Real-Time Business Intelligence for the Utilities Industry

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In today's competitive environment with rapid innovation in smart metering and smart grids, there is an increased need for real-time business intelligence (RTBI) in the utilities industry. Giving the fact that this industry is an environment where decisions are time sensitive, RTBI solutions will help utilities improve customer experiences and operational efficiencies.
The focus of this paper is on the importance of real-time business intelligence (RTBI) in the utilities industry, outlining our vision of real-time business intelligence for this industry. Besides the analysis in this area, the article presents as a case study the Oracle Business Intelligence solution for utilities.
Keywords: *real-time business intelligence, data latency, external real-time data cache, real-time data warehouse, Oracle Utilities Business Intelligence*

1 Introduction

Over the past years, energy consumption has increased dramatically. The rise in consumption of energy resources has meant increasing costs and CO_2 emissions, and the reduction of non-renewable supplies.
In an effort to cut costs and CO_2 emissions, measures are being taken to reduce energy consumption and to use more energy from renewable sources.
The term smart grid has been frequently used in the last few years in order to meet the challenges facing developed and developing countries alike, such as the growing demand for electric power, the need to increase efficiency in energy conversion, delivery, consumption, the provision of high quality power, and the integration of renewable resources for sustainable development. [1]
The smart grid will provide a large volume of sensor and meter data that will require intelligent analytics that move further than data management, querying and reporting.
In addition to increased amounts of data, utilities must manage an increasingly varied set of data from a variety of sources. Sources can include real-time data from external resources such as weather and geospatial information or real-time data about energy production and consumption. Integrating these sources of data in order to make real-time business decisions will require more advanced business solutions.

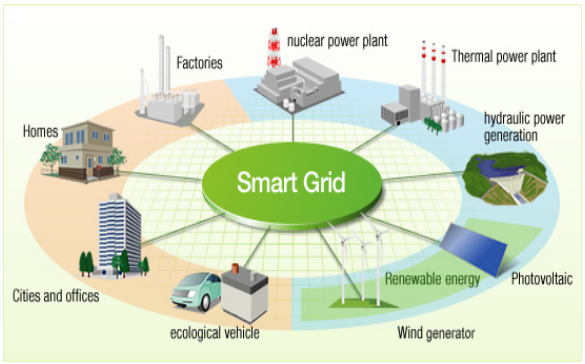

Fig. 1. Smart grid [2]

To survive in this competitive world, a utility enterprise must have the ability to integrate data from numerous sources, compile and filter that data and also analyze and present the data in a clear way in order to support rapid and confident decisions.
True business intelligence can support, grow and ensure the success of the utilities enterprise, and assist the business user in gathering and analyzing data that is critical to forecast and predict demand, anticipate pricing adjustments, manage utility programs, and customers, installations, equipment, facilities, billing, and industry and governmental regulations. [3]

But utilities industry is an environment where decisions are time sensitive, so this paper focuses on the importance of real-time business intelligence for utilities.
The rest of the paper is structured as follows. Sections 2 and 3 define business intelligence and real-time business intelligence. Section 4 makes a review of relevant literature. Section 5 presents Oracle Utilities Business Intelligence solution, while section 6 outlines our vision of real-time business intelligence for the utilities industry. Finally, we conclude this paper in section 7 with a number of results and observations.

2. Defining Business Intelligence

There are numerous definitions of business intelligence by some professionals in the industry.
According to Wayne W. Eckerson, Director of Research and Services for The Data Warehousing Institute (TDWI), "business intelligence is an umbrella term that encompasses a raft of data warehousing, and data integration technologies as well as querying, reporting and analysis tools that fulfill the promise of giving business users self-service access to information". [4]
Cindi Howson thinks that "business intelligence allows people at all levels of an organization to access, interact with, and analyze data to manage the business, improve performance, discover opportunities and operate efficiently."
Common functions of business intelligence technologies are reporting, online analytical processing, analytics, data mining, process mining, complex event processing, business performance management, benchmarking, text mining, predictive analytics and prescriptive analytics.

Fig. 2. Some of the general functions of BI systems [5]

Powerful BI features include personalised dashboards, automated alerts, graphs, charts, gauges and other view options that enable clear, concise display of data with complete drill through analytical capability. [3]
Business intelligence solutions help energy companies in many ways, by enabling them to [6]:

- Optimize the supply chain by providing data access to suppliers, distributors, and customers to enhance performance and responsiveness (all while reducing costs);
- Improve stock control by providing visibility across the organization and supply chain to enhance just-in-time management and reduce excess inventory;
- Minimize procurement inefficiencies by analyzing supplier performance, and driving negotiations and pricing structures;
- Respond quickly to market opportunities by tracking and analyzing operational data from inventory, financial, point-of-sale, and marketing;
- Differentiate and refine product offering by analyzing historical information and assessing product profitability on a geographic basis;

- Strengthen customer relationships and increase their value by tracking customer behavior and service issues, better targeting promotions, and improving service deliver.

According to Dr. Richard Hackathorn, creator of the Time-Value Curve, "the value of data is directly proportionate to how fast a business can react to it. In other words, a corporation loses money every time it delays getting information into the hands of decision-makers." [7]
Latency is the temporal delay between the moment of an event initiation and the moment an action is taken to respond to that event.

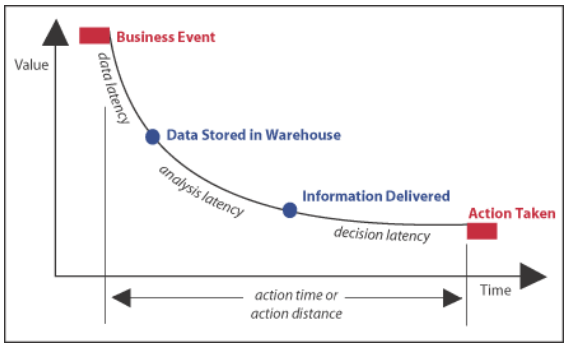

Fig. 3. Latency into the decision-making process [8]

There are three types of latency in a decision making process [9]:
• *data latency* - the period of time needed to collect the data from the source systems, to prepare it for analysis and save it into the data warehouse or data centers;
• *analytic latency* - the period of time needed to access and analyze the data, to transform the data in information, to apply the business rules.
• *decisional latency* - the period of time needed to review the analysis, decide the action to be taken and implement the action.
The degree of latency in a BI system is one of the most important issues because business executives and analytics simply want these systems to deliver the right information in the right format and to the right people, at the right time, so they can make optimal business decisions. (**Fig. 4**)

Fig. 4. The role of BI systems

3. Defining Real-Time Business Intelligence

Real-time business intelligence is the process of delivering information about business operations as they occur, with minimum latency.
All real-time BI systems have some latency, but the goal is to minimize the time from the business event happening to a corrective action or notification being initiated. [10]
Right-time is a better term to use than real time. "Right-time implies that different business situations and events require different response or action times. When planning a right-time processing environment, it is important to match technology requirements to the actual action times required by the business - some situations require close to a real-time action, whereas with others, a delay of a few minutes or hours is acceptable." [11]

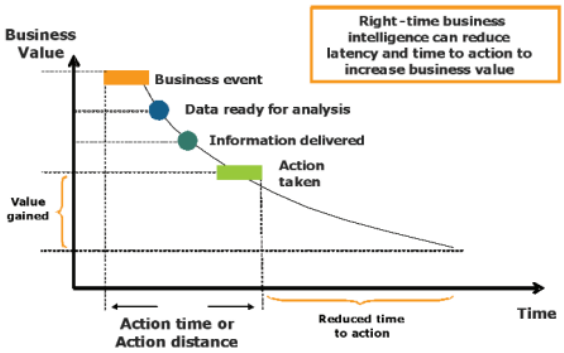

Fig. 5. RTBI latency [12]

In this context, real-time means a range from milliseconds to a few seconds after the business event has occurred.

For example, in order to keep the smart grid performing optimally, a system for monitoring and managing an electrical utility needs data delivered in milliseconds, so that problems can be solved within seconds or minutes. In this example, data must be accessed, processed and delivered in milliseconds. Besides data latency, data unavailability is another impediment to efficient real-time business intelligence.

Giving the fact that utilities are dependent on real-time business intelligence, the unavailability of this intelligence due to a failed system could stop the operations. Great availability of the real-time business intelligence services is vital.

RTBI provides almost the same functionality as the traditional business intelligence, but operates on data that is extracted from operational data sources with zero latency, and provides means to propagate actions back into business processes in real-time. [13]

While traditional business intelligence presents historical data for manual analysis, real-time business intelligence compares current business events with historical patterns to detect problems or opportunities automatically. This automated analysis capability enables corrective actions to be initiated and or business rules to be adjusted to optimize business processes. [14]

A real-time business intelligence system is based on a real-time ETL and a real-time data warehouse.

Also known as active data warehouse, real-time data warehouse is a combination of fast technologies and fast-paced business processes.

One of the most challenging parts of building any data warehouse is the process of extracting, transforming and loading (ETL) the data from the sources. Talking about real-time data warehouse, additional challenges are being introduced. The traditional ETL process involves downtime of the data warehouse while the loads are performed, but when loading real-time data, there cannot be any downtime of the system. For some applications, increasing the frequency of the current data load may be a solution.

Beside the raised costs, real-time data warehouse brings up some important issues like data modeling, scalability, OLAP and query tools. To resolve these problems, researchers proposed various solutions.

Storing real-time data along with the historical data, in the same fact tables, can be a good idea from the data modeling perspective because a real-time data warehouse is modeled just like a traditional data warehouse. But many query and OLAP tools that are not so real-time aware and tables frequently changings bring up another issue – caching.

From the administration perspective, storing real-time data in separate fact tables is the most complex approach.

Storing real-time data in different tables from historical data, but in the same table structure, and using database views to combine these smaller tables, more easily updated, into a single logical table do not resolve caching issues. Nobody wants that the query tools return old cache results when we need real-time data.

4. Literature review

The utilities industry is expected to be one of the fastest-growing industries in adopting business intelligence technology in the next few years.

IDC Energy Insights announced in 2011 the availability of the new report "Business Strategy: Ready for the Dip…Err…Plunge? Utility Business Analytics", that exposes the critical need for the utilities industry to use business intelligence solutions to support automation processes, to take better decisions and to allow customers to manage their energy lifestyles.

Unlike any other research available in the industry, this report details how utilities can efficiently leverage business analytics in both the near and long term to improve operations, increase customer satisfaction, and continuously optimize business decisions. [15]

In its "2012 Utility Industry Survey on Business Intelligence/Analytics," BRIDGE Energy Group questioned more than 14.000 energy industry officers on their experiences with business intelligence solutions.

29 percent of utilities reported that they are planning a major business intelligence program within the next two years, and another 62 percent were planning smaller scale projects, like adding a predictive analytics tool. [16]

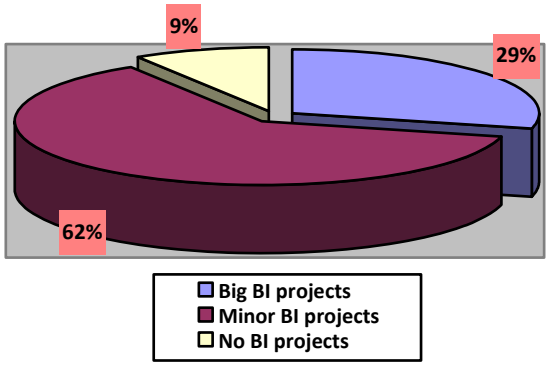

Fig. 6. Utilities expectations

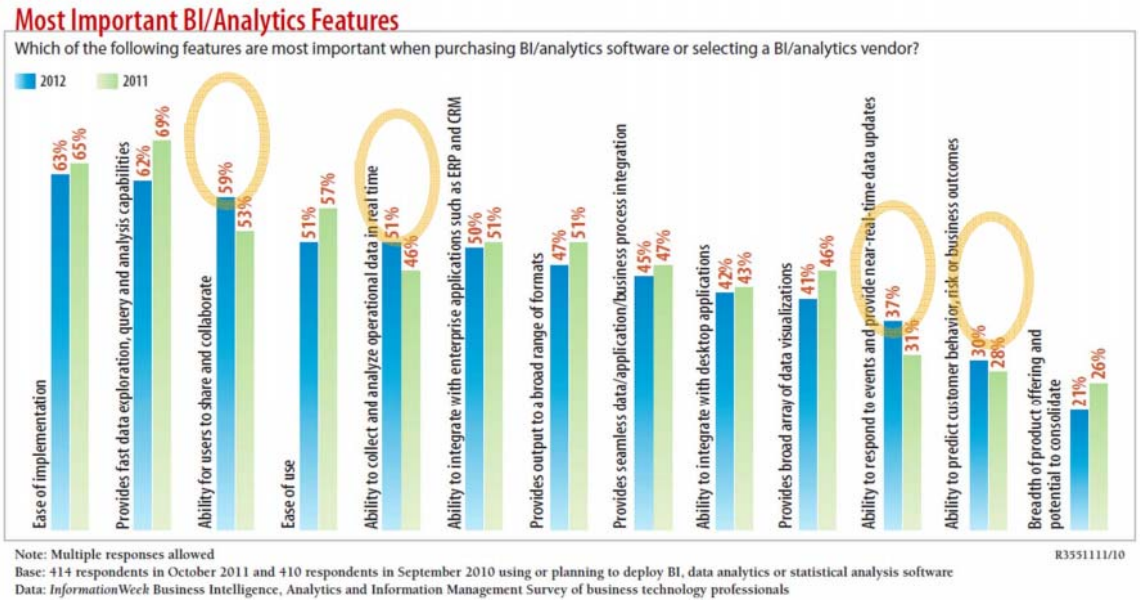

Fig. 7. Most important BI features [17]

According to numerous surveys, utilities expect to expand business intelligence with more programs that involve predictive modeling, the ability to collect and analyze operational data in real-time, and to respond to events and provide near-real-time data updates. (**Fig.7**)

In the academic literature, few articles deal with real-time business intelligence:

- ✓ In "Towards real-time business intelligence" article, B. Azvine et. al. [18] discuss the issues and problems of current BI systems and then outlines their vision of future real-time BI.
- ✓ In 2006, B. Azvine et al. [13] present their vision of what future real-time business intelligence would provide, discuss the technology challenges involved, and describe some of their programmes towards the implementation of our vision.
- ✓ B.S. Sahay and Jayanthi Ranjan [10] focus on the necessity of real-time BI in supply chain analytics. They believe that supply chain analytics using real time BI in organizations will derive better operational efficiency and KPI for any organization in SCM.
- ✓ D. Sandu [9] reviews the differences in the various types of business intelligence.
- ✓ Judith. R. Davis [19] presents a case study which describes the specific business problem, the right-time BI solution, benefits achieved, return on investment (ROI), features critical to success and implementation advice.

5. Oracle Utilities Business Intelligence – case study

Oracle Utilities helps utilities prepare for smart metering and smart grid initiatives that enhance efficiency and provide critical intelligence metrics that can help drive more-informed energy and water usage decisions for consumers and businesses. [20]

Oracle Business Intelligence for Utilities facilitates utilities to simply organize data into reports, ad-hoc queries, in-depth analyses and set up notifications and alerts. This solution delivers intelligence thru maps, charts and graphics, making it easy to manage complex data and to understand relationships. Utilities can use these ***near real-time*** visuals to improve decision-making and to update rapidly on situations like outage restoration.

The Oracle Utilities Business Intelligence data-warehouse is a separate database from your operational database. All data extracted from the production system and transferred to the Oracle Utilities Business Intelligence data-warehouse is held in star schemas.[20] (**Fig. 8**)

The tables in a star-schema are divided into two categories: facts and dimensions. Every star-schema has a single fact table (at the center of the star) and one or more dimensions [20]:

• *Fact tables* contain individual rows for every occurrence of a fact in the production system. Fact tables contain columns called measures. It is these columns that are aggregated to calculate key performance indicators (KPIs).

• *Dimension tables* are used to "slice" the facts in different ways. For example, the star schema above would allow users to "slice" the financial fact by the attributes on the 6 dimensions linked to it.

ETL programs are provided for every fact and dimension in Oracle Utilities Business Intelligence. (**Fig. 9**)

The extract programs are extracting operational data and performing some transformation activities. A separate extract program is used for every distinct fact and dimension.

Figure 10 illustrates the components involved in Oracle Utilities Business Intelligence's ETL methodology.

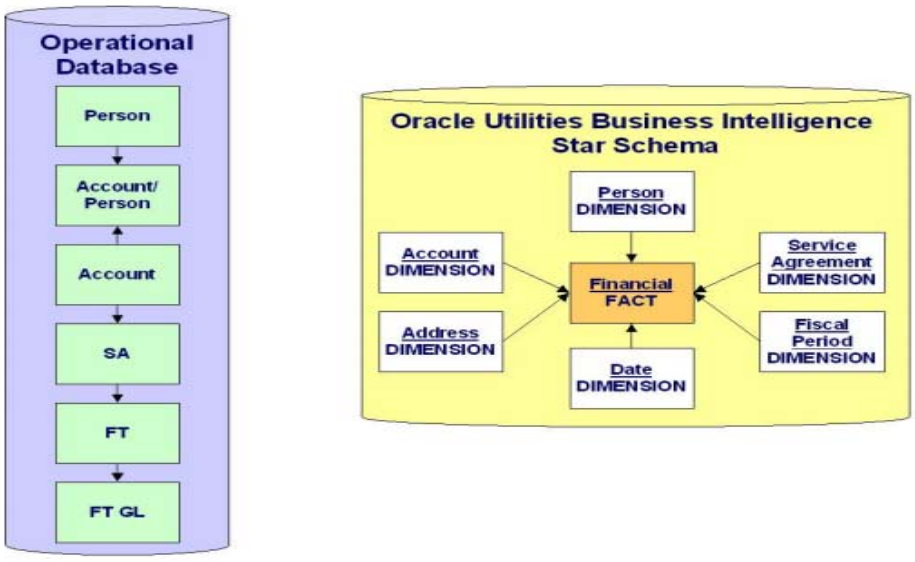

Fig.8. Oracle Utilities Business Intelligence – star schema [20]

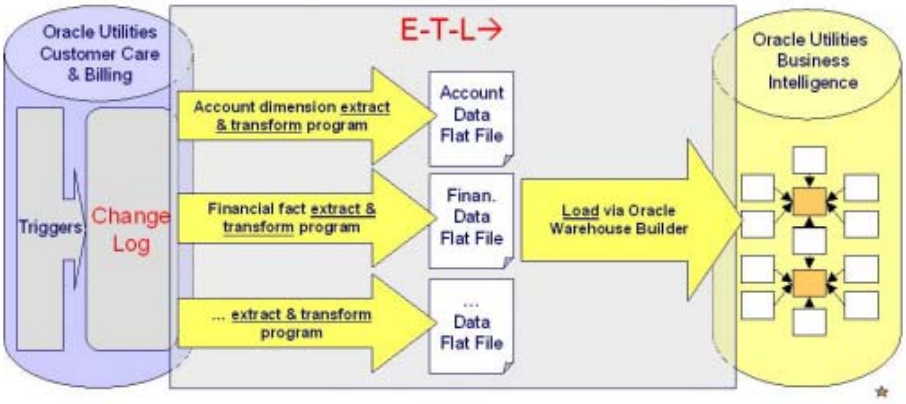

Fig.9. ETL process [20]

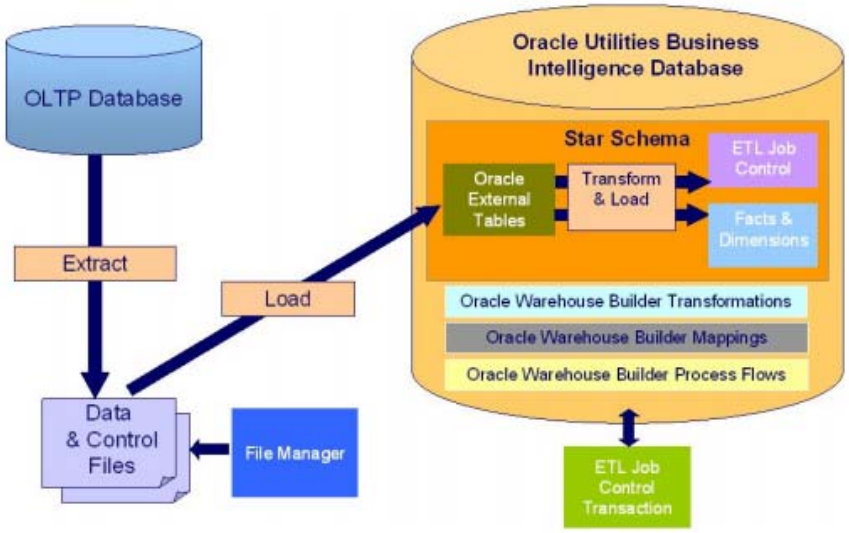

Fig.10. ETL methodology [20]

6. Our RTBI vision for the utilities industry

This paper proposes a RTBI solution for the utilities industry, considering the type of data source.

For real-time data, such as weather data, data about sensors and meters states, production and consumption data, we propose to use an external real-time data cache. This data cache contains only the tables that are real-time, while non-real-time date are extracted, transformed and loaded directly into the traditional data warehouse.

Using an external real-time data cache we can eliminate performance problems associated with the process of integrating real-time data into a data warehouse.

Also, this can solve other problems like internal inconsistency and data latency.

Having all the real-time activity on the external cache database, the warehouse does not support any additional load, so the scalability and query problems will be solved.

The connection between the real-time data cache and data warehouse is accomplished by scheduled and real-time updates when certain conditions are met. For example, production and consumption data are updated hourly, while alerts based on measurable factors or alerts caused by the malfunctioning equipment need to be updated instantly into the data warehouse.

In order to create advanced business analytics, with a just-in-time information merging solution, we can easily merge real-time data from the external real-time data cache with the historical information from the data warehouse.

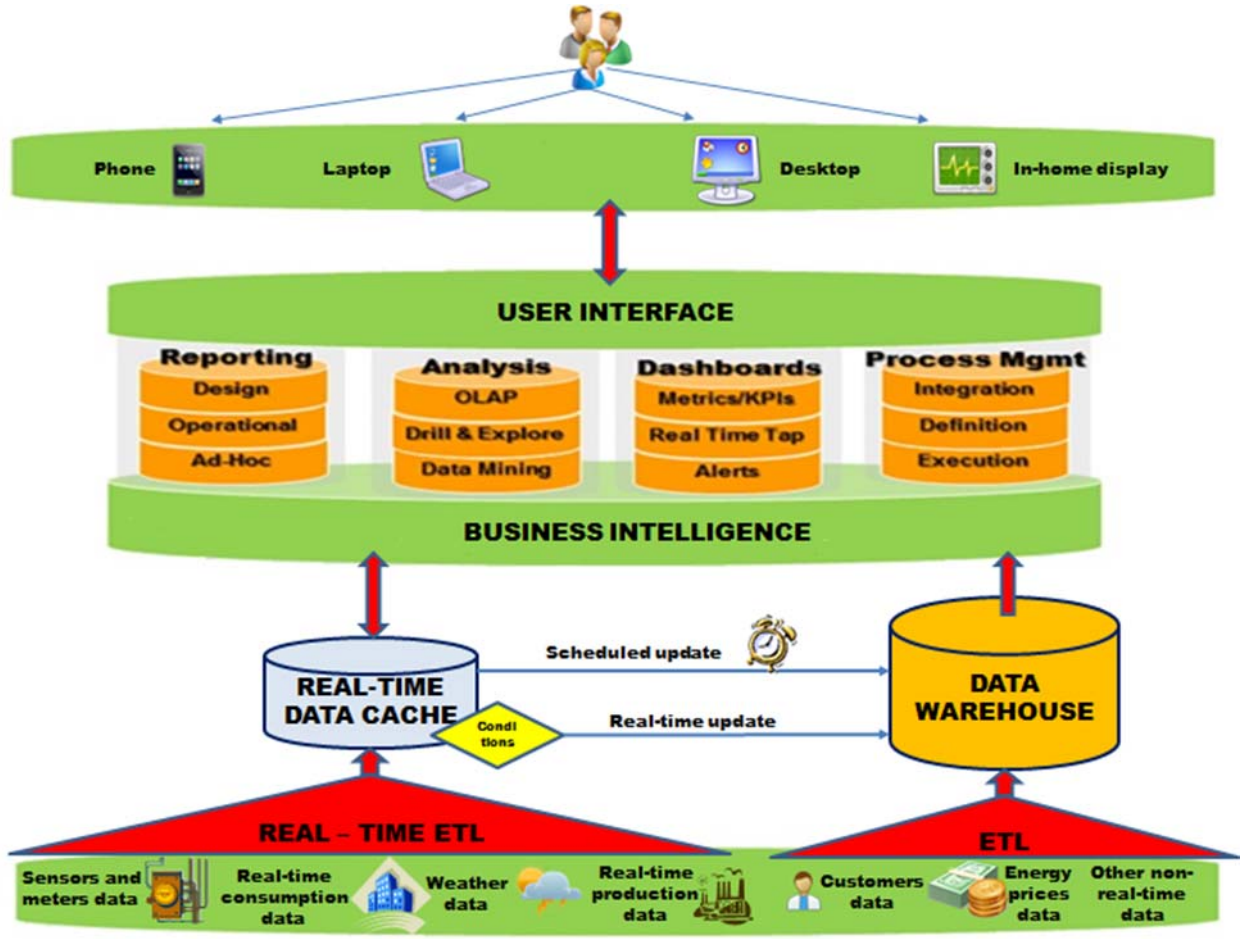

Fig.11. Our RTBI vision for the utilities industry

7. Conclusions

An ideal business intelligence system gives utilities the right information in the right format, at the right time, so they can make optimal business decisions. Giving the fact that this industry is an environment where decisions are time sensitive, utilities need RTBI solutions to improve customer experiences and operational efficiencies.

Our vision of real-time business intelligence for the utilities industry proposes the use of an external real-time data cache and a traditional data warehouse, in order to eliminate performance problems and to solve problems like internal inconsistency, scalability and data latency.

Although many technologies are available to implement real-time business intelligence, many challenges remain to make this a reality.

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