exactly the same as paper versions
- Use forms in offline and online scenarios
- Attach files of different formats to a PDF inside
- Put remarks on PDF documents and collaborate on PDF reviews

Although SAP ADS are running in a SAP NetWeaver Java system, the services itself are not completely implemented in Java. ADS still use a proprietary coding which is not implemented on all platforms. To close this gap, SAP recommends installing an additional stand-alone Application Server Java on a platform supported by ADS (see SAP Note 925741). For IBM i, it is recommended to install ADS as a stand-alone service (ADS Hub) on a Windows server with an SAP MaxDB database (see SAP Note 2039539). In this case, the MaxDB license for ADS will be free of charge. SAP Note 607141 explains how to request and install the license key for this installation. In general, one SAP ADS server can serve all SAP systems in the SAP landscape.

Figure 19: Adobe Document Services integration into an IBM i based landscape

SAP BusinessObjects

SAP BusinessObjects offers a broad portfolio of tools and applications designed to help customers to optimize business performance by connecting people, information and businesses across business networks.
One central component of SAP BusinessObjects is the SAP BusinessObjects Enterprise server. The Enterprise server offers an integrated suite for reporting and analysis of data from various sources. It also serves as an information delivery hub, making reports available to end users via a variety of web based interfaces. Other BusinessObjects frontend applications connect to the Enterprise server.

While the Enterprise server is a self-contained system that runs on either a Windows, Linux or UNIX system, it can make use of IBM i as a data source. Data source can be any SAP system running on IBM i, like an ERP or BW system, as well as any database running on IBM i. To integrate the Enterprise server more tightly to the IBM i landscape, the server could also take advantage of the IBM i hosted virtual disks. See section PowerVM IBM i Hosted Disks for more details.

SAP BusinessObjects provides various means to connect to data sources. More details about how to connect data sources running on IBM i are described in the white paper SAP BusinessObjects and IBM i, which can be found in the SAP on IBM i Wiki at IBM developerWorks.

**Figure 20:** SAP BusinessObjects components utilize IBM i as data source

**SAP HANA**

SAP HANA is a specialized stand-alone in-memory database that can aggregate very large data sets in a short period of time. For SAP systems running on IBM i, HANA is not required but in certain cases can be used to accelerate certain SAP Business Suite applications.
In this so-called side-by-side scenario, the SAP systems are running on the IBM i operating system and Db2 for i relational database. SAP HANA is used for specific data processing tasks. The SAP Landscape Transformation (SLT) replication server is used to provide almost real-time data replication sourcing from the SAP application running on IBM i to SAP HANA. Only the tables required to perform the tasks are replicated to the SAP HANA appliance. Communication between the SAP HANA appliance and the SAP system on IBM i is done via standard SAP APIs and TCP/IP network interfaces.

IBM POWER8 hardware and a Linux partition are required to use SAP HANA. A NetWeaver application server is also required for running SAP Business Suite solutions with SAP HANA, and that application server can run on an IBM i partition. See SAP Notes 2188482 and 1751271 for HW and IBM i application server information regarding SAP HANA. SAP Note 1705999 discusses SLT data replication in more detail.

**SAP Supply Chain Management (SCM) Extensions LiveCache and Optimizer**

SAP Supply-Chain-Management (SCM) is part of the SAP Business Suite. It offers the ability to collaborate cross company and to plan, execute and coordinate corporately on the entire supply network.

A former additional product for SCM called Advanced Planner & Optimizer (APO) is meanwhile integrated into SCM. Optional features of APO were the APO LiveCache and the APO Optimizer, now called SCM LiveCache and SCM Optimizer.

The SCM LiveCache is a server which keeps all planning relevant data in the main storage to speed up the data processing. The persistence layer of the SCM LiveCache server is an SAP MaxDB database.

The SCM Optimizer is an enhanced optimizer to support planning by mathematical algorithms or heuristics.

Currently these optional SCM features are running only on Windows, Linux or AIX. To run the solution on IBM i, these SCM programs have to be installed on a dedicated server or partition. The SCM LiveCache and the SCM Optimizer may be used as a single feature, or they may be used in parallel, depending on the needs of the customer. To integrate the additional servers more tightly to the IBM i landscape, the server could also take advantage of the IBM i hosted virtual disks. See section PowerVM IBM i Hosted Disks for more details.

To communicate with the remote SCM LiveCache server, an SCM LiveCache client has to be installed on IBM i, which is done automatically since SCM 2007.
SAP Fiori User Experience
The SAP Fiori User Experience (UX) for transactional applications allows users to run simple SAP transactions on mobile devices as well as desktops systems. SAP Fiori Transactional Apps require that the complete gateway infrastructure of SAP Fiori Apps is installed in the landscape. These applications can run with SAP Business Suite systems running on IBM i. The SAP Fiori apps reference library is available at https://www.sap.com/fiori-apps-library. More information about SAP Fiori in general can be found in the SAP Fiori Community at https://www.sap.com/community/topic/fiori.html.
IBM i Application Integration with SAP

IBM i is a proven business software platform capable to run many different applications available from IBM and other software vendors. Those applications can be integrated with an SAP system in several ways, where the most common are:

- SAP NetWeaver Process Integration to integrate external data sources,
- SAP NetWeaver Business Warehouse to integrate non-SAP databases,
- ABAP reports, JAVA programs for custom integration of external data,
- Access to SAP from external applications utilizing RFC, JDBC, JCo.

To exchange data between an SAP NetWeaver Application Server ABAP and non-SAP programs running on IBM i, you can use the SAP NetWeaver RFC SDK. The SAP NW RFC SDK is coming in three flavors:

1. An ILE version in EBCDIC that can be used for ILE programs (RPG, COBOL, C/C++) using Latin-1 character sets (single-byte).
2. An ILE version in Unicode that can be used for ILE programs using Unicode (UCS-2) character sets.
3. A PASE version in Unicode that can be used by C/C++ programs compiled under AIX and running in PASE.

For more details and installation instructions see SAP Note 1097997.
Further Topics and References

For the topics covered in this document there is more information available on the following websites:

- SAP ERP Foundation rapid-deployment solution: https://www.sap.com/services/rapid-deployment/erp-foundation.html
- IBM System Storage Copy Services and IBM i: http://www.redbooks.ibm.com/abstracts/sg247103.html
- SAP on IBM i High Availability – Cluster Awareness: https://blogs.sap.com/2014/05/13/sap-on-ibm-i-high-availability-cluster-awareness/

The following topics show and exploit specific features of the platform and are viewed as important. However, they are not part of a reference architecture. Therefore, they are not covered in detail in this document. To learn more about these topics, see referred documentation:

- IBM Insight Tool for SAP to gather performance workload and utilization statistics: https://www.ibm.com/partnerworld/wps/servlet/ContentHandler/techline/FAQ00000867
- Out of the SAP Services portfolio of service offerings, the SAP EarlyWatch Check is essential. It analyzes the components of SAP software, including the operating system and database. Information can be found at https://support.sap.com/support-programs-services/services.html
- IBM PowerVC Virtualization Center: http://www.ibm.com/systems/power/software/virtualization-management/
- IBM i Backup Recovery & Media Services: http://www.ibm.com/systems/i/support/brms

Find more information of interest here:

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