The Microsoft Platform for SAP ERP
2015 Edition Whitepaper

by

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1 MANAGEMENT OVERVIEW

There is an ever increasing need for continually improving IT operating efficiency and the arrival of true enterprise-ready Cloud services has had a tremendous acceleration effect on trends in the market. In this whitepaper, we will look closely at the Microsoft platform in the SAP data center and how operating costs can be lowered by using the Microsoft platform.

These trends are observed by REALTECH in specific reference to data centers running SAP solutions:

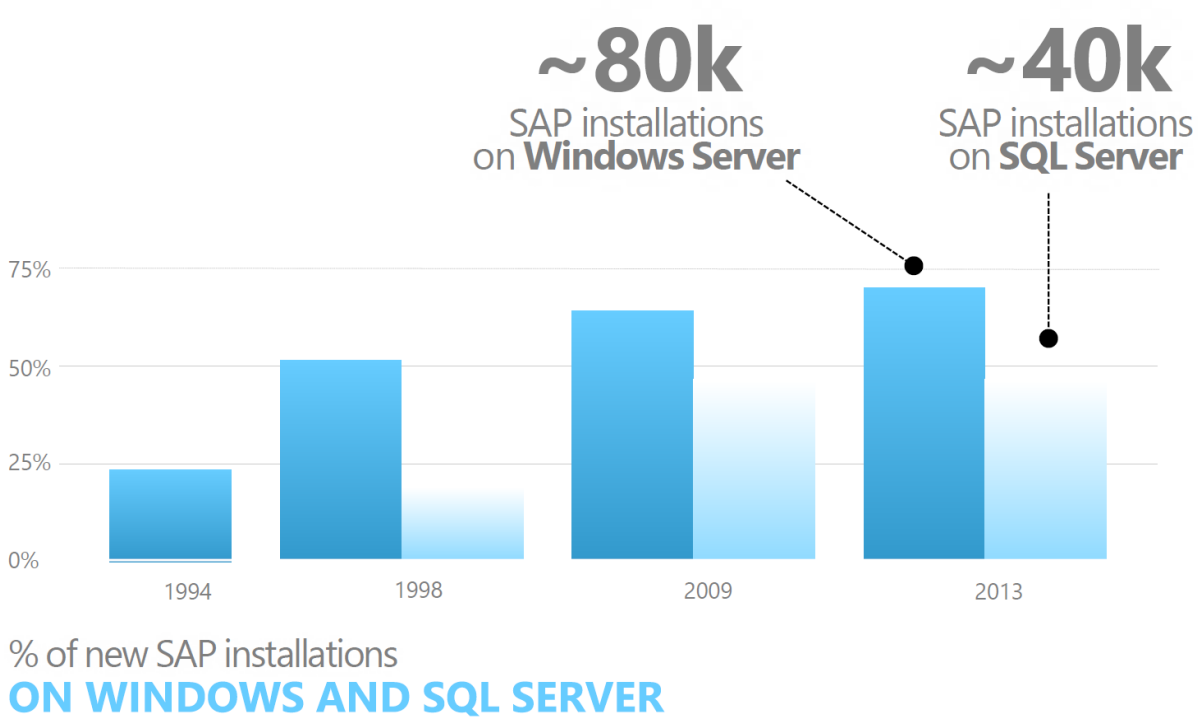
- The recognized tendency is to move away from proprietary hardware: Mainframe and UNIX hardware is being phased out of the data center. Industry standard servers (commodity servers) offer very high performance at low cost.
- Disk subsystems and networks are viewed as commodities.
- Software: operating systems and databases are becoming commodities, which are expected to run with a low Total Cost of Ownership (TCO).
- Infrastructure as a Service (IaaS) providers are leveraged more and more as extensions to the customers' own datacenters.

For the data center, this in turn means that the trend is moving toward standardization (at all levels mentioned before) and homogenization of the environment. This holds several advantages:

- Better procurement conditions and less complexity in vendor support structures.
- Less dependency on specialists in the IT department.
- Interchangeability and integration in existing solutions.
- Lower operating costs through reduced complexity.
- Higher level of service - a process has to be established only once, training has to be given only once.
- The IT department can tap its staff's existing extensive knowledge.
- More flexibility and faster deployment of new system.

These changes take place in datacenters running SAP, be it on-premises at a customer site, at the datacenter of a provider/outsourcer, or in the cloud through an "Infrastructure as a Service" (IaaS) provider.

Homogenization and standardization on the Microsoft platform seems to be the obvious choice, since almost any datacenter already operates this platform, has trained staff, and therefore a good part of the needed skill is already in place. This is also reflected in new installations in the following chart, taken from "Microsoft Data Platform for SAP Executive Summary - May 2014.pdf". [i]



The SQL Server share is steadily increasing and is estimated to be 1/3 or more of all new installations.[ii] So for new installations, the advantages of the Microsoft platform are convincing to any SAP customers. For a platform change, called migration in the SAP environment, there is sometimes the perception that a platform change has the showstoppers "high cost of know-how-transfer" and "high cost of migration". [iii]

2 PLATFORM INFRASTRUCTURE FOR SAP

The discussion in the 2009 Edition of this whitepaper showed that any SAP Operations can run on commodity x86_64 hardware, therefore there is no need to run SAP on non-commodity hardware any more. In the following we will therefore examine solely the x86_64 platform.

2.1 On-Premises Platform

In the recent commodity server power has increased dramatically, both in terms of processing power and bandwidth. Also corresponding parts like SAN, SSD, 10 Gigabit Ethernet and so forth enables SAP on Microsoft platform to handle any required workload within a SAP implementation.

Announced SAP benchmarks proved that achieved SAPS for a new processor generation has gained by 60 per cent within one year. Thus, any SAP system at any required sizing can easily run on the Microsoft platform. SAP and Microsoft jointly announced Hardware Configuration Standards as to simplify the setup of new on-premises servers. [iv] Recent benchmark examples are show below.

	SAP Cert	SD Users	SAPS	Hardware	Platform
2 Sockets	2014045	16,025	87,680	Cisco UCS C240 M4	Windows Server 2012 DC + SQL Server 2012
4 Sockets	2014026	24,460	133,820	Cisco UCS C460 M4	Windows Server 2012 DC + SQL Server 2012

2.2 Microsoft Azure Virtual Machine Services - Infrastructure as a Service (IaaS)

The arrival of easily usable and bookable IaaS is a turning point in the discussion of the infrastructure platform. All security and network questions put aside, the usage of IaaS provides flexibility and turnaround times not achievable with traditional hardware and in virtualized environments only in a very structured and automated environment.

As of November 2014, the following Azure Virtual machines (VM) instance types are supported by SAP: [v]

In 2-tier configuration (Database, SAP on one virtual Server):

VM Type	VM Size	RAM	SAPS
A5	2 CPU	14 GB	1.500
A6	4 CPU	28 GB	3.000
A7	8 CPU	56 GB	6.000
A8	8 CPU	56 GB	11.000
A9	16 CPU	112 GB	22.000
D11	2 CPU	14 GB	2.325
D12	4 CPU	28 GB	4.650
D13	8 CPU	56 GB	9.300
D14	16 CPU	112 GB	18.600

The D-series virtual machines feature solid state drives (SSDs) and 60% faster processors than the A-series. Furthermore, the SSD solution has advantages with regard to a new capability in MS SQL 2014, where the so-called Extended Buffer Pool Extension can reside on SSD. [vi] The latest information on Azure VMs and corresponding SAPS can be found in SAP OSS Note 1928533 – SAP on Azure Supported Products and VMs.

Released SAP benchmarks listed on
http://global.sap.com/campaigns/benchmark/appbm_cloud.epx
also show an Amazon EC2 c3.8xlarge Instance with 2 processors / 20 cores / 40 threads, Intel Xeon Processor E5-2680 v2, which results in 31.830 SAPS. These SAPS Numbers are getting close to purchasable hardware (a 2 Processor / 24 Cores / Intel Xeon Processor E5 will benchmark at 50.000 SAPS or above) which means that the Azure environment is becoming a viable alternative to on-premises-solutions.

According to Microsoft, even VM types with 32 vCPUs and 448GB of RAM are being evaluated (as of November, 2014), which will achieve even higher benchmarks and more SAPS. Considering the sizing

of the various machines, with the new VMs approximately 38,000 SAPS might be targeted for this solution. vii

2.3 Software

2.3.1 SAP Software on Windows

SAP is very conservative about the environment for its ERP software and SAP has its own release process for database and operating systems. SAP will only support its ERP package on combinations released by SAP. The general rule is that this combination is supported until either:

a) SAP discontinues support for its software or

b) The manufacturer of the database or the operating system discontinues the support for its software product.

Details on which releases are currently part of the SAP maintenance program and their underlying technology platforms are shown in the addendum.

There are three technical platforms currently in support by SAP for its main ERP Package: [viii]

- SAP NetWeaver 7.0

  Released to Customer: 24.10.2005

  General Availability: 06.06.2006

  End of Mainstream-Maintenance: 31.12.2017

- SAP NetWeaver 7.3

  Released to Customer: 29.11.2010

  General Availability: 30.05.2011

  End of Mainstream-Maintenance : 31.12.2020

- SAP NetWeaver 7.4

  Released to Customer: 10.05.2013

  General Availability: 10.05.2013

  End of Mainstream-Maintenance: 31.12.2020

This gives SAP customers long-term predictability and planning security.

The information from the SAP support site about the platform availability matrix is condensed into the following table:

	Windows Server 2008 (R2)	Windows Server 2012 (R2)
MS SQL Server 2008 (R2)	NetWeaver 7.0x NetWeaver 7.3x	
MS SQL Server 2012	NetWeaver 7.0x NetWeaver 7.3x NetWeaver 7.4x	NetWeaver 7.0x NetWeaver 7.3x NetWeaver 7.4x
MS SQL Server 2014		NetWeaver 7.0x NetWeaver 7.3x NetWeaver 7.4x

Disclaimer: this chart is for illustrative purposes only. Up-to-date and detailed information can be found on the SAP website. Information about the release planning for MS SQL Server 2014 is preliminary – taken from SAP Note 1966681[ix]

This shows that there are always options to either upgrade the SAP ERP System on the existing platform and then upgrade the platform or to go the other way and first modernize the platform before upgrading the SAP ERP System.

However, upgrading either SAP or WIN/SQL platform requires planning and perhaps action: Depending on the start release of SAP it might be required to perform a two-step upgrade.

The supported Matrix can be found at https://service.sap.com/sap/support/pam

2.3.2 Database for SAP: MS SQL Server 2012

SAP started the official support for SAP R/3 on Microsoft SQL Server in 1995. The market numbers show that it is now accepted as a stable, scalable and enterprise-ready database in the SAP community.

According to IDC: [x]

"SQL Server is the relational database unit share leader, shipping more than twice [as many database servers] in CY2013 than Oracle and IBM combined. In the traditional IT market for database [server] shipments, SQL Server's market share landed at 47.1%, gaining +1.8% over the prior period and was the only competitor to gain share."

With the release of SQL Server 2008 R2 and SQL Server 2012, Microsoft has provided new features which continue to reduce TCO for its SAP customer base. With the advent of SQL Server 2014, there are more features to reduce TCO and increase the business value of the SAP System.

2.3.2.1 Scalability

Over the past two decades, Microsoft has continually improved upon SQL Server. With the introduction of 64-bit processors, SQL Server has demonstrated its power as a database. It is accepted by customers of all sizes, running SAP ERP and BW databases as larger than 20TB, showing just how well it can scale to any customer size requirement.

With MS SQL Server 2012, Enterprise Edition and above, the maximum resources of the database are only limited by the underlying Operating System.

	Windows Server 2008 R2	Windows Server 2012 R2
Max number of Logical Processors (Number of cores, including Hyperthreading cores)	64	640/320 (as Hyper-V Host)
Physical memory	1 TB	4 TB

2.3.2.2 High Availability

The Microsoft SQL Server offers several options for increasing the availability of SAP databases. They differ in underlying technology and approach. SAP currently supports the most powerful of the high-availability configurations offered by SQL Server, with standby databases, log shipping, clustering and database mirroring. The latter two are supported with the newly released cluster configuration introduced with SAP NetWeaver 7.0 and later (see SAP ERP Software on Windows).

AlwaysON / Database Mirroring / Log Shipping

Starting with MS SQL Server 2012 and further refined with MS SQL Server 2014, the so called "AlwaysOn" functionality gradually replaces the different HA/DR technologies.

With AlwaysOn, it is possible to replicate a primary database with synchronous data replication with up to two secondary databases (resembling database mirroring) and also have another two additional databases with asynchronous data replication. More secondary instances are available in SQL Server 2014. The data is transmitted via a standard TCP/IP connection, thus removing the need for expensive disk-subsystem mirroring and also blending in with the existing network infrastructure. Regardless of the setup (synchronous or asynchronous), this scenario provides protection from a high-level check against data corruption in underlying infrastructure layers - the data on the secondary database is valid on a transaction log level. By using synchronous replication of data between primary and secondary, AlwaysOn also provides protection from losing committed business transactions.

With this functionality the database has an out of the box configuration, which equally protects against infrastructure malfunction, like server, storage and disaster.

Synchronous data replication means that every update or insert transaction from an application is sent to the primary database instance and also to a secondary instance. The primary database commits the transaction to SAP only after the secondary database acknowledges the transaction. That keeps both databases in the same state at all times. To minimize any impact on performance, the connection between the nodes should have enough bandwidth and operate with low latency. On-the-fly compression reduces the network traffic, so more customers can deploy a synchronous mirrored database.[xi]

Where that is not feasible, **asynchronous** data replication presents another alternative. Here the application does not have to wait for the commit by the secondary instance, although this holds the

risk that a small amount of data loss is likely in the event of a manual failover. The advantage of **asynchronous** data replication is that longer distances can be bridged. A connection from an on—premises primary instance to a secondary instance in the public cloud realized with Azure has been tested successfully.[xii]

Beginning with AlwaysOn, the secondary instance can also be used for performing backups and functions like DBCC CHECKDB. This reduces the I/O load on the primary (productive) instance. In addition, in the case of a disaster of the primary database, a transaction log backup can be executed on the secondary database. This reduces the loss of transactions, providing all the data for a full recovery and a low Recovery Point Objective (RPO).

Log Shipping

With Log Shipping, the transaction log backup from the (productive) database on the primary instance is copied to the secondary instance. Dependent on the configuration of SQL Server Log Shipping, the transaction log backup can be restored immediately or a restore delay can be configured. If the restore delay is long enough, such a configuration also provides protection against user error (e.g. deleting important data or dropping a whole table). For that, the lag of the transaction log backup restore needs to be set to an appropriate length. (Usually 1-24 hours) Also the secondary database instance can be behind a long-distance WAN, since only the compressed transaction log backup files have to be transferred.

If a user or application error occurs, the Log Shipping process can be paused and the missing data can be extracted from the secondary database just before the error occurs with a point in time recovery. However, this is manual work and needs to be executed carefully.

Such a Log Shipping configuration can be realized with out of the box functionality of SQL Server. SQL Server Log shipping is suitable as well for synchronizing databases running in SQL server instances hosted on-premises and SQL server instances hosted in Microsoft Azure Virtual Machine Services.

With such a setup, the instance at Microsoft Azure could be a “last line of defense” in a disaster recovery concept. It would act as a remote copy of the data with a small, inexpensive virtual machine. If disaster strikes, the infrastructure can be resized at Microsoft Azure to a more powerful hardware and take over the productive load.

Clustering

MS SQL Server integrates easily in the Windows Server Failover Cluster (WSFC) functionality of the Windows Server platform. Starting with SQL Server 7.0 in 1998, deployment into a WSFC configuration can be performed directly during the initial SQL Server installation, making it straightforward and quick.

Clustering SQL Server instances provides automatic failover and with that a way to recover not only from server-side hardware failures but also from potential software failures. In many cases, the end user will not even notice the switchover process at all.

The different functionalities of AlwaysOn/Database Mirroring, Log Shipping and Windows Server Failover Clustering can be combined in order to tailor to specific customer requirements. Most of these functionalities work over different subnets which makes it easy to leverage geographically spread datacenter or cloud infrastructure.

Summary:

The different approaches, advantages, and disadvantages are shown as an overview in the following table. This is a very short overview – in practice each customer must assign their own meaningful weights to each of the scenarios. For some, the automatic failover might be a key criterion, while for others the minimum requirements of the infrastructure are crucial. These measures can also be combined to achieve the desired results.

The architectural design of a SAP landscape is a complex process, requiring both expertise and experience as well as the ability to identify and compile the customer's requirements. REALTECH routinely provides architectural consulting to customers so that best compromise of availability, budget and manageability is reached.

	Clustering (MSCS)	AlwaysOn - async (DB Mirroring)	AlwaysOn - sync (DB Mirroring)	Log Shipping	BlockDevice Mirroring (sync)
Automatic Failover Recovery Time Objective (RTO)	+	+	+	-	+
No Rollback Recovery Point Objective (RPO)	O	+	+	-	+
Protects against: User Error	-	-	-	++	-
Protects against: Software failure	+	+	+	O	-
Protects against: Server failure	+	+	+	+	-
Protects against: Disk Subsystem failure	-	+	+	+	+
Infrastructure requirements & costs (Server, Disk subsystem, LAN)	O	O	O	+	--

2.3.2.3 Fully Integrated with SAP

Any feature introduced by the database vendor needs to be supported by SAP.

With SAP NetWeaver 7.0 Support Stack 12, SAP introduced a powerful database monitoring transaction. The new transaction, called 'DBACOCKPIT', replaced the various SAP transactions and reports that had been used before. The DBA cockpit uses one well-designed transaction screen to oversee all functions needed to manage and monitor several databases. It is possible to connect from one central DBA cockpit to local and remote SQL Server instances – including any SAP release level or even to databases that are not used for a SAP system.

A new authorization concept was also implemented, allowing a granular configuration of privileges and rights. This allows different administrators responsible for different database installations to leverage the use of one central cockpit. [xiii]

It is now possible to use the new SQL Server Data Management views with the SAP monitoring tools, which provide some helpful administrative information, including query execution statistics andusage statistics of indices and tables. This information helps administrators to monitor the query performance of the SQL Server system under SAP workload. With the help of SQL server functionality, which can suggest the creation of new indices, a SAP Basis administrator has comprehensive data to identify improvement potential for queries and recommendations to improve specific queries. With newer versions of DBACOCKPIT SQL Server execution plans are stored. This enables a DBA to examine poor query execution plans even if a plan is not current and not in the SQL plan cache anymore.

An interface for the Windows PowerShell is integrated in all the different versions since SQL Server 2008 Management Studio, allowing administrators to script recurring tasks. This allows for faster execution of repetitive tasks and for higher consistent quality.

2.3.2.4 SAP Tools for MS SQL Server

SAP provides the SAP Tools for MS SQL Server free of charge for all of its customers using the MS SQL server. The SAP Tools for MS SQL Server are based on the SAPinst installation tool and are used to configure database-related parameters of an SAP system running with MS SQL Server.

The SAP Tools for MS SQL Server can be used to:

- Perform the final adjustments on the database required when performing a system copy using the detach/attach or backup/restore method. This only applies to SAP systems based on SAP NetWeaver 6.40 or lower.
  If you want to copy an SAP system based on SAP NetWeaver 7.0 or higher, you must perform the standard system copy procedure offered by SWPM/70SWPM using the detach/attach or backup/restore method. The required SQL Server logins are also performed by SWPM. In fact, the functionality of SAP Tools is used but integrated into SWPM.
- Convert the SAP system to a schema-based configuration.
- Upgrade your SQL Server.
  This applies to all SAP releases starting with 4.6C, including upgrades to SQL 2005, SQL Server 2008, SQL Server 2012 and SQL Server 2014.[xiv]

Data Compression

One of the main cost drivers in a SAP ERP environment is the requirement for high-end disk storage. With production SAP databases easily reaching several terabytes in size, the cost of the high-end storage required to house them also increases considerably. SAP has also been applying (more or less) subtle pressure to use Unicode, which increases the size of databases, depending on the DBMS system even further. Not only is the disk subsystem required to hold many Terabytes of data, the disk I/O operations conducted per second also need to be sustainably high for SAP ERP Systems. Therefore any functionality in the DBMS platform to reduce the allocated space on disk by the SAP database is welcome with SAP customers and an important measure to lower cost of ownership.

Database Compression applied to its data by the DBMS, like SQL Server, also has the very welcome side effect of reducing the I/O load on the disk subsystem. Because the data is compressed in the DBMS by the CPU before being going to a persistent storage, the size is reduced prior to reaching the SAN. This reduces the probability of a bottleneck in the connection of the SAN disks. Also the Cache Buffer can hold more data so that less I/O requests need to go to the disk-subsystem. CPU power leveraged for compressing is usually not a problem with recent hardware so the benefits of compression outweigh the drawbacks by a wide margin.

Over the years, Microsoft developed different in compression types for SQL Server:

- Starting with SQL Server 2008, Microsoft released so called Row and Page Dictionary compression. SAP customers were the first customers using row compression which (especially for SAP BW) resulted in a considerable reduction of database volume.
- With SQL Server 2008 R2 Microsoft tied an optimization to the Row and Page Dictionary compression with the purpose of eliminating database volume increases by using SAP Unicode versions. This new functionality, called UCS2 compression, is used automatically as soon as tables are getting compressed. This leads, despite the UC Conversion, to a decrease of database size. The corresponding SAP note has been modified since SQL Server 2008 R2. [xv]
- Since 2011, all tables SAP NetWeaver based applications create in SQL server database (based on SQL server 2008 R2 or later releases of SQL Server) are fully Page Dictionary compressed. All SAP Software Provisioning tools, as well as SAP Platform Migration Kit will apply SQL Server's most space efficient compression to all tables without exception.
- With SQL Server 2012, Microsoft introduced a Column store format in which indexes could be created. Moving data in such a Column store format further improved compression of the data. This is especially true in the SAP BW environment.

In order to apply compression to an already existing SAP database, SAP NetWeaver provides a Report called "MSSCOMPRESS". This report can run online. An existing database can be converted on a table-by-table basis from a non-compressed state into a fully compressed state, either during scheduled offline time, thus using all available CPU power, or online, parallel to production usage but without any service interruption. SAP has released a central note with regard to compression and Disk I/O. [xvi]

With increasingly more powerful commodity servers available, the transparent compression of databases table and indexes is a good way to decrease the physical size of the database without running into CPU resource bottlenecks. What effect on database size does the compression have?

The usual customer experience was, as confirmed by a case study with Quanta Computer, that a compression rate of factor 4-5 could be achieved by applying Page Dictionary compression to a non-compressed SAP Unicode database. [xvii]

Experience regarding the effect of SQL Server's Page Dictionary compression when migrating SAP database from other DBMS platforms to SQL Server depends on the usage of database compression on the original source systems with a different DBMS and the availability of database compression by the source DBMS release.

The savings are much higher than the nominal disk space. Because each SAP database is stored in several images (e.g. test systems, backup), the savings in disk space are dramatic. Therefore it is not rare that customers with large SAP landscapes report saving about 50-150 TB of high-end storage space, thanks to SQL Server Database compression. Experiences from the field, from Microsoft and from REALTECH show a decrease of database size from 40% to >70%. [xviii]

The amount of disk I/O is also reduced, because the data is compressed on the database server on the fly before going to the SAN. This reduces the I/O load on the SAN as well. These effects together reduce the need to invest in expensive high-end disk storage.
Another effect is that the Buffer Cache hit rate increases. Because of the compression, the buffer cache which lies in main memory can hold more data, so that there are less requests that need to go to the disk subsystem. This actually increases the performance of the SAP System.

Backup Compression

One of the infrastructure cost drivers is not only to store the different SAP databases with high volumes, but also to manage the many backups that one usually needs to store in these databases. In order to reduce this portion of the costs, SQL Server 2008 introduced the possibility to compress backups. Customer experience has shown that independent of the usage of Page Dictionary compression in the SQL server database, compression rates of 4-5 can be achieved. This means that the space needed by the backup is reduced to only 20%-25% of the original size. In essence, up to 80% of the often valuable backup space can be saved. Backup compression is a standard feature of SQL Server Enterprise Edition. The advantages of using backup compression are a much lower load on the backup infrastructure (network, SAN, backup servers, tapes) and a much higher net throughput. This applies to the backup process, but even more to the restore process – allowing for easier fulfillment of Service Level Agreements. In addition, the costs for backup infrastructure are greatly reduced, e.g. because fewer tapes are needed and the existing tape library offers sufficient capacity even if the SAP databases increase in size. SQL Server backup compression is supported within SAP DBACockpit. [xix]

2.3.2.5 Additional SAP BI Features (application)

Starting with MS SQL Server 2012, the column-store has been implemented. The column store is optimized for aggregation of mass data and can be used side-by-side with the row oriented store. This is a long term investment of Microsoft to improve the customer experience of using MS SQL Server with SAP BW. In the first implementation with MS SQL Server 2012 it is a read-only column store. It is described in SAP Note 1771177 - SQL Server 2012 column-store support for SAP BW

The benefits are:

Space savings

Space (on disk and also in main memory) is saved because the column store compresses much better than classic indexes and also because secondary indexes can be removed once the column store has been created. The column-store compression is much more efficient than the page compression mentioned above.

Query performance

Because the index is smaller in size, it can be scanned faster than a classic index.

Also the scan process is optimized for parallel execution on more than one CPU thread.

Fast index creation

If the table has several million rows or more, the parallel creation of the index will speed up the creation of the column store index.

Easier BW Administration

BW aggregates are often no longer needed because equivalent results are now generated “on the fly”. Therefore, the aggregates no longer need to be designed and created beforehand. This reduces the cost and effort for BW administration.

However, based on customer experience, there are situations where aggregates are in place or are beneficial for a certain scenario. [xx] As a consequence, Microsoft and SAP has developed an extension for the SAP BW support for SQL Server 2012 column-store. [xxi]

This is described in 1951490 - SQL Server Column-Store for SAP BW Aggregates

Attention should be paid to the recommended SAP NetWeaver support package stacks (SPS): [xxii]

SAP BW	NW support package stack	BW SP
7.0	30	32
7.0 EHP1	15	15
7.0 EHP2	15	15
7.1 EHP1	13	13
7.3	11	11
7.3 EHP1	11	11

7.4	6	6

Also important is the fact that the column-store index is deleted before a BW cube is compressed and then re-created again afterwards. That is because it is -up to SQL Server 2014- read-only, and it is done automatically. The re-creation needs to be checked only in the case of an error during this process.

With Microsoft SQL Server 2014 a new functionality - Modifiable Column Store Index – will be introduced. [xxiii]

More details on the implementations can be found at:

http://msdn.microsoft.com/en-us/library/gg492088%28v=sql.110%29.aspx

and

http://msdn.microsoft.com/en-us/library/gg492088.aspx

According to SAP Note 1771177 "SQL Server 2012 column-store support for SAP BW" and the attached documentation:, the compression reduced the space usage "of SAP BW e-fact tables by additional 50% to 80% (even compared to page compression)".

Also the "majority of the SQL queries we tested, ran about 3 to 6 times faster."

Reporting Services

Previously, Microsoft released "Reporting Services" at no extra licensing cost. The Reporting Services allow users to build powerful reports on SAP BW Data and are certified to run reports on SAP BW. [xxiv]

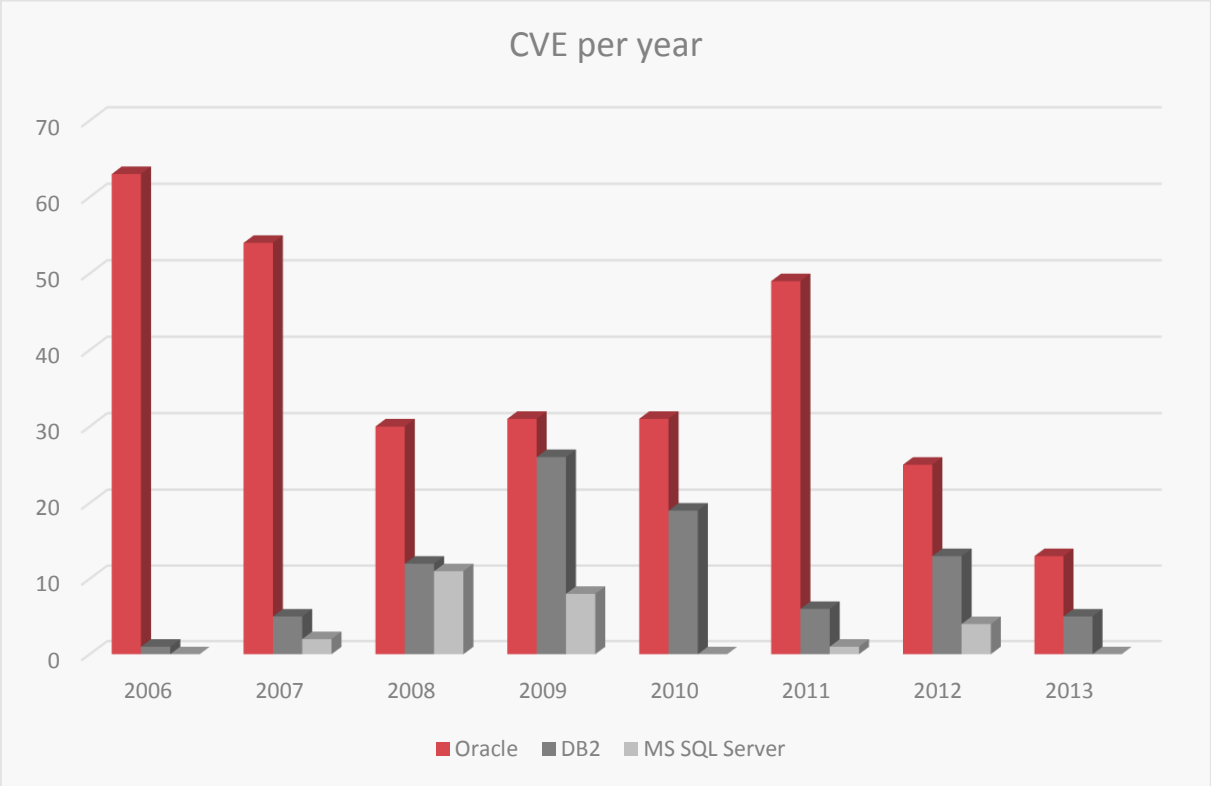
The Integration Services allows direct extraction of data from an SAP BW System into a MS SQL Server. This data can then be analyzed using the Microsoft Analysis Services.[xxv]

2.3.2.6 Security

According to data from the National Institute of Standards and Technology (NIST), Microsoft SQL Server has considerably less vulnerabilities than other databases in the SAP environment. [xxvi]

A selection on the number of CVE (Software flaws) over the last few years:

	2006	2007	2008	2009	2010	2011	2012	2013
Oracle	63	54	30	31	31	49	25	13
DB2	1	5	12	26	19	6	13	5
MS SQL Server	0	2	11	8	0	1	4	0



The National Vulnerability Database (NVD) is the U.S. government repository of standards based vulnerability management data. [xxvii]

2.3.3 Database for SAP: MS SQL Server 2014

Microsoft SQL Server 2014 was released in April 2014 by Microsoft. As of the publication of this whitepaper, SQL 2014 is expected to be certified soon.

The SAP note 1966681 – "Release planning for Microsoft SQL Server 2014" will be updated as soon as SQL Server 2014 is supported.

The SAP note 2114876 - Release Planning SAP BW for SQL Server Column-Store explains, how cusomers can join SAP's general Test, Evaluation and Assessment (TEA) program in order to evaluate the new functionality described below.

SAP Note 1986775 – "Configuration Parameters for SQL Server 2014" already gives advice on how to configure MS SQL Server 2014 for best performance and security to work with SAP NetWeaver.

Some of the major enhancements that are important in the SAP market are: SQL Server 2014 extends the Column Store Performance and Storage Efficiency gains seen in SQL Server 2012. Also, SQL Server 2014 has a fully modiable Column Store Index

Column-Store Scenarios

Writeable Column Store

Will be described in SAP Note 1949486 - SQL Server 2014 column-store support for SAP BW

Runs for all SAP BW releases 7.x on SQL Server 2014

Used for e-fact and f-fact tables of SAP BW cubes and aggregates

- **Modifiable Column Store Index**

SQL Server's column-store capabilities were greatly extended with SQL Server 2014. Key improvements are as follows:

- Besides keeping the functionality of the read-only non-clustered column store index, a clustered column-store index was introduced.
- The Clustered Column-store index is modifiable

The principles of SQL Server's column-store with its in-memory optimized data representation remained untouched and have been optimized for improved performance. These extensions of SQL Server 2014 column-store have a dramatic impact on the scenarios in which column-store indexes can be used in conjunction with SAP BW. With SQL Server 2014, the clustered column-store index will be applied to f-Fact tables within SAP BW cubes as well. Microsoft promised to release detailed

descriptions about the way SQL Server 2014 column-store is integrated and is leveraged by SAP BW as soon as SQL Server 2014 is supported by SAP on this blog site:
http://blogs.msdn.com/saponsqlserver

An article about column-store of SQL Server 2014 also can be found here:
http://blogs.msdn.com/b/saponsqlserver/archive/2014/01/16/new-functionality-in-sql-server-2014-part-1-modifiable-column-store-index.aspx

Flat Cube

It is described in SAP Note 2029797 - Support for Flat Cube on Microsoft SQL Server

Runs in SAP BW releases 7.4 SP 8 (and newer) on SQL Server 2014

Introduces an additional cube type: The Column-store Optimized Flat Cube

- **Online Index rebuild (Low Priority Wait)**

Despite online index maintenance functionality in SQL Server, there are some low level locks required for some split seconds at the start and the end of an online index build/rebuild.

This requirement, and the way the MS SQL Server deals with queries from SAP application (read uncommitted) can lead to blocking problems with:

- Online Index Create
- Partition Split in partitioned tables

The solution offered in SQL Server 2014 is to facilitate 'low priority waits' which:

- Provides processing of higher priorities thus preventing the blocking of real world workload
- Get instantly assigned where no competing lock is on the table
- Can be defined in wait time

Also see: http://blogs.msdn.com/b/saponsqlserver/archive/2014/01/17/new-functionality-in-sql-server-2014-part-3-low-priority-wait.aspx

- **Backup/Restore Enhancements**

Besides requirements by some compliance regulations, customers looking into Hybrid deployments between on-premises and public cloud, needed backups taken by SQL Server to be

encrypted. So far the only possibility to encrypt a SQL Server backups was to encrypt the underlying database. An effort that often turned out too massive for just having the backups encrypted. Besides the side effect that SQL Server backup compression would not be able to compress such encrypted backups anymore. Therefore, backup encryption was introduced into SQL Server 2014 which provides the following capabilities:

- Encryption of the backup even without encryption of the database itself
- Backup compression is executed before the data is encrypted. This means the full compression experience is provided before encryption is applied
- Support non-encrypted databases (don't need to turn on Transparent Data Encryption anymore)
- Encryption keys can be stored on-premises while backing up files in the cloud
- Different policies for databases and their backups

2.3.4 Platform Advantages

Beyond its technology, the Microsoft platform also assists in the establishment of reliable, pragmatic and result-oriented procedures. These can be standardized through the various management solutions provided by Microsoft or automated by using the PowerShell environment. This leads to easy-to-follow procedures that can benefit from an IT department's existing set of conventions. For example, configuration and change management procedures can be used for a MS Exchange Server as well as for a SAP database or central instance server. That means that these procedures must be put in writing and maintained only once.

One of the major challenges to effective operations is proper personnel. Because the Microsoft platform is already familiar to the non-SAP portion of an IT department, there is a pool of well-educated staff already at hand. Some customers have even switched the platform of their SAP environment to the Microsoft platform mainly primarily to take advantage of the availability of well-trained computer personnel for that platform. Other customers have expressed an unwillingness to train for several different platforms and have therefore decided to follow a strict "two-vendor-strategy" consisting of SAP and Microsoft.

A study conducted by Wipro showed the financial benefits for SAP customers to migrate to the Microsoft platform to be up to 61% ROI.[xxviii]

Microsoft is positioned well to enable Hybrid SAP landscapes between on-premises datacenters and Azure IaaS. By providing an Operating System Platform for on-premises bare-metal deployments,

private cloud and public cloud, Microsoft is in a unique position to make deployments and operations of Business Software deployments like SAP more transparent and efficient. Latest developments show Microsoft enabling scenarios where Azure can be used:

- Hosting Recovery Services which control and enable disaster recovery between on-premises sites. With hosting the control of the disaster recovery workflow in Azure, one can host this control function in a highly available 3rd location that is available independent of the state of the on-premises datacenters
- Extending functionality of Asynchronous Hyper-V Replication and Azure Recovery services, so that on-premises VMs can be replicated into Azure where they could take over in case of a disaster. In this case the customer might not need to provide a second on-premises location or datacenter at all and still enjoy sufficient disaster recovery capabilities.
- Extensions in SQL Server 2014 that allow to leverage Azure storage resources directly, independent of running on-premises or in an Azure Virtual Machine.

2.3.5 Microsoft System Center

Virtualization reduces the number of physical servers. It does not however inherently mean a reduction in the number of virtual servers. While one of the virtues of virtualization is the ability to provide a number of (virtual) servers on short notice, it carries with it the challenge of managing an increased count of virtual servers. The Microsoft System Center – the Microsoft family of system management products – is a comprehensive solution optimized for the management of Microsoft Windows Server operating systems running in the virtualized data center.

It consists of

- System Center Virtual Machine Manager – providing support for consolidating multiple physical servers within a virtual infrastructure. The SCVMM also enables administrators and authorized users to rapidly provision virtual machines.
- System Center Data Protection Manager – providing data protection on physical and virtual machines for backup and business continuity.
- System Center Operations Manager – providing a solution for unified health monitoring of physical and virtual machines.
- System Center Configuration Manager – providing a solution for change and configuration management.

With these solutions readily available without licensing costs, the TCO of setting up and running a virtualized data center is reduced.

2.3.6 Hardening of the SAP System Running on Microsoft

Hardening involves configuring a system to use only those functions that are necessary for operation. Advance planning must be conducted before hardening is implemented on a system, including the addressing of the following issues:

- Decision on what level of security is required
- Review of specifications for SAP systems and other systems communicating with SAP
- Identification of areas where hardening may be required
- Cost/benefit analysis based on effectiveness, time and cost vs. security needs
- Finalization of what is to be hardened

Hardening is recommended for three areas of systems running SAP:

- Network hardening

  By hardening the network in an SAP environment one can easily reduce the vulnerability to attacks on the SAP systems and those systems that communicate with SAP. This can be accomplished by network hardware, IPsec policy scripts, hardware-based packet filtering, Microsoft ISA Server and/or SAP Router.

- Service hardening

  Service Hardening involves the evaluation of currently needed services on the SAP systems and systems used by SAP, and disabling those services that are not necessary.

- Other hardening

  A variety of steps can be taken to further harden the SAP environment, including IIS hardening, SQL Server hardening, SAP-specific hardening, antivirus software, and hardening of the SAP users' workstations.

Once the decision-making process is complete and hardening has been implemented, a complete check must be carried out. This is to confirm that the SAP systems are operating as expected, that users are able to access the systems as needed, that third-party systems are able to communicate with SAP and vice versa, and that no errors are generated during the running of reports that previously ran without error.

A final security check should be carried out to make certain that all scheduled hardening steps were in fact implemented. Microsoft recommends the Microsoft Baseline Security Analyzer to check the security of Microsoft products.

For further detailed information refer to Microsoft's released a Whitepaper 'Security Guide for SAP on SQL. [xxix]

2.3.7 Zero Downtime Patching

With the current clustering scenarios recommended by Microsoft and SAP, it is possible to have almost zero downtime when patching the servers.

Windows Server Failover Clustering (MSFC) (the successor to Microsoft Cluster Service (MSCS)) operates such that only the database and (A)SCS instances are now clustered. End users are connected to dialog servers located on other servers that are not part of the cluster. When the (A)SCS instance is failed over from its server to the same server where the database is running, only users just logging on will be affected. Current users will not experience any loss of service. Meanwhile, the server where the (A)SCS was previously running can be patched and restarted as needed.

The only time an end user may experience a short interruption in service is when the clustered SQL Server instance is failed over to another node. At that point, any current long-running batch job will fail and any new database requests will experience a delay while the database instance restarts on the other cluster node.

When using synchronous database mirroring, the mirroring process can be suspended for a period while the mirror is patched. The mirroring process will then resume and once the two databases are in sync again, a manual failover can be initiated without any service interruption to the end-user. At that point the primary database can be patched, after which a failover back to the primary database can be initiated. This procedure provides effective “zero downtime patching" for the database.

2.3.8 Operation of MS SQL Server

A study conducted by Alinean concluded that "overall, Microsoft SQL Server required significantly less effort to install and maintain, than Oracle". This results in "over a 350% difference in annual costs per database" [xxx]

Configuration of the database is crucial to achieving high performance operation of a SAP system running on SQL Server. A few relatively simple configuration guidelines need to be followed, as SQL Server is already a powerful, easy-to-handle database requiring only a low level of administrative overhead.[xxxi]

With SAP, MS SQL Server should ideally use multiple data files of the same size – normally four, eight, 16 or 32 files – depending on the size of the system. SQL Server makes sure that all files are filled

proportionately to the same degree with the need to have Trace Flag. Where possible, different LUNs should be used for each file to get the best performance.

In general, one log file is used for the SAP database. This file should be placed on a fast disk, because all logging action done by SQL Server is first written to the log file.

The SQL Server tempDB performs all sorts, hash joins and aggregations performed by the database system. When combined with SAP ERP, the workload handled by this system database is rather low, so no tuning is necessary.

To avoid database freezes caused by a data file overflow, SQL Server is able to grow all files automatically if necessary. This design guarantees reliability and is one feature that makes SQL Server easy to handle while keeping the administrative overhead minimal.

Another useful feature provided by SQL Server is known as auto update statistics. Up-to-date statistics are a requirement for an efficient database. During the runtime, a well-configured SQL Server automatically updates the statistics of modified tables to ensure that the database optimizer is able to generate an intelligent execution plan.

Conclusion: *The Microsoft platform provides numerous features to optimize operations for a safe, efficient and flexible service. Beyond its technological advances, the platform also benefits from established procedures for the existing Microsoft solutions and from the explicit and implicit training of computer personnel. This lowers the TCO, increases the reaction speed to business requirements and increases the delivered quality.*

3 INTEGRATION

3.1 Active Directory (Single Sign-On / Identity Management)

Among the most demanding issues that companies face are Governance, Risk and Compliance. Considerable effort is being put in adjusting the rights of users within SAP systems so that rules and regulations can be fulfilled. All this necessitates valid identity management to ensure that those carefully adjusted rights are available only to the person to whom they are assigned. Single Sign-On (SSO) is a bridge to fulfill the business-side compliance requirements with the reality of IT conditions.

Microsoft and SAP provide a set of technologies to ensure a safe and cost efficient solution to SSO. In general, power users will access SAP from within a SAPGUI, SAP's implementation of the presentation layer, running on Microsoft Windows on the front end.

If the SAP back end system is running on the Windows platform as well, the authentication information from the front-end windows can be reused. This can be set up "out-of-the-box" and does not require any third-party software solution. As such, this critical solution is fully supported by SAP and Microsoft through the regular support channels, without any further licensing expenses.

This easy implementation will not only make the next audit easier, but also lowers the burden on the help desk. Studies show that up to 40% of all support desk calls involve identity management. This can be lowered by reducing the number of identities a user has to manage.[xxxii]

3.2 SAP Gateway for Microsoft

SAP Gateway for Microsoft is a flexible interoperability framework that integrates data from SAP systems to Office 365, including SharePoint Online. With SAP Gateway for Microsoft, customers can create Apps for Office and SharePoint applications that leverage SAP data.

Microsoft SharePoint 2013 is a good platform for enabling collaboration, content management and data-driven decision processes with LOB data integration across the whole organization.

SharePoint 2013 is widely used in customer organizations and is often viewed as a Mission Critical application like SAP. Downtime for a SharePoint installation is categorized as a business-critical event. Customers have responded to this by:

Implementing high availability scenarios for their SharePoint infrastructure. These increased business demands on the availability of SharePoint and the underlying MS SQL Server database are becoming more and more aligned to the demands placed on an SAP installation.

This produces synergy effects. Major parts of the operational concepts of the operational handbook can be reused. The system design and the architecture need be completed only once. The same holds true for the establishment of procedures and handling instructions, and for training as well.

Once this has been accomplished every member of the IT staff can handle the complete Microsoft based infrastructure, be it for the SAP installation or the SharePoint installation.

3.3 Synergy during Knowledge Transfer for the Internal Staff

One very important synergy effect comes through the “on-call duty.” It is much more efficient to provide “on-call duty” for only one database than to maintain current knowledge for several platforms. This reduces the workload and stress levels for the IT staff. It also represents a more effective use of the training budget, since training can be focused instead of distributed amongst several databases.

A customer migrating SAP from a different database will have to retrain the administrators of the existing database. Delta training courses for experienced database administrators and operating system administrators are available for precisely that scenario. A database administrator does not need to relearn database fundamentals. There are differences in the way functionality is applied and the way it must be configured. Experience shows that an experienced database administrator requires one week of attendance at a delta class to administer a new database. After that, the database administrator is able to work as efficiently and reliably as before. Thus, the training costs for retraining the personnel are often less than estimated or perceived.

4 MIGRATION OF SAP SYSTEMS

A migration in the SAP domain is typically a heterogeneous system copy, also known as an OS/DB migration. This involves moving/migration of a current SAP system to a new OS, a new RDBMS vendor, or both. In recent years, Unicode migrations have also been necessary for customers with multiple-language needs. Since 2007 it has been possible to combine a heterogeneous system copy with a Unicode migration and an upgrade, referred to as a Combined Upgrade and Unicode migration (CUUC) with a source system of the release 4.6C and newer or Twin Upgrade and Unicode migration (TUUC) with a source system older than 4.6C.

Real business issues are forcing a growing number of IT organizations to consider fundamental changes in their IT infrastructure – migration to a different hardware platform, different databases, or both. There are various potential causes for this and the benefits can be substantial. Some of the reasons to migrate include but are not limited to the following:

- Additional hardware requirements
- Upgrade to ECC 6.0
- Migration to UNICODE due to multi-language SAP requirements
- Rapid growth of a company
- Data center consolidation
- Increasing hardware and/or software licensing costs
- Reduced or no availability of support for current operating system or databases, e.g. Informix
- Merger with another company
- Standardization of systems
- Total Cost of Ownership (TCO) needs to be lowered

As an independent technology consulting company specializing in state-of-the-art solutions for SAP, the REALTECH consulting organization's experience encompasses all of the various operating systems, databases and clustering software solutions that are supported by SAP. REALTECH is a pioneer in SAP OS/DB migrations, having not only performed the first productive migration worldwide back in 1998, but also emerging as the first company to use the "migration toolkit," yet unsupported at that time. REALTECH has completed over 1100 migration projects since then. In each

case, the productive migration was completed successfully and according to plan. A great number of migrations had the target of Windows and MS SQL Server.

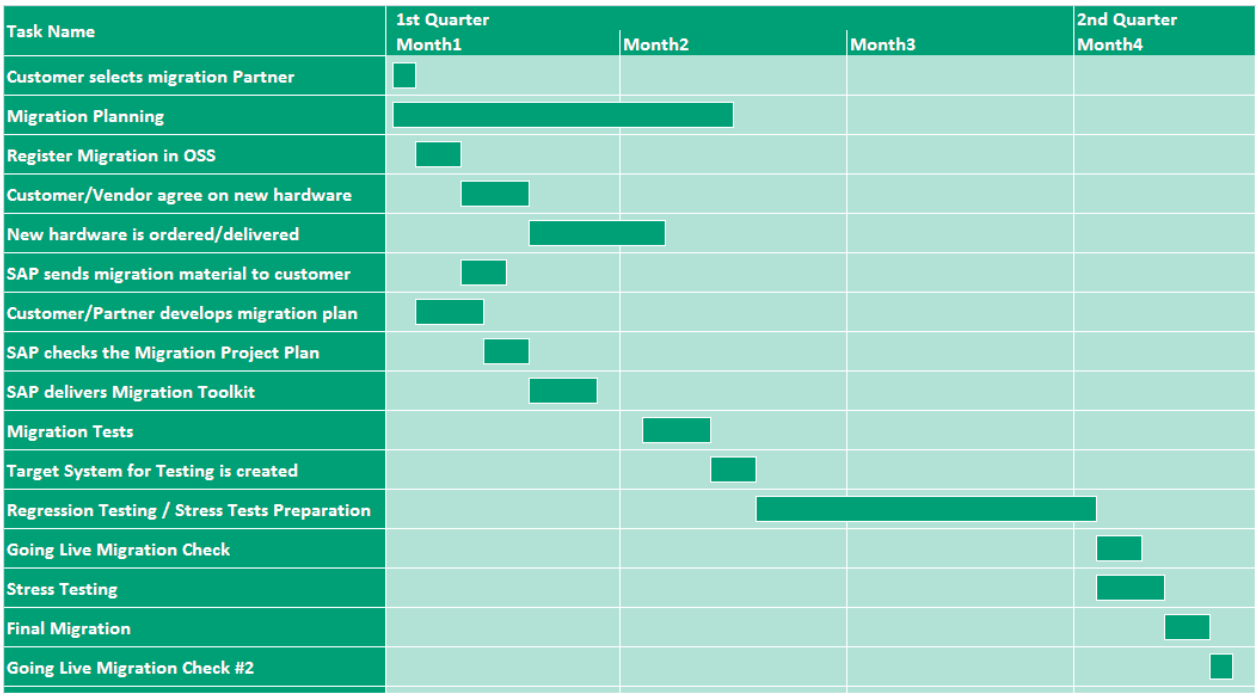
Migration customers have been choosing SQL Server in ever-increasing numbers as the choice for their new database platform. The reasons are cost and ease-of-use. The administrative tools are based on a user-friendly and intuitive graphical interface. With a minimum of training, administrators can become competent in administrating SQL Server. The availability of the SQL Server Online Help, directly accessible from the SQL Server Management Studio (SSMS), lends greatly to accelerating the administrators familiarity with the features in SQL Server.

4.1 Project Planning

The migration of a SAP system is based on a well-defined framework. However, due to the changes involved, planning and executing a migration requires the coordinated interaction between the various customer teams, SAP and the migration specialist(s). A detailed migration plan is required with input from all teams. REALTECH can support the customer in that process.

4.1.1 Project Overview

The final version of a well-prepared migration plan will be highly detailed and largely customer-specific. The framework of the project plan, however, is always the same and is based on REALTECH's best practices, which are aligned with the requirements specified by SAP. This framework is made up of the core tasks contained in the following table. A customer should plan on a minimum of 12 weeks to complete a simple migration of one system line.



4.1.2 Technical Migration

Because customers can usually only afford a certain amount of downtime, one of the primary restrictions for migrations is time. For most migrations, this is typically a normal two-day weekend. However, with databases growing ever larger year after year, migration during a normal weekend has become more challenging. REALTECH has the experience necessary to maximize the capabilities of the tools available for migrating any system. To date, REALTECH has been able to migrate any database regardless of size within a normal two-day weekend.

In order to optimize the migration-related downtime, it is necessary to perform test migrations. In some cases – especially when the database size is many terabytes – other measures are required as well. When a large database needs to be migrated within a very tight maintenance window, several steps can be taken to ensure the migration process is as efficient as possible.

Export and import processes can be split and thus run in parallel. If this parallelization is not sufficient, even the handling of tables can be split and parallelized.

A recent study conducted by Microsoft, SAP and REALTECH shows that migration times can be shortened by splitting a greater number of large tables from the application class packages and then further splitting them into smaller pieces. The bottleneck then becomes the I/O subsystem, and the shortest technically possible export and import times are achieved.

REALTECH works in the SAP group that has been supporting SAP on the Microsoft platform for several years now. As such, REALTECH's consultants – and by extension REALTECH customers – enjoy the latest know-how and deepest understanding of the processes and tools involved.

4.2 Risk Assessment / Risk Mitigation

Because migration is an infrequent project for customers, the risks involved are typically lower than estimated. Proper planning and testing is essential to managing that risk.

The following areas must be covered in the project plan:

Regression Testing

The key transactions and functionalities used by customers should be tested on the target system to ensure that the transactions run as expected. Here the existing documentation and the validation process for key processes and transactions can be used. Since a migration is by definition a 100% identical copy of the system, it is rare that issues arise here.

Interfaces

A customer's productive systems may utilize several interfaces to other SAP systems and other non-SAP external systems. Interfaces to other SAP systems are usually independent of the platform beneath the SAP system. Interfaces to non-SAP systems might make use of operating system or database system specific functionality and require extra attention. The tests here are set up in the same way as they are for regression testing.

Printing and Other Output Methods

This is a subcategory of interfaces. A change of OS may dictate changes to the printing method used by the systems being migrated. There are several possible methods for handling printing from a SAP System and some or all of them may currently be in use. REALTECH helps determine the best methodology for printing support for the target SAP systems, including development of an implementation plan. These changes can often be scripted and executed in batches during the productive migration process.

5 EXECUTIVE SUMMARY

Commodity servers, based on x86-64 processors, provide high amounts of processing power, thus eliminating the need for proprietary hardware for any SAP installation. Windows Server 2012 has the features needed to harness this computing power for SAP installations and to ensure stability, green IT and reduced costs through consolidation and virtualization. It also provides the opportunity to react flexibly to changing business requirements. The Microsoft SQL server achieves this through features that provide high performance, disaster protection and cost reduction by decreasing the amount of disk space needed.

The Microsoft platform has shown itself to be a stable platform overall, with SAP still supporting installations released 9 years ago. The requirements of the future, especially cost reduction and increased flexibility coupled with uncompromised stability and performance are all covered by the Microsoft platform. Other advantages include the close integration of SAP systems running on the Microsoft platform with the existing IT infrastructure and other essential applications from Microsoft such as Active Directory and Microsoft Office SharePoint server. The benefits achieved through the consolidation of databases and operating systems all contribute to a reduction in the TCO.

Any customers already using a Microsoft solution will benefit from reduced training overhead for IT staff and synergy effects in service and support. A higher level of service can be provided, because know-how, processes and service procedures can be reused. Dependency on IT staff is reduced. Delta training for already experienced IT staff is minimal. Additional cost savings and agility can be achieved by the same customers as they adopt a Hybrid Cloud architecture leveraging Microsoft Azure, reusing most of the Know-How that has been built up.

The migration to the Microsoft platform involves only a minimum level of risk, because SAP's tools and the SAP-certified and experienced consultants from REALTECH ensure a 100% perfect migration. Any functionality based on SAP standard interfaces will work in the new environment with a minimal amount of conversion work. Downtime has also not been a problem to date: every migration carried out by REALTECH, regardless of size, has been completed within a standard two-day weekend.

[i] http://download.microsoft.com/download/8/b/e/8be3e9a0-690d-4271-afec-91922a078dba/SAP_Microsoft_SQL_Server_and_SAP_Business_Solutions.pdf

[ii] SAP does not publish information about the platform used, so these numbers are estimates.

[iii] http://www.computerwoche.de/knowledge_center/datacenter_server/1899752/

[iv] 1612283 - Hardware Configuration Standards and Guidance

[v] SAP Applications on Azure: Supported Products and Azure VM types

[vi] http://msdn.microsoft.com/en-us/library/dn133176.aspx

[vii] http://blogs.msdn.com/b/saponsqlserver/archive/2014/10/30/more-azure-vms-supported-by-sap-now.aspx

[viii] No differentiation for different EhP has been made in order to abbreviate.

[ix] 1966681 - Release planning for Microsoft SQL Server 2014

[x] Source: IDC Multi-Client Study, Server Workloads 2014, June 2014

[xi] SAP Note 965908 - SQL Server Database Mirroring and SAP Applications and 1772688 - SQL Server AlwaysOn and SAP applications

[xii] http://www.microsoft.com/casestudies/Microsoft-Azure/GF-Health-Products/Manufacturer-Uses-Hybrid-Cloud-Model-to-Gain-Increased-Storage-Unprecedented-Agility/710000003971

http://blogs.msdn.com/b/igorpag/archive/2014/07/03/deep-dive-sql-server-alwayson-availability-groups-and-cross-region-virtual-networks-in-azure.aspx

[xiii] SAP Note 1027146 - Database administration and monitoring in the DBA Cockpit

[xiv] SAP Note 683447 - SAP Tools for MS SQL Server

[xv] 1139642 - Hardware Requirements in Unicode Systems

[xvi] 1744217 - MSSQL: Improving the database performance

[xvii] http://www.microsoft.com/casestudies/Microsoft-SQL-Server-2012-Enterprise/Quanta-Computer/Quanta-Computer-Boosts-Performance-of-Its-SAP-ERP-System-with-In-Memory-Technology/4000010953

[xviii] http://blogs.msdn.com/b/saponsqlserver/archive/2011/02/21/clp-optimize-storage-improve-performance-amp-streamline-dba-tasks-with-sql-2008-r2-page-compression.aspx

[xx] http://blogs.msdn.com/b/saponsqlserver/archive/2014/03/13/sql-server-column-store-with-sap-bw-aggregates.aspx

[xxi] 1951490 - SQL Server Column-Store for SAP BW Aggregates

[xxii] 1771177 - SQL Server 2012 column-store support for SAP BW

[xxiii] http://research.microsoft.com/pubs/193599/Apollo3%20-%20Sigmod%202013%20-%20final.pdf

[xxiv]http://download.microsoft.com/download/E/D/F/EDF235B0-3FFD-468D-BD29-2F33ADB4BC0C/SQL_SAPBW_Datasheet.pdf

[xxv]http://download.microsoft.com/download/3/3/9/339550a1-c0f7-4299-adbf-67ca0e8a413e/SAP%20MS%20BI.pdf

[xxvi] See:

https://web.nvd.nist.gov/view/vuln/search-advanced
Information as of 11/17/2014:

Search Parameters:

- Contains Software Flaws (CVE)
- CPE Vendor: cpe:/:oracle
- CPE Product: cpe:/:oracle:database_server

-

- Contains Software Flaws (CVE)
- CPE Vendor: cpe:/:microsoft
- CPE Product: cpe:/:microsoft:sql_server

-

- Contains Software Flaws (CVE)
- CPE Vendor: cpe:/:ibm
- CPE Product: cpe:/:ibm:db2

[xxvii] It is a product of the NIST Computer Security Division and is sponsored by the Department of Homeland Security's National Cyber Security Division

[xxviii] http://download.microsoft.com/download/B/A/8/BA83B159-3272-42E6-A77D-20F2B9472335/BI/Wipro-Moving_ERP_to_SQLServer.pdf

[xxix] http://blogs.msdn.com/cfs-file.ashx/__key/communityserver-components-postattachments/00-10-31-09-19/Security-Guide-for-SAP-on-SQL-v2.0.docx

[xxx] http://download.microsoft.com/download/a/4/7/a47b7b0e-976d-4f49-b15d-f02ade638ebe/Alinean-TCAStudy.pdf

[xxxi] http://download.microsoft.com/download/d/9/4/d948f981-926e-40fa-a026-5bfcf076d9b9/SAP_SQL2008_Best%20Practices_Part_I.docx

[xxxii] http://download.microsoft.com/download/c/6/c/c6c42b9f-66f4-47b3-99be-8e5afa1ddc9a/SSO%20with%20MS%20and%20SAP.pdf