DATA WAREHOUSING AND THE FUTURE

A SOLUTION FOR A NEW GENERATION OF BUSINESS REQUIREMENTS

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**SUMMARY**

Data warehousing technology has evolved significantly over the decades, keeping pace with changing and ever-growing demands that businesses place on their data warehouse solutions. New technologies have reshaped the landscape for business data again and again, while new business processes and new business models have emerged — in part enabled by these new capabilities and in part driving requirements for further development. The core requirements for what a data warehouse fundamentally is, and what is called upon to do, have evolved right along with the technologies and business processes supported. While that evolution is almost certain to continue, future data warehouse implementations will probably not involve so much an expansion of these core requirements as an expansion of how they are fulfilled, marked by a significant acceleration of performance and simplification of architectures. As data grows more central to business processes across the board, the success of such solutions will be more directly linked to business outcomes. SAP BW/4HANA is a next-generation data warehousing platform, one that demonstrates today how tomorrow’s data warehousing solutions will reduce complexity while driving real-time results from rapidly growing data sets.
INTRODUCTION

The reality is that those who use data warehousing technology will continue to do so.¹

From its earliest deployments some three decades ago, the data warehouse has been a disruptive technology. As data has become more central to every aspect of what businesses do and ultimately what they are, the data warehouse has become an increasingly critical part of the enterprise data landscape – spinning off a series of subsequent disruptions in its own right (data marts, data warehouse appliances) and playing a central role in the emergence of many others (business intelligence, big data, data science.) Throughout this time, data warehouses have handled a wide range of workloads in service of a vast number of use cases. Meanwhile, their core value proposition has remained fairly consistent.

Vincent Rainardi outlines five basic requirements² that a data warehouse typically must meet:

1. An integrated view of the organization’s data for strategic analysis
2. A consistent view of the organization’s data resources with data that has been cleared of anomalies which can lead to a false impression of the business’ function
3. A consolidation of the organization’s data history beyond what is retained by current operations for deep analysis of the business’ functions over time
4. A tested and verified environment for analysts to access data so that each new draw of data doesn’t become a “science experiment” in and of itself
5. A high-performance environment for doing data analysis that does not interfere with day-to-day activity of the business

This paper outlines how that list of requirements has evolved over the years, how data warehousing solutions are addressing those concerns today, and what businesses will require of such solutions in the years to come. Building as accurate a picture as possible of future data warehouse requirements involves coming at the issue from more than one perspective, as well as taking an incremental approach that builds to a more complete understanding. This exploration of the future of data warehousing encompasses three major topics:

- Evolution of the Data Warehouse
- A Changing Landscape
- A Business-Focused Future

Evolution of the Data Warehouse

The evolution of the data warehouse over more than three decades provides needed context in shaping a description of the future of the data warehouse. Two major drivers lie behind this evolution: the

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¹ Linthicum, David "The cloud and big data are no threat to data warehouses" InfoWorld June 6, 2014 https://goo.gl/5Xg0AE
² Rainardi, Vincent "Why Do We Need a Data Warehouse?" Data Warehousing and Business Intelligence December 3, 2012 https://goo.gl/HYI3RP
relentless development of new technologies and the emergence of new business processes (as well as whole new business models.) Businesses have become increasingly digital entities over the years, a trend that is likely to accelerate. Business processes require greater integration of disparate data sources, scalability to manage rapidly growing volumes of data, and ever-faster response times. Organizations demand deeper analysis of data, and simpler tools for putting analytical capability into more hands.

Alternative Approaches

The enterprise data warehouse as deployed in thousands of organizations worldwide supports a vast array of architectures, use cases, and form factors. A “data warehouse” may be a basic operational reporting environment built from a single transactional system or it may be a cutting-edge solution uniting transactional, machine, and social data to support deep and complex analysis in real time. It may provide information for daily (or monthly, or quarterly) reports or it may feed complex analysis into live business processes several times a second.

A Business-Focused Future

While the need for greater speed and greater analytical sophistication will only continue to grow, the biggest shift in data warehousing in coming years may be towards closer alignment with business challenges and requirements. A next-generation data warehousing platform such as SAP BW/4HANA provides a good introduction both to the technical and business process capabilities that will shape the data warehouse of tomorrow.
PART 1: EVOLUTION OF THE DATA WAREHOUSE

The EDW supports reporting and analysis on (usually) highly structured data, playing a critical role for many organizations in enabling both internal and external reporting – ensuring, among other things, SLA (service-level agreement) and regulatory compliance – as well as more strategic analysis of business processes, market performance, etc. ³

Getting a handle on the future direction of data warehousing requires first understanding what a data warehouse is and how the data warehouse as we know it came to be. The development of the first data warehousing solutions for the enterprise was part of a broader story of an ongoing "division of labor" among business data management systems. Originally, businesses could generate reports from the data repository attached to a transactional system, which, obviously, remains a common practice today.

But that level of reporting does not permit deeper analysis, greater historical perspective, or the ability to look at data from multiple sources at the same time. Data warehousing began with the need to integrate data for analysis, which at that point primarily meant centralizing data from multiple transactional repositories built on the same database platform.

Clean, Consistent, Historical Data

Years of multimillion-dollar investments in large data warehousing, business intelligence, ERP, and CRM deployments and consolidations have only fanned the flames of discontent around data quality, data consistency, and ultimately, data value.⁴

As organizations implemented these centralized repositories for analyzing data, both benefits and shortcomings were soon to emerge. One of the most important benefits was recognizing that the lifespan of data within the analytical environment could be, and would have to be, significantly extended. The data warehouse enabled a longer-term perspective than had previously been available; it began to make sense to think and talk in terms of data history. This added a whole new perspective to analysis as businesses began to look at increasingly long-term trends and to compare year-over-year performance.

From the start, data preparation was a critical step in loading data into the warehouse. One of the chief stumbling blocks for organizations implementing a data warehouse was a tendency for data from disparate sources, and often from the same source, to be inconsistent and error-ridden. Even small abnormalities in the data were likely to limit the scope of analysis and produce inaccurate and unreliable results. Or they could prevent analysis from taking place at all. As a result, cleaning and organizing data became critical functions within the data warehousing cycle. The process would quickly encompass not

³ "The Contextual Data Lake: Maximizing Data Lake Value via Hybrid Environments that Provide Completeness, Context, and Accelerated Analytics Capability" SAP 2016 https://goo.gl/6zuuFK
⁴ Berson, Alex and Larry Dubov Master Data Management and Data Governance (Second Edition) McGraw-Hill Education November 2010
only data cleansing but the full ETL (extract, transform, load) process, which normalizes data according to a pre-defined schema to enable faster and more efficient analysis.

**Adding Speed and Scalability**

Although the first data warehouses were built on specialty database platforms, it became increasingly common for organizations to build their data warehouses on the same database infrastructure used for online transaction processing (OLTP). Over time, several factors emerged to challenge this approach. The sheer amount of data businesses were working with grew rapidly. The complexity of the analysis grew at an equally fast pace. The footprint of reporting and analytics continued to expand within the organization, with new users coming on board to tax the data warehouse environment with an ever-growing number of increasingly sophisticated analytics tasks. All the while, businesses looked to achieve their analytics objectives faster. However, as data volumes grew, analytical workloads became more complex, and the time available to produce results began to shrink, businesses began looking for alternatives. This was especially true for large enterprises, who turned to an emerging class of specialty analytics databases to address these issues.

Organizations managing very large data loads often encountered slow-downs caused by the orientation of the data. The process of writing transaction records benefits from a row-based architecture. Each row of data represents all the details of a completed transaction: time, customer name, billing address, products ordered, shipping address, etc. Analytical processes, on the other hand, are built around grouping data by the dimensions defined by the database columns. A typical query might examine the number of transactions within a given time frame, or list customers by size of spend. Database vendors also introduced massively parallel processing (MPP), a new computing paradigm that greatly improves data warehouse scalability. A data warehouse running on an MPP database seamlessly leverages multiple processors for the coordinated analysis of large datasets, eliminating read-write slowdowns and providing open-ended scalability.

Another innovation was developed to eliminate such bottlenecks by doing away with time spent on reading and writing altogether. In-memory processing provides exactly that advantage. Performing analysis on data in RAM provides for more or less instantaneous results so long as all the data required for analysis can be stored in memory, and greatly accelerated analysis in instances where most of the data accessed for analysis is stored there.

**Making Analysis Reliable and Adaptable**

A technology stack that supports all the requirements discussed up to this point is ultimately only as valuable to an organization as its ability to deliver analytics results reliably and in line with business needs. In parallel to the major developments outlined above, a new set of tools emerged to give businesses that kind of capability. Such systems would not only address specific BI requirements, they would enable businesses to avoid turning each new project or set of requirements into a separate
“science project.” BI grew to encompass a number of specialty areas including advanced statistical processing and data visualization.

A key development was the introduction of fully integrated data warehouse management system software. Such solutions are designed to provide a comprehensive infrastructure for data warehousing, including the database and data management tools, analytics and reporting tools, data extraction tools, and preconfigured data modeling and business information to expedite deployment.

The core requirements for any data warehousing solution
PART 2: ALTERNATIVE APPROACHES

Just as organizations previously looked beyond OLTP in favor of new database technologies configured especially for analytics, recently they have engaged in a somewhat more dramatic pivot—away from relational databases altogether.⁵

Facing the challenges associated with growing data sets and demanding new use cases driven by digital business models, organizations began looking at alternatives to the technology stack which has supported traditional data warehousing up to this point. Apache Hadoop was the first, and remains the most important, of these technologies. It was built up from technology that Google developed in order to

....usefully index all the rich textural and structural information they were collecting, and then present meaningful and actionable results to users. The Hadoop platform was designed to solve problems where you have a lot of data — perhaps a mixture of complex and structured data — and it doesn’t fit nicely into tables. It’s for situations where you want to run analytics that are deep and computationally extensive, like clustering and targeting.⁶

Along with NoSQL databases and other new, open source technologies, businesses are increasingly turning to Hadoop as an alternative for storing large quantities of multi-structured data, often deploying via commodity hardware or the Cloud to offset storage and deployment costs. It is fair to say that Hadoop and its related technologies have kicked off a wave of disruptions within the data warehousing space. The traditional data warehouse model has been pushed to the breaking point by exponentially growing datasets and the need for real-time results. Just as it has evolved from the start, the data warehouse is being called upon to transform itself again.

The big data era raises unprecedented challenges for the data warehouse

⁵ “SAP BW/4HANA: The Next-Generation Data Warehouse is Here” SAP September 2016 https://goo.gl/7KRMnE
⁶ Turner, James “Hadoop: What it is, how it works, and what it can do” O’Reilly January 12, 2011 https://goo.gl/gkfuuY
Data Architectures: Competing Models

One of the reasons that accurately assessing the future of the data warehouse is so difficult is that there is disagreement as to what should or should not be called a "data warehouse." Architectural and use-case debates have been going on roughly for as long as data warehouses have existed. The prototype for all such debates was carried out by two of the founders of data warehousing, Bill Inmon and Ralph Kimball. It centered on how to begin building a data warehouse: top-down (Inmon) or bottom-up (Kimball)? Wayne Eckerson added hybrid and federated approaches. Those two approaches have become more prominent in recent years as new data types, new approaches to analysis, and new delivery models have emerged. Meanwhile, the questions about what is and is not a data warehouse have only proliferated. The emergence of big data platforms has sparked a number of new and contentious issues: can a data warehouse be built on Hadoop? What should the relationship be between the data warehouse and the data lake? Does a business even need a data warehouse any longer?

Such debates are not just intellectual exercises; they represent very real differences in how organizations frame their basic approach to providing an environment to support analytics. Depending on the analytical workloads, the business use cases, and technology and budgetary considerations, an organization may be looking for any of the following properties in deploying or managing their data warehousing solution:

- Real-Time
- Agile Deployment
- Multi-Structured Data
- Open Scalability
- Cloud-Ready
- Advanced Analytics
- Open Data Discovery

In the following sections, we look at several prominent data warehouse architectures to see how they map to these requirements.

Conventional EDW

A conventional EDW environment integrates data from multiple sources throughout the organization for analysis. Well-defined data integration and data preparation tools and processes apply a common schema to all data as it is ingested into the system. Typically, all data resides in a common repository, providing a “single version of truth” for the organization. Subsets of that full data collection may reside in departmental data marts. Data management, database administration, and security are all managed centrally, as is a common repository of definitions and other metadata.

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A conventional data warehouse can provide high-performance analytics via use of a columnar architecture and in-memory processing, as described in Section 1. In most instances where in-memory processing is deployed, a data temperature management scheme defines which data is “hot,” to be kept in memory, and which data is “cold,” to be written to disk. True real-time analytics processing requires that both operations and analytics be performed on a common in-memory database platform such as SAP HANA.

A conventional EDW is typically deployed on an MPP database platform to provide open-ended scalability. As applications, databases, and infrastructure increasingly move to the cloud, the range of deployment options grows. An EDW can be deployed on-premises, via private cloud, via public cloud, or — as is increasingly the case — via a hybrid environment. A wide variety of BI and analytics applications can run on such an environment, everything from self-service analytics applications for broad deployment throughout the organization to high-end, predictive modeling and other advanced statistical analysis used by data scientists and other power users.

The standard data warehouse is not equipped to handle multi-structured data, meaning that it cannot easily support data from the Internet of Things (sensor and other machine data), social media data, and other non-transactional / non-operational data types. Because the EDW is ultimately schema-driven, organizations cannot easily perform the kind of open-ended data exploration that digital business models increasingly demand. Such an environment does not lend itself to agile development and deployment models that are the hallmark of digital business.

A conventional EDW environment can meet many, but not all, of the analytical requirements that business face today
Contextual Data Lake

When the data lake is transformed into a "one way" data lake, the only benefit to the business of the data lake is as a cheap facility for the storage of useless data. The data lake as a cheap form of storage hardly justifies the expensive investment organizations have made.\(^9\)

An architecture that many businesses have deployed in recent years is a loose EDW / big data hybrid that leverages some of the advantages of both environments. The data warehouse can provide rapid analysis of structured data, while the data lake can support the warehouse by providing context to better inform decision-making at every level of the enterprise. Contextual data can add tremendous business value to an enterprise analytics environment. Because the data lake supports multi-structured data, businesses can explore machine- and user-generated data to segment customers by behavior as well as demographics, and to make surprising connections between seemingly unrelated factors.

\[\text{A data lake can bring much-needed contextual data to an EDW environment, but such a hybrid environment is not a fully integrated solution}\]

Making multi-structured data available within the EDW enables open-ended data discovery in addition to adding context to the standard analysis the EDW can support. However, these new capabilities come at a cost. While the data lake feeds into the EDW in this configuration, the two remain fully separate environments. This makes real-time performance difficult to achieve while rendering scalability difficult to manage. The distinct data environments do not share a common schema (as is applied to all the data)

\(^9\) Inmon, Bill *Data Lake Architecture: Designing the Data Lake and Avoiding the Garbage Dump* Technics Publications April 2016
within a conventional EDW). Like an EDW, a contextual data lake can support a wide variety of analytics options, but with much greater difficulty and usually with a longer lag time to implement. Similarly, the administration, security, and metadata management become more complex and add significant time and work cycles to every deployment.

**Next-Generation Data Warehouse**

[Mobile connectivity and the Internet of Things are spawning a new class of transactions from apps, sensors, and all kinds of metrics, in which the aggregate of the transactions is more important than any individual one. In these instances, companies need to push the limits of the technology to focus on high-volume data captured in memory and a simultaneous need to analyze that data in real-time. These capabilities are best served with a memory-first architecture.](10)

Both the conventional data warehouse and hybrid EDW / big data approach offer robust and growing capability to handle many of the analytics challenges that business face today; however, this growth is taking place in the face of unprecedented acceleration of business and technology requirements. The growth of data sets and the shrinking of time windows for viable response are exponential. Business today is increasingly digital; and the digital world occurs in real time. Even as businesses strive to manage those contradictory demands, they are faced with a confusing array of new data types and structures that they must manage effectively.

These demands push current architectures to the breaking point. As the EDW struggles to handle new data types and massive data sets, Hadoop and its associated technologies falteringly attempt to replicate the kinds of performance, and the general business applicability, of the data warehouse as it has evolved over three decades. The combined pressure on both fronts is the reason Gartner is calling for “a significant augmentation of existing enterprise data warehouse strategies.”

The next-generation data warehouse is a logical environment that fully integrates the EDW and big data environments. Built on an in-memory data platform, the next-gen warehouse supports zero-latency operational reporting to meet the demanding requirements of digital business models. It supports federation of content and the ability to access needed data from any source. It also supports both data streams and sequential data to enable the kinds of complex, behavioral, and heavily segmented analyses that organizations are increasingly looking to do.

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10 Orenstein, Gary "Why In-memory Is the Future of Computing" Data Informed March 21, 2016 https://goo.gl/TGb2wM

11 Gartner Magic Quadrant for Data Warehouse and Data Management Solutions for Analytics February 2016 http://goo.gl/fWckvJ
The next-generation data warehouse provides a fully integrated environment for real-time analysis for the enterprise.

The next-generation data warehouse overcomes the barriers that block both the conventional EDW and the contextual data lake from meeting the full set of analytical demands that businesses currently face. The reason it represents the future of data warehousing, however, is not limited to its delivery of specified capabilities. As outlined in the following section, the next-generation data warehouse represents the future of data warehousing because of the business value it delivers.
PART 3: A BUSINESS-FOCUSED FUTURE

In a world that is increasingly information-driven, data management is no longer merely a reflection of your organization’s administrative competency, but rather a unique strategic differentiator that can mean the difference between success and failure in the marketplace.  

In reviewing the history of data warehousing technology and surveying the landscape of current deployment options, it is easy to lose sight of the fundamental drivers behind any data warehousing implementation — from the largest hybrid EDW/Hadoop environment to the smallest departmental data mart. Ultimately, businesses implement data warehouses in order to satisfy business needs. Unfortunately, the organizations themselves often get caught up in the hype cycle and allow technology, rather than business value, to drive their data warehousing strategy. But perhaps more often, they make the opposite mistake of benchmarking their analytics performance against industry standards or what they see their competitors doing. Data warehousing thought leader Krish Krishnan outlines the conundrum as follows:

The data warehouse has been built on technologies that have been around for over 30 years and infrastructure that is at least three generations old, compared to the advancements in the current-state infrastructure and platform options. There are several opportunities that are being missed by organizations:

- Gaining competitive advantage
- Reducing operational and financial risk
- Increasing revenue
- Optimizing core business efficiencies
- Analyzing and predicting trends and behaviors
- Managing brand presence, channels, and reputation
- Managing customer expectations proactively

Lost opportunities from businesses using out-of-date platform and infrastructure for data warehousing

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13 Krishnan, Krish Data Warehousing in the Age of Big Data Morgan Kaufmann June 2013
To be truly effective, any data warehousing strategy must begin with business strategy. It is the marriage of those two related, but distinct, sets of requirements that sets the next-generation data warehouse apart.

**SAP BW/4HANA: Business Expertise Meets Next-Generation DW Performance**

Since its introduction more than a decade and a half ago, SAP Business Warehouse (BW) has served as the foundation for data warehousing solutions that meet all of the core data warehousing requirements outlined in Part 1 of this document. SAP BW delivers these capabilities while providing a unique perspective on and alignment with business processes owing to SAP’s dominant position in enterprise business solutions. At the same time, SAP HANA has introduced a new paradigm for real-time computing: a single copy of the data, without the need for aggregates or special indexing, which can support all transactional and analytical workloads and use cases. Through data federation and an Apache Spark-based distributed computing platform called SAP HANA Vora, SAP HANA seamlessly delivers that capability into big data environments to create a fully integrated solution.

Now SAP BW/4HANA merges the power of the SAP HANA in-memory platform with the business process expertise of SAP BW to take that value proposition to a new level. Combining the strengths of the SAP HANA in-memory platform with the SAP BW enterprise data warehouse, SAP BW/4HANA establishes a new paradigm for data warehousing. This new paradigm addresses the challenges of big data and real-time processing while opening up new and untapped opportunities for the businesses that use it.

*SAP BW/4HANA delivers on the promise of the next-generation data warehouse*

The following sections detail how SAP BW/4HANA addresses each of the core requirements of a data warehousing solution and how each core capability adds business value to the solution.
**Integrated View**

As a true data warehousing solution, SAP BW/4HANA fully integrates data as required from multiple applications. Because businesses today must integrate data from a wide variety of sources beyond the traditional operational business systems, SAP BW/4HANA leverages SAP HANA Smart Data Access to rapidly access live data in remote systems including other data warehouses, business systems, operational data stores, data marts, dynamic tiers of analytic storage (such as SAP IQ), and Hadoop systems with big data. Bringing all of these disparate sources together in real time into a single virtual repository delivers on the core next-generation requirement for a *logical data warehouse*. Designed from the ground-up as an in-memory solution, SAP BW4/HANA uniquely delivers this much-needed model.

**Business Value:** To name only one benefit of the advantages of easily integrating new data sources, organizations no longer have to limit their understanding of customer behavior and needs to the few data types that a conventional EDW is comfortable with. Easy integration of all relevant data adds up to better segmentation of customers, a deeper understanding of their needs, and more accurate predictions of their next move. This can be a true point of differentiation, one that brings about significant competitive advantage.

**Clean and Consistent View of Data Resources**

Uniting the diverse data sources that today’s businesses rely on is an important first step, but it is only half the battle. A business must be confident that its data has been appropriately prepared and cleansed to provide reliable results. Not only does SAP BW/4HANA support the logical data warehouse concept, it adds the necessary management and control over these data sources to provide consistent views of...
data where it is — avoiding the traditional requirement for an ETL process that physically moves that data into local storage.

**Business Value:** Missing or erroneous data can lead to faulty analysis and bad business decisions. Time and resource spent truing up data after the fact — or even just running it through an elaborate ETL process before being able to analyze it — are time and resources that could have been better applied to more productive activities. TDWI has estimated that bad customer data alone costs businesses more than $611 billion annually.\(^{14}\) Moreover, the costs of bad data compound over time. Each time an organization expends additional time or resource plugging holes or cleaning up after the fact, it simply adds to the loss already incurred.

![SAP BW/4HANA protects businesses from losses incurred from inaccurate or incomplete data as well as the opportunity costs associated with preventing/mitigating such losses.](image)

**Consolidation of Data History**

In Part 1 we saw how the original impact of incorporating historical data into the data warehouse derived from extending the business’s view of the past. Today it is equally important to access historical data that is complete and accurate up to the millisecond. In keeping with core data warehousing requirements, SAP BW/4HANA provides the traditional view of data history for the business. But when incorporated with technologies such as SAP HANA Streams for streaming data and SAP HANA Vora for data managed by big data technologies (Hadoop, Spark), SAP BW/4HANA provides a view of data history that remains accurate in real time, including Internet of Things data from sources such as consumer

devices, RFID, smart meters, and portable monitoring devices. Businesses increasingly use such data to track core behavioral and logistical processes.

**Business Value:** As noted above, access to the right data can make all the difference in anticipating customer needs and, as a result, keeping customer satisfaction levels optimal. It can also prove critical to guarding the online reputation of the business when things go amiss. (A timely response to problems can make all the difference in keeping the narrative positive.) When tracking telemetry or other machine / sensor data in support of manufacturing, shipping, or fleet management, up-to-the-second data completeness and accuracy can be all that stands between the business and detecting a critical failure before it occurs. Additionally, just-in-time manufacturing and logistics require that kind of accuracy in order to ensure that customer needs are met and that supply chains don’t break down.

![SAP BW/4HANA enables businesses to ensure that timely information is available to manage respond to mishaps and prevent process breakdowns](image)

**High-Performance Environment**

Because SAP BW/4HANA is exclusively tuned to leverage the SAP HANA infrastructure, which was built from the ground up to solve business analytics data problems, it can deliver outstanding performance far beyond what a typical EDW can accomplish running on a standard database. For example, SAP BW4/HANA can resolve in seconds data inquiries that used to take hours. With this vastly enhanced performance, companies with SAP BW/4HANA can operationalize real-time solutions, such as real-time customer sentiment analysis and retail offers, self-adjusting marketing campaigns, and in-clinic health solutions. Where previously the sheer volume of data and complexity of relationships within it stretched the capability of traditional environments to the breaking point, SAP BW/4HANA delivers real-time results.
**Business Value:** As we noted above with the example of time and resource devoted to fixing problems with bad data, the value of making the best use of available data is often subject to a compounding effect. In this instance, real-time accurate returns on queries can create a virtuous cycle of favorable and improving outcomes. This is especially true in an area such as customer sentiment, where taking too long to engage can represent missed opportunities or rapidly diminishing levels of customer satisfaction — while rapid responses can quickly turn a situation around or move a satisfied customer towards new offers representing net new business. Rapid analytical insights can support whole new methodologies for delivering products and services (such as the in-clinic health solution mentioned above.) Such solutions can drive business results to new levels that could never be achieved using an analytics environment with built-in lag times.

![Diagram](imageUrl)

**Tested and Verified Environment**

SAP BW/4HANA organizes not only the data, but the metadata of the logical data warehouse. This creates a comfortable and logical environment in which an analyst, a data scientist, or an end user can access this data in a consistent and reliable fashion – such as with SAP BusinessObjects Cloud.

**Business Value:** One of the most pervasive factors impacting whether businesses can realize the rewards of their analytics environment is how easily analysis is implemented, deployed, and modified. Once again, the business impact often comes down to opportunity costs. In many organizations, data scientists and other power users end up spending the majority of their time managing analytics for others – including creating queries and troubleshooting the environment. In those cases, the business suffers from not getting the higher value analytical work the power users would otherwise have been able to provide. It can also suffer when line managers and other end users don’t have the access they
needs in order to do their jobs. The logical data warehouse removes roadblocks to the business getting the full benefit of its analytics environment.

**Conclusion**

The core value propositions associated with data warehousing were established early on and have remained largely consistent since the technology was first introduced. In the meantime, both technology and business have evolved rapidly, creating the demand for new ways to accomplish those same basic goals. The next-generation data warehouse, as described here, presents the best model for delivering on those value propositions in the face of new requirements around the size and makeup of data sets and the time available to produce results. SAP BW/4HANA delivers a complete next-generation data warehouse solution. SAP BW/4HANA delivers the functional requirements that data warehouses must deliver today as well as the business value that organizations will be demanding of their analytics environments for years to come.