# The Data Warehouse of SAP BW HANA

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## ABSTRACT

SAP saw its powerhouse beginnings in 1972 and has been on the cutting edge of technology ever since. A recognizable brand, SAP is now the largest company in Germany and the largest non-American software company by revenue. The company has attracted 440,000 customers worldwide on a wide range of products with 17,000 subscribing to the ERP packaged solution SAP S/4HANA. Of that group of businesses, 92% are Forbes Global 2000 companies, making SAP's moniker "SAP: The World's Largest Provider of Enterprise Application Software" believable.

To run robust, real-time ERP software, a dependable data warehouse is a must. SAP over the past ten years, has been modernizing the data warehouse. The introduction of SAP HANA, the in-memory database platform was a revolution and made data retrieval faster, simpler, and smarter. Next revolution was SAP Business Warehouse (BW) on HANA placed the Business Warehouse on top of HANA providing additional speed and efficiency. This study will compare SAP BW HANA to other popular data warehouse products and speak to significant features.

With the popular use of data warehousing, trends begin to emerge. This study intends to explore The Big Data issue and processing capabilities and the popularity of the in-database analytics. The advent of cloud computing and services has changed the landscape of data warehousing as has topics such as data optimization. ELT as an alternate to ETL will be explained.

This study will stack SAP HANA up against IBM D2 and Oracle NOSQL. Who is winning the RDBMS race or is it the customer who is benefiting from the healthy competition in the way of a vast array of choices in this market? More trends such as security, data quality and of course performance will be dissected.

Lastly, with the increase in popularity of SAP products over the last decade, implementations are on the rise. Whether upgrading, converting, or installing fresh, each implementation will have challenges, lessons learned and pitfalls, which this study also intends to document.

# INTRODUCTION

## Evolution of SAP HANA:

SAP was founded in 1972 by a group of German entrepreneurs and has had a 49-year history of success. These five former IBM employees would change the way businesses computed, processed, and stored data by modernizing the data warehouse. In 1992, SAP added to its domain a solution called SAP R/3 which was composed mainly of middleware to combine systems. This solution would be rebuilt into SAP ERP in 2004. SAP ERP required a robust, scalable, real-time updatable data warehouse. At the same time, cloud computing became available and thus, SAP HANA was born which stands for "High Performance Analytic Appliance".

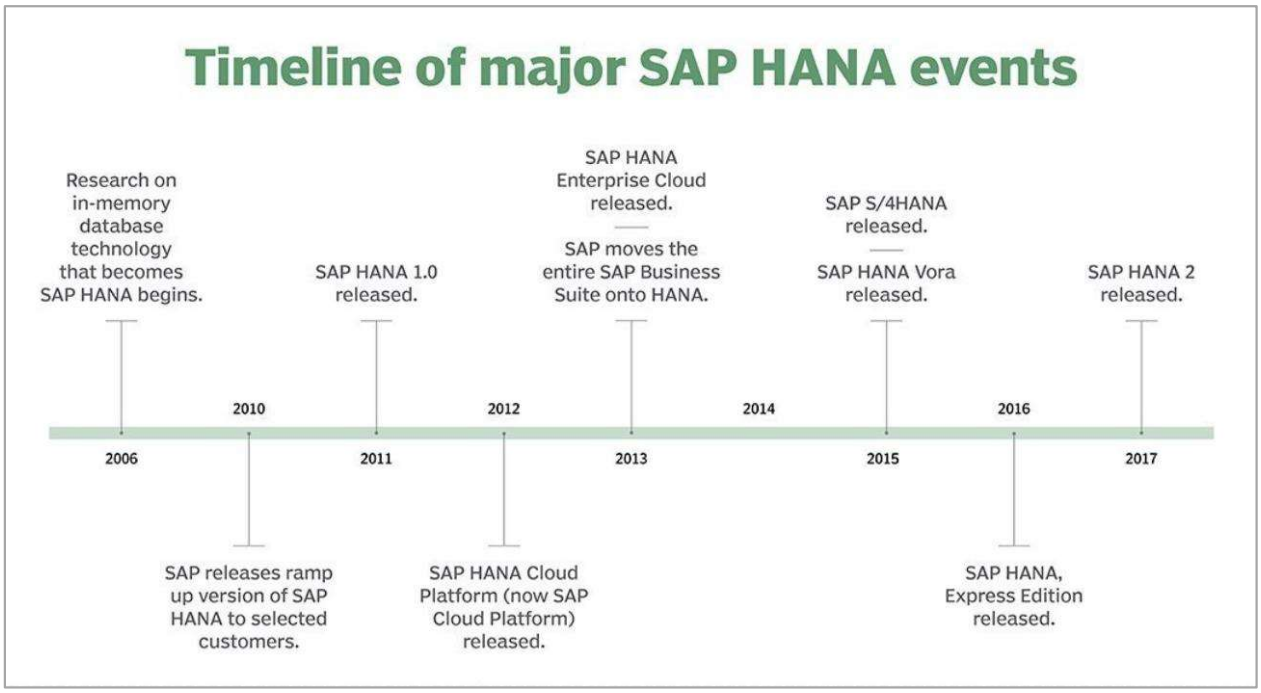


*Figure 1 - Timeline of major Hana events*

The research based on SAP HANA begun in 2006 where the goal was to create a database that could operate with a less response time for OLTP AND OLAP processes. The first official version of SAP HANA was released in 2011 with a variety of new features. Over the years SAP releases versions of HANA such as Base Edition, Spatial Edition, Platform Edition and Enterprise Edition. The SAP HANA Express Edition was released in 2016 which aimed the software to operate on laptops and other resource-constrained hosts such as a cloud-hosted virtual machine.

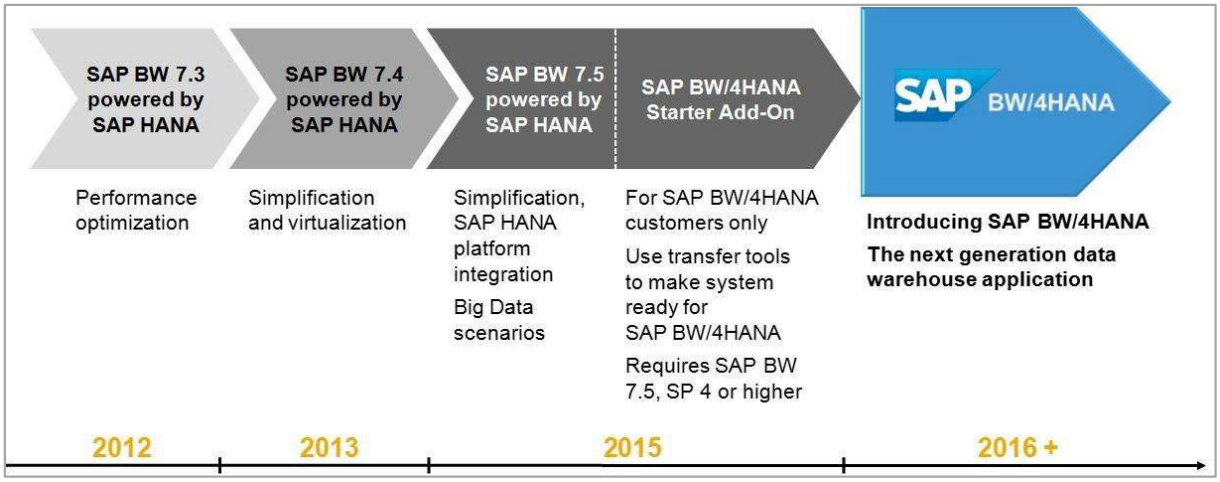


*Figure 2 - SAP Business Warehouse powered by HANA (Source: SAP)*

Today SAP BW HANA and SAP BW/4HANA can be deployed as a traditional on-premises solution or deployed in the cloud through partnerships with Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform, IBM and others. SAP also offers their own cloud services platform – SAP Business Technology Platform as well as a private cloud solution – SAP HANA Enterprise Cloud. Whether a company chooses to go hybrid, private or public cloud, there is an SAP HANA solution to fit.

## REVIEW OF LITERATURE

Data warehousing is an invaluable tool to organizations and has been around for quite some time. The literature encompasses various aspects of data warehousing. Some cover specific deduplication algorithms such as suffix blocking (Allam, 2018) while others cover specific implementations in the clinical space and how the issue of security and privacy was addressed (Chen, 2012; Kong and Xiao, 2015).

Various resource types were referenced due to varied nature of the research questions. Websites were referenced for case studies and information regarding technological architectures and capabilities. Due to the rapid pace in which technology changes, these resources provided an up-to-date perspective of current features and architectures.

The combined resources provided the authors the ability to gain insights about various aspects of data warehousing.

## METHODOLOGY / RESEARCH QUESTIONS

The purpose of this paper is to explore different aspects of Data Warehousing. The research conducted was guided by the following questions:

- What are five current trends in data warehousing?
- How does SAP HANA compare to other databases?

- What are some important issues/topics that should be addressed when implementing a data warehouse?
- What benefits, lessons learned, and pitfalls were experienced during the implementation of a data warehouse using SAP BW HANA?

To address these questions, several scholarly journals and websites were referenced. This paper is exploratory; as a result, the authors synthesized information found in the mentioned documentation to answer the research questions.

## FIVE CURRENT TRENDS OF THE DATA WAREHOUSE

### Ready for Big Data

Many organizations rely on online platforms such as social media and mobile applications to gain insight and communicate with their audience. Big data is among the many things these online platforms can bring, but data warehouses must increase their capabilities to keep up with this large intake of information. According to Partner, "Times have changed but the traditional data warehouse really hasn't kept up to the changes in the volume, velocity and variety of data we're all faced with managing today" (Partner, 2019). A data warehouse can analyze historical data for data mining and BI. From banking to healthcare, organizations can analyze their copious amounts of data and employ the use of predictive and prescriptive analytics for their data warehouses.

### In-Database Analytics

With predictive analytics, prescriptive analytics, and data mining becoming the standard, organizations must increase processing speed so their data warehouse can keep up with this extensive data intake. One way to speed up processing would be employing in-database analytics, "by adding the analytical capabilities closer to where the data are, that is, the database software itself. By doing this, the time spent in moving the data (this can be terabytes of data) from the warehouse to the analytical processing software is reduced or eliminated" (Hoffer et al., 2019, p.435). Data analytics is now integrated with the functionality of a data warehouse, and processing time has been cut down. Vendors like Oracle, SAS, and Teradata have employed the use of in-database analytics.

### The Cloud

Since data warehouses are now storing vast quantities of data that are being produced at a fast rate, it may be expensive to keep this data in-house. The cloud has abilities like scalability for data storage and allows users to access it through the internet remotely. With no need to rely on in-house infrastructure, cloud services can lower the budget for maintaining infrastructure remotely through the cloud. But there are also drawbacks to using the cloud; platform dependency can occur if the cloud provider's service goes down in quality or changes in any way. If a more cost-effective solution were to be discovered after migrating to the cloud, relocating the data warehouse elsewhere might be difficult.

### Data Optimization and Transformation

With social media generating large amounts of big data, inevitably, unstructured data will also be collected. With this need for processing complex data, organizations have turned to technologies like Hadoop. According to Hoffer, Ramesh, and Topi (2019), "Hadoop play(s) a critical role in helping achieve this transformation and storage in a cost-efficient and timely fashion" (p.436). Relational databases are not optimal for storing unstructured data, so organizations have started using Hadoop to efficiently store large amounts of data and process a variety of data. Data that Hadoop has processed can be transformed into data that can be stored into databases. Organizations such as Facebook, Amazon, eBay, and IBM have started using Hadoop.

### ELT (Extract, Load, Transform)

ELT is an alternative way to load data into a data warehouse. With this technique, data is extracted and loaded straight into the data warehouse without performing any transformations. After the extract and load stages are done, the transformation process will be used on the warehouse where the data is kept. For business decisions and reporting purposes, the transformed data is once more loaded back into the warehouse. Now data warehouses can have support for unstructured data. In comparison to ETL, the cost is lower due to the utilization of Software as a Service.

## COMPARISON OF SAP HANA WITH OTHER DBMS

SAP HANA is one the SAP's highest profile product. It is an in-memory database and application development platform used for processing large amount of data and enabling data analysts to query high volume of data in actual time.

### Features of SAP HANA:

1. In-Memory Database System: It stores information completely in the main memory, different from traditional or on-disk database systems that store records in a disk store structure. Other conventional databases read memory data in 5 milliseconds whereas SAP HANA in-memory database reads data in 5 nanoseconds.
2. Real-Time Analytics: Expert Analytics is a data mining toolset that can be used to build predictive models to learn insights from the data. Being a part of SAP Predictive Analytics, various types of data analyses can be performed such as time series forecasting, trend and classification. In Expert Analytics, one can derive the data from a smaller CSV file to a larger dataset in SAP HANA.
3. Columnar and row-based data storage: Though SAP HANA is enhanced for column storage, it also stores data in row wise tables. A row-based orientation stores a table as a series of records whereas a column-based stores the entities in the adjacent memory locations.
4. Parallel Processing: With the usage of above explained column-based data storage in SAP HANA, data is available vertically and hence actions can be performed on different

columns. When there is a need for processing more than 1 column, it is then operated by a different processor.

5. Application lifecycle management: A tool which can help a user in all the phases from modelling, product structure, application development, deployment, and manage or keeps a track on products, delivery units and packages.

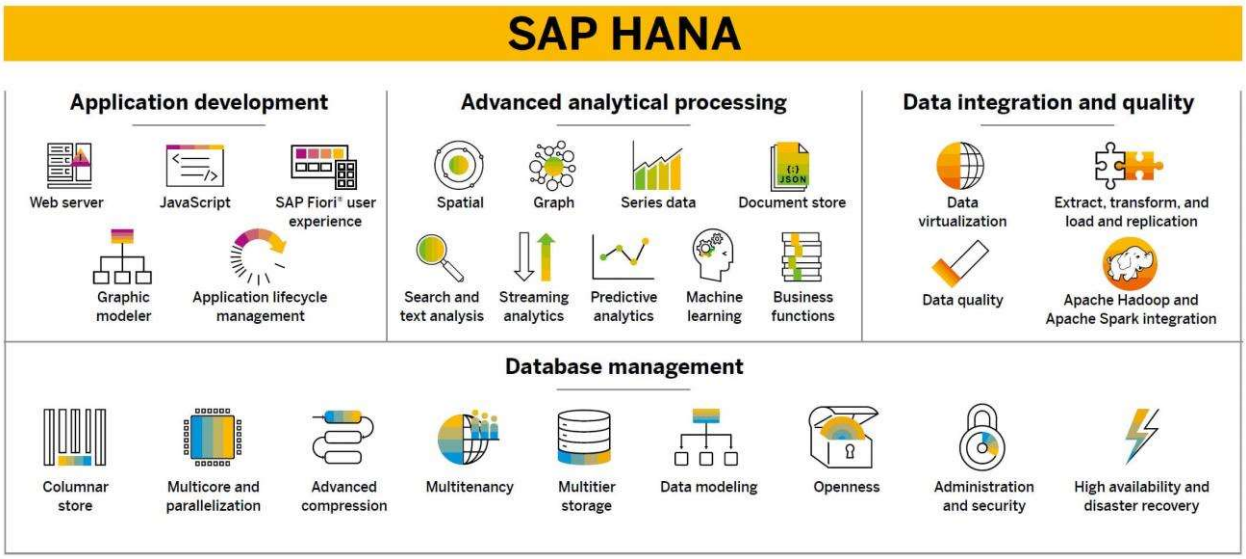


*Figure 3 - HANA's Comprehensive Services Framework (Source: SAP)*

## Comparison chart of SAP HANA with Oracle NOSQL and IBM D2.

| SAP HANA | Oracle NOSQL | IBM D2 |
|---|---|---|
| In-memory storage is the greatest strength for SAP HANA. | Manages multiple database instances on a single server. | IBM pureScale enables the data to be accessed through multiple hosts and allows users with a process that needs high availability for online transaction processing. |
| Storage Replication: It does constant replication of all persisted data, including the data of every executed transaction to a remote, network storage system on a secondary site. | RMAN (Recovery Manager) recovers or restores database files during downtimes and outages. | High availability Disaster Recovery: It safeguards high availability for complete or partial failure and can be backing up to 3 remote standby servers. |
| Data Modeling: Attribute-view, Analytical-view and Calculation-view. | Data Modeling: Key-based, column-based, document-based and graph-based. | Data Modeling: Logical database design using Entity relationship modeling, Unified modeling language and physical database design. |

| | | |
|---|---|---|
| SAP HANA has an expanded application development service which is a built-in web service utilizing which can build apps to evaluate large amounts of data online. | Development tools: Allows developers to use their IDEs such as IntellJ to query NOSQL with a pre-built plugin. | Built for Data Science and Artificial Intelligence: Consists of popular data science languages like Python, PHP, Java, and Jupyter. |
| Multi version concurrency control: Each user is related to the database where a snapshot of the database can be seen at a point of time. Any modifications made by the writer will not be seen by other users of the databases until the alterations have been committed. | Multi version read consistency: It is used to occur multiple versions of data and the data restored by the query is committed and reliable with respect to a single point in time. | IBM D2 lacks the dominant multi-version read consistency and influences users to select between accuracy and concurrency. This means that DB2 users must either block writers to read consistency or accept inaccurate results. |

*Table 1 - Comparison chart of SAP HANA with Oracle NOSQL and IBM D2*

# DATA WAREHOUSE IMPLEMENTATION ISSUES/TOPICS

Organizations generate data from various disparate sources. Data warehouses (DW) provide them the infrastructure needed to store and utilize their data in meaningful ways, regardless of the data source. Analysts and/or decision makers can utilize the data to reap several benefits. In the medical field, DWs aide in improving patient safety, workflow efficiency, and reduce costs, among other benefits (Chen, 2012). Before implementing a DW and reaping the benefits, several issues/topics need to be taken into consideration during implementation which are as follows: security and policy, performance, and data quality.

## Security and Privacy

Organizations implementing a DW need to take necessary steps to protect data stores and the privacy of their clients. Data owned by organizations are assets malevolent actors target for monetary gain. In 2020, 5,000 IT managers across several countries were surveyed on behalf of Sophos regarding several aspects of ransomware. From this survey, Sophos identified that organizations, small, medium, and large, were targets of Ransomware. Moreover, 51 percent of respondents reported being a target of ransomware (Sophos 2020). All organizations are potential targets of ransomware which is evident by the survey results. In addition, certain industries within certain countries also must abide by certain privacy laws. In the United States, for example, any organization managing health information must comply with the Health Insurance Portability Accountability Act (HIPAA). The law protects the privacy of clients' health information and places restrictions on how and when these data can be utilized or disclosed ("The HIPAA Privacy Rule," n.d., para. 1).

Organizations can employ various tools to protect the security and privacy of their data. Puppala et al. (2016) implemented a clinical data warehouse at Houston Methodist Hospital with security and privacy in mind. Their implementation utilized various access controls, the architecture was

designed to provide the best protection, and data anonymization to protect client privacy. Regarding the architecture, the application, application database, and DW database were all placed within their own firewall. In addition, the decision was made to maintain one central DW due to the ease of securing one DW compared to various data marts. SQL Sever 2008 was employed, and its contents were encrypted using Transparent Data Encryption (TDE). With TDE, data is encrypted prior to being written on the disk and decrypted prior to returned the data to the requesting application. Lastly, the patient information stored in the DW was de-identified to protect the privacy of patients.

Moreover, Kong and Xiao (2015) implemented a DW to support the secondary use of health information. They implemented one central DW that provides data to data marts. To protect data from unauthorized access, they utilized data encryption. Data were encrypted to protect it at rest and in transit. They avoided encrypting the hard disk and using network layer encryption protocols due to its negative impact on performance, effort required to configure, and high compute resource consumption. In lieu of the mentioned encryption methods, the authors chose to encrypt the data at the application level for both data at rest and in transit. Moreover, the data were going to be shared among several organizations for research. As a result, the data were categorized into two groups, private and public. Those classified as private, i.e., contained sensitive information, were encrypted while public were not which saved computing resources. As evident by these implementations, data warehouse administrators have various tools and/or methods that can be employed to protect the security and privacy of data.

### Performance

When implementing a DW, performance must be provided consideration. Performance affects the response time of queries which impacts user experience and the efficiency of obtaining information to make decisions. One of the aspects of a DW that impacts performance is the data model that is chosen. A study performed by Rorimpandey et al. (2018) compared the performance of the following four data models: 1) Data Vault, 2) Star Schema, 3) Optimal Normal Form, and 4) Anchor Model. The authors of the study populated the mentioned models with the same facts. Data were loaded into small, medium, and large tables to compare query performance. Then, thirteen questions, or information needs, were developed and answered using each of the models. The queries were run several times to obtain an average which was then analyzed using the ANOVA statistically technique to determine if there was a significant difference in performance. The information needs tested various aspects of a query such as the use of the 'LIKE' operator or joining tables with subqueries. The results determined that there was a significant difference between the performance of the data models. Upon closer inspection, Star Schema was less performant than the other models. The authors contribute this result to the level of redundancy stored in the models. As the authors point out, these models would need to be compared using different vendor technologies or business scenarios. One thing is clear from this study, a data model should be evaluated to determine if it will meet the needs of the business prior to implementing its usage.

### Data Quality

DW afford organizations the ability to make informed decisions; however, the quality of those decisions is influenced by the quality of the data. Poor data quality can originate from the data source or during the integration process. Data originating from various sources can introduced errors in the form of data duplication (Liu, 2019). In addition, the processing of integrating and analyzing these data provide ample opportunity for data quality to be compromised (Jones-Farmer et al., 2014). Although quality data is key, the process of cleaning it has a cost associated to it which may constrain an organization regarding what data should be cleaned (Liu, 2019). As a result, during implementation, organizations should identify and implement tools and/or methods geared towards supporting data management.

A step that aides in the support of data management is understanding the nature of the data being stored to effectively measure data quality. Data, for the purposes of measuring quality, can be placed into two categories, each requiring different measurement tools. One category is referred to intrinsic and the other contextual. Intrinsic refers to data quality dimensions that are objective whereas contextual refers to dimensions that depend on the business context. Organizations should plan to incorporate pertinent information in a metadata repository as this will serve as a reference towards understanding the technical aspects of the data and the business context. Metadata can be utilized in the development of quality controls (Jones-Farmer et al., 2014).

As mentioned, organizations need to identify tools/methods that can be utilized for improving the quality of data. One method for improving data quality in DWs is referred to as suffix blocking. This method is comprised of two components, record linkage and entity resolution. This method, or algorithm, aides in producing duplicate-free datasets. Record linkage refers to process of identifying duplicate records, and entity resolution refers to the process of consolidating the duplicate records. Due to the inefficiency of comparing all records during record linkage, blocking is performed. Blocking excludes records assumed to not contained duplicates which limits the dataset being compared for duplicates. However, due to the blocking process being heuristic, some duplicates may be inadvertently excluded, thus reducing the accuracy of the record linkage. For implementations requiring real time DW updates, incremental blocking is not efficient nor as accurate as other methods. As a result, suffix blocking is presented as a better alternative. To perform record linkage using suffix blocking, a data structure containing the suffixes of all records is created for comparison. This method provides an efficient and accurate way of identifying duplicate records. Suffix blocking is not the only algorithm available for producing duplicate-free data (Allam, 2018). As a result, when implementing a DW, research should be performed on what methods will be utilized to address data duplication.

## SAP BW HANA IMPLEMENTATION CASE STUDIES

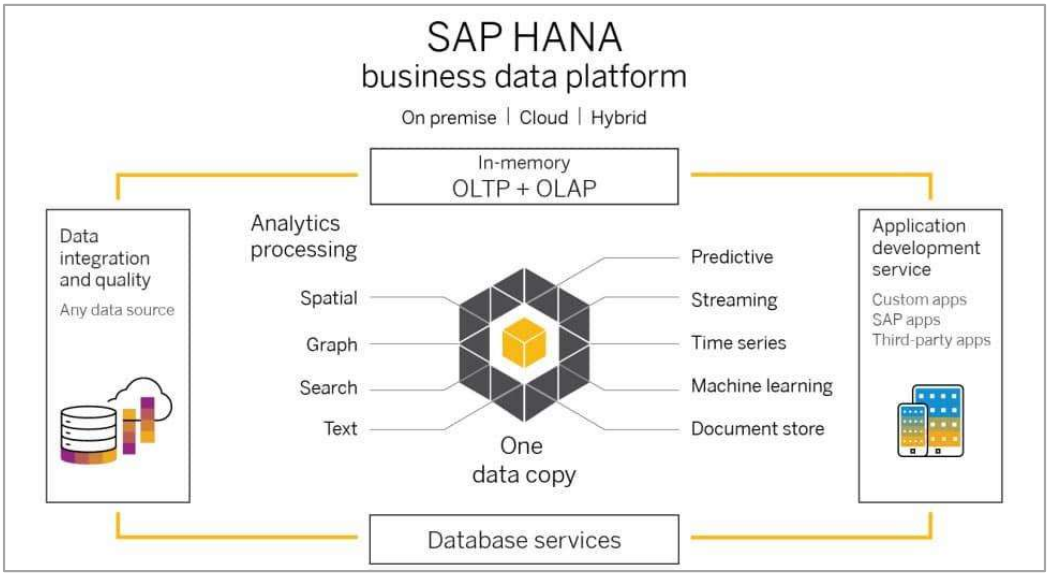


*Figure 4 - SAP HANA, The Business Data Platform for All Applications (Source: SAP)*

Implementing to the SAP HANA BW is the first step in gaining access to the tools and applications of the SAP business data platform. There are several strategies for implementation which are In-Place Conversion, Remote Conversion and Shell Conversion. The In-Place Conversion takes the existing SAP BW and transfers all data, objects, and elements to SAP BW/4HANA.Prequisite is that the client be on at least version SAP BW 7.5 powered by SAP HANA or they should choose an alternative conversion methodology. A Remote Conversion is treated as a brand-new install and enables the client to move whole data flow or transfer only selected data flows from any DB to a new installation of SAP BW/4HANA. The Shell Conversion sets up a fresh installation of the SAP BW/4HANA landscape but does not transfer or synchronize existing data sets. SAP offers much assistance in the way of Implementation Documentation, Simplification Lists, Staffing and other guidance.

### Case Study Company A – Global Technology Manufacturer/Distributor ($59 bil annual rev)

ASUG – American's SAP Users' Group in conjunction with SAP published a case study for the 2019 ASUG Annual Conference. In the presentation, a case study was made of a large global technology firm's implementation to SAP HANA BW. Below are some of the details that were shared.

### Benefits Obtained

In general, SAP HANA provides real-time analysis and decision-making capability. With SAP HANA at the base of an operation, the company can process large amounts of data while the business is still processing transactions. Both, the transactional speed and the business intelligence speed is lightning fast.

SAP HANA stores and processes data in columns as well as rows in the database so operations can be parallelly processed in SAP HANA. Parallel processing increases the speed of all processes.

With SAP HANA BW the Global Technology Manufacturer was able to transform current data practices to gain efficiency and agility. Another benefit attained was that SAP BW4HANA was able to replicate more complex parts of an existing BW system with 350+ BI assets. The consolidation improved efficiency and speed. Also, the options for security improved after the transition.

## Lessons Learned

Simplifying BI as a result of the implementation had wide reaching effects and specifically Finance, the Supply Chain, Services and Sales Operations. Finance was able to plug into a vendor payables aging tool. Operations was able to leverage real-time insights into operational performance and Sales started using robust customer interaction tools.

| |
|---|
| **Business capabilities to Technology mapping** |
| Consolidate business requirements while eliminating duplicate requests |
| Prioritize requirements while considering various factors such as business impact |
| Mapping requirements to right tools & technology |
| **Architectural vision** |
| Establish an optimized architecture that can cater to different types of reporting needs |
| Identify the right tools and technology to be leveraged |
| **UI Experience** |
| Enable the platform to ensure unified user experience |
| **BI Governance** |
| Establish the right governance model including lineage, data dictionary to ensure development consistency |
| **Change management** |
| Enable a strong yet robust management of change process |

*Table 2 – Overarching Lessons Learned in SAP HANA BW Implementation (Source: ASUG)*

## Pitfalls to Avoid

One of the pitfalls in general of implementing the high performing SAP HANA BW is that the client may be able to functionally use a cost-effective SAP powered Data Lake instead. Another guideline on the pathway to "Simply BI" is to not build business rules and use BI for transactional purposes.

Several more pitfalls emerged during the implementation and those involved:

-Improperly scoping the project – company tried to do too much at one time

- Improper Team Selection - SAP HANA BW teams can range from one to over 100. It is important to properly vet and install the SW team.

- Starting the SAP BW implementation at an improper point in the calendar or fiscal year. This project could take several weeks to several months or a year depending on scope and size. Keep timing in mind when planning i.e. do not schedule at fiscal year close etc.

## CONCLUSION

SAP BW/4HANA is a powerful, modern, enterprise data warehouse and backend that can consolidate data across organizations. SAP innovates with one trusted source for all insights. With proper planning, guidance and support, implementation can be seamless. The reward for many organizations is fast, 360°-degree, real-time access to information and functional business intelligence tools that lead to actionable insights.

These gains depend on a successful data warehouse implementation. SAP and third parties such as Americas' SAP Users' Group will continue to guide the way. The most successful implementations have proper planning, staffing and observe and avoid the pitfalls and issues that have befallen other organizations.

Data warehousing issues and trends such as big data, data quality, security and of course performance will continue to drive technological advances in cloud and on-prem. Companies will only demand global data and business intelligence at a faster pace in this global economy.

## REFERENCES


Allam, A., Skiadopoulos, S., & Kalnis, P. (2018). Improved suffix blocking for record linkage and entity resolution. *Data & Knowledge Engineering*, 117, 98-113. https://doi.org/10.1016/j.datak.2018.07.005

Chen, E. T. (2012). Implementation Issues of Enterprise data Warehousing and Business Intelligence in the Healthcare Industry. *Communications of the IIMA*, 12(2), 39-50.

Damrongsakmethee, T., & Neagoe, V. E. (2017). Data mining and machine learning for financial analysis. *Indian Journal of Science and Technology*, *10*(39), 1-7.

Franz Färber, Sang Kyun Cha, Jürgen Primsch, Christof Bornhövd, Stefan Sigg, and Wolfgang Lehner. 2012. SAP HANA database: data management for modern business applications. SIGMOD Rec. 40 (December 2011), 45–51. DOI:https://doi-org.mimas.calstatela.edu/10.1145/2094114.2094126

Hoffer, J. A., Ramesh, V., & Topi, H. (2019). Modern database management (13th ed.). Pearson Education.

Implementing SAP BW on SAP HANA. (2016). ProtoView, 3(28), ProtoView, 2016-07-01, Vol.3 (28).

Jones-Farmer, A. L., Ezell, J. D., & Hazen, B. T. (2014). Applying Control Chart Methods to Enhance Data Quality. *Technometrics*, 56(1), 29-41. https://doi.org/10.1080/00401706.2013.804437

Kong, G., & Xiao, Z. (2015). Protecting privacy in a clinical data warehouse. *Health Informatics Journal*, 21(2), 93-106. https://doi.org/10.1177/1460458213504204

Liu, Q., Feng, G., Tayi, G. K., & Tian, J. (2019). Managing Data Quality of the Data Warehouse: A Chance-Constrained Programming Approach. *Information Systems Frontiers*, 23(2), 375-389. https://doi.org/10.1007/s10796-019-09963-5

Partner, Lynda (2019, May 21-22). A Big Data Reality Check: A View From The Front Lines Of Data Analytics [Keynote Address]. Data Summit, Boston, MA, United States.

Puppala, M., Tiancheng, H., Xiaohui, Y., Shenyi, C., Ogunti, R., & Wong, S. T. C. (2016). Data security and privacy management in healthcare applications and clinical data warehouse environment. *2016 IEEE-EMBS International Conference on Biomedical and Health Informatics (BHI)*, 5–8. https://doi.org/10.1109/BHI.2016.7455821

Rorimpandey, G. C., Sangkop, F. I., Rantung, V. P., Zwart, J. P., Liando, O. E. S., & Mewengkang, A. (2018). Data Model Performance Data Warehousing. *IOP Conference Series: Materials Science and Engineering*, 306(1), 12044. https://doi.org/10.1088/1757-899X/306/1/012044

## REFERENCES CONTINUED


SAP S/4HANA. ASUG. (n.d.). https://www.asug.com/insights/sap-product/sap-s-4hana?taxonomySAPProduct%5B%5D=1339118#insights.

SAP HANA Case Study - The Turning Point for Kellogg's, Shire & Concepcion. DataFlair. (2021, May 19). https://data-flair.training/blogs/sap-hana-case-study/

Sophos (2020). The State of Ransomware 2020: Results of an independent study of 5,000 IT managers across 26 countries. https://www.sophos.com/en-us/medialibrary/Gated-Assets/white-papers/sophos-the-state-of-ransomware-2020-wp.pdf

The HIPAA Privacy Rule (n.d.). Retrieved from https://www.hhs.gov/hipaa/for-professionals/privacy/index.html

Week 3 of ASUG Best Practices: SAP S/4HANA Virtual Experience Examines Executing Your Implementation. ASUG. (n.d.). https://www.asug.com/insights/week-3-of-asug-best-practices-sap-s-4hana-virtual-experience-examines-executing-your-implementation.

*Why use sap hana | Sap hana features | Edureka*. (2020, April 28). Edureka. https://www.edureka.co/blog/why-use-sap-hana/

*IBM docs*. (n.d.). IBM - United States. https://www.ibm.com/docs/en/db2-for-zos/11?topic=getting-started-db2-zos

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