CONCEPTUALIZING BUSINESS INTELLIGENCE ARCHITECTURE

MOHAMMAD SHARIAT, Florida A&M University
ROSCOE HIGHTOWER, JR., Florida A&M University

Given today's business environment, at times a corporate executive may feel overwhelmed by the amount of information available and the coverage of what is actually known as Business Intelligence (BI) architecture. There are literally hundreds of product offerings to choose from. For example, a simple Google search for "business intelligence software" yields more than 24 million responses including more than 50 different vendors. Shariat and Nwakanma (2006) strongly recommend that customers view the future as involving collaboration and cooperation between all parties within the business as well as the external vendors in order to properly manage enterprise information technology systems. This manuscript defines business intelligence, explores the basic difficulty in managing a firm's business intelligence architecture, and offers a comprehensive BI framework to aid an executive with appreciating the complete enterprise view. This is in total contrast to today's vendor "BI dashboard" view that appears to be easy to design, quick to implement, and simple to

INTRODUCTION

Over the past ten years many business information analysis terms have become popular. Terms like Business Performance Management and Business Process Management (BPM), Corporate Performance Management (CPM), Business Activity Monitoring, Customer Relationship Management (CRM) etc., have become popular terms in the information technology industry. Today, these terms are all a part of what is called Business Intelligence (Zaman 2005).

The term "Business Intelligence (BI)" first was used in the mid-1990s by the Gartner Group Inc., one of the world's largest information technology companies. In September 1996 one of the Gartner Group's reports referred to BI in forward thinking enterprises as "information and applications available broadly to employees, consultants, customers, suppliers, and the public. The key to thriving in a competitive marketplace is staying ahead of the competition. Making sound business decisions based on accurate and current information takes more than intuition. Data analysis, reporting, and query tools can help business users wade through a sea of data to synthesize valuable information from it – today these tools collectively fall into category called Business Intelligence (Gartner Group 1996)."

The Marketing Management Journal
Volume 17, Issue 2, Pages 40 - 46

BACKGROUND

Traditionally, enterprises have stored a huge amount of disparate (i.e., departmental, geographical unit, aggregated, and historical) data on variety of computer storage platforms over the past fifty years. The individual departments and/or geographical units within the enterprises frequently took advantage of evolving technology and were able to access and use the data independently. Thus, a pattern was developed for operational information systems. However, over time, the whole enterprise found it more and more difficult to build a common reference, integrate, correlate, have immediate access to, and to decipher the data at the enterprise mission level.

During the 1960s, database management systems (DBMS) gained popularity in business operations by integrating and monitoring operational and transactional data. In the1970s Decision Support Systems (DSS) evolved with

the objective of providing the organization decision makers with supportive data for decision-making processes. During the1980s Executive Information Systems (EIS) evolved and extended the delivery of information to executive officers across the enterprise.

Today, both of these systems not only share some of the objectives with BI, but also share some of their major tools and techniques. Other technologies and tools such as OnLine Analytical Processing (OLAP), and Data Warehouse (DW), developed during the 1980s. The OLAP tools allow the user to query, browse, and summarize information in an efficient, interactive, and dynamic way. OLAP tools, although initially developed for use in the DSS and EIS domains, today represent a vital component of both the BI and data mining technology. They provide an aggregated approach to analyzing large amounts of detailed data. OLAP databases are often referred to as hyper cubes or simply cubes since they have a multidimensional nature. A cube is a visual representation of a multidimensional table that has just three dimensions: rows, columns and layers.

The DW technology is composed of two main components, data repository and Meta Data. The data repository, usually referred to as Data Warehouse, is a logical collection of integrated information designed and gathered from many different operational data to support management decision-making. It contains a wide variety of data that present a coherent picture of business conditions at a single point in time. Meta Data, in its simple definition, is data about data. Meta Data is a collection of rules and directions that guide the extraction, transformation, cleansing, and loading data into the DW.

PROBLEM STATEMENT

An architecture is the fundamental organization of systems embedded in its components, their relationship to each other and the environment, and the principles governing its design and evolution. The software architecture is defined as the system structure comprising software elements, their externally visible properties, and their relationships. The externally visible properties include service (processes), performance characteristics, and shared resource usages.

BI architecture is structured differently and uses different terminology than other information technologies in use today. This is particularly observable in the relationship between BI vendors and BI clients. General names have been given to the physical components, some components relationships and functions have been obscured, and component interdependencies abstracted. While some generalizations and abstractions are required to accommodate a variety of design choices and changes in technology or component arrangement for performance efficiencies, a standard BI architecture must be adopted. Vendors and clients of BI technology must establish a general structure to remain stable while still enabling flexibility and the ability to tailor to a variety of business information system environments and industries. The differences in language (i.e., naming, components, processes, and relationships) can be overcome with a better understanding of a standardized BI architecture, its organization, and its relationship to other enterprise information systems.

The BI architecture and infrastructure has been illustrated and presented in many different ways in the current information technology (IT) literature. Some use a traditional view of software architecture and describe the systems in terms of software, hardware, middleware, application suites, data warehouses and business transactions.

Others present standard Business Intelligence as a BI Pyramid to show how to distribute the different BI tools to different user groups. The BI pyramid generally consists of the following:

1. Software on the top of the pyramid is called the “Dashboard”. The dashboard is used for executive management interaction with the BI.

2. The middle section of the pyramid is OnLine Analytical Processing (OLAP) and ad hoc query for middle management.
3. The lower level of the pyramid uses preformatted report generators for operational management.

Typically, Executive Information Systems (EIS) and Decision Support Systems (DSS) architectures are depicted in pyramid shape to show how the information is distributed to different levels of management. Pyramid architecture's application to BI technology is, to a great extent, due to the BI technology overlap with EIS and DSS. From the perspective of some executives there is no difference between BI and EIS or DSS. According to Fuchs' view of senior management "…what used to be called Executive Information Systems (EIS) …has now evolved into so called dashboards (Fuchs 2005)." We suggest that the dashboard is the most visible component of BI.

Still others present one major component of BI architecture and abstract all other layers and/or components, focusing on data Extraction, Transformation, and Loading (ETL) operations. The ETL is the process of extracting data from the operational data sources or external data sources, transforming the data that includes cleansing, aggregating, summarizing, integrating, as well as basic transforming, and loading the data into some data warehouse form (Raynolds 2006).

Given today's business environment, at times a corporate executive may feel overwhelmed by the amount of information available and the coverage of what is actually known as Business Intelligence (BI) architecture. There are literally hundreds of product offerings to choose from. For example, a simple Google search for "business intelligence software" yields more than 24 million responses including more than 50 different vendors. Shariat and Nwakanma, in a 2006 article about ERP and DSS convergence, strongly recommend that customers view the future as involving collaboration and cooperation amongst all parties within the business as well as the external vendors in order to properly manage enterprise information technology systems. While most of BI products have similar architecture (components) and the same objectives (functions) "various marketing techniques may make the relevant differentiation quite difficult for corporate executives (Business Intelligence: The Way It Should Be 2005, ¶2)."

In 2006, most vendors initially avoided referring to the complexity of data and/or hidden layers of BI, especially if there are multiple data sources and if particularly those sources include customized enterprise applications for ERP, CRM, or SCM. Some of these applications have their own data warehouse with complex database schemas (Meta Data) that were developed prior to the evolution of BI. The average vendor today focuses on presenting the BI dashboard, its ease of use, and quick implementation.

PROPOSED SOLUTION

The key words in the definition of BI architecture are components (elements), the relationships among the elements, and the externally visible properties. These properties include services, performance characteristics, and shared resources. According to early Gartner Group's (1996) definitions in general, Business Intelligence (BI) represents a set of business information processes for collecting and analyzing enterprise (business) information, the technology used in these processes, and the information (knowledge) obtained from these processes. BI is frequently referred to as an umbrella term that brings together almost all of the data disciplines of an organization. We posit a BI architecture that standardizes most popular methods of presenting BI technology and complies with the popular definition of BI. (See Figure 1 Standardized Business Intelligence Architecture).

Figure 1
Standardized Business Intelligence Architecture

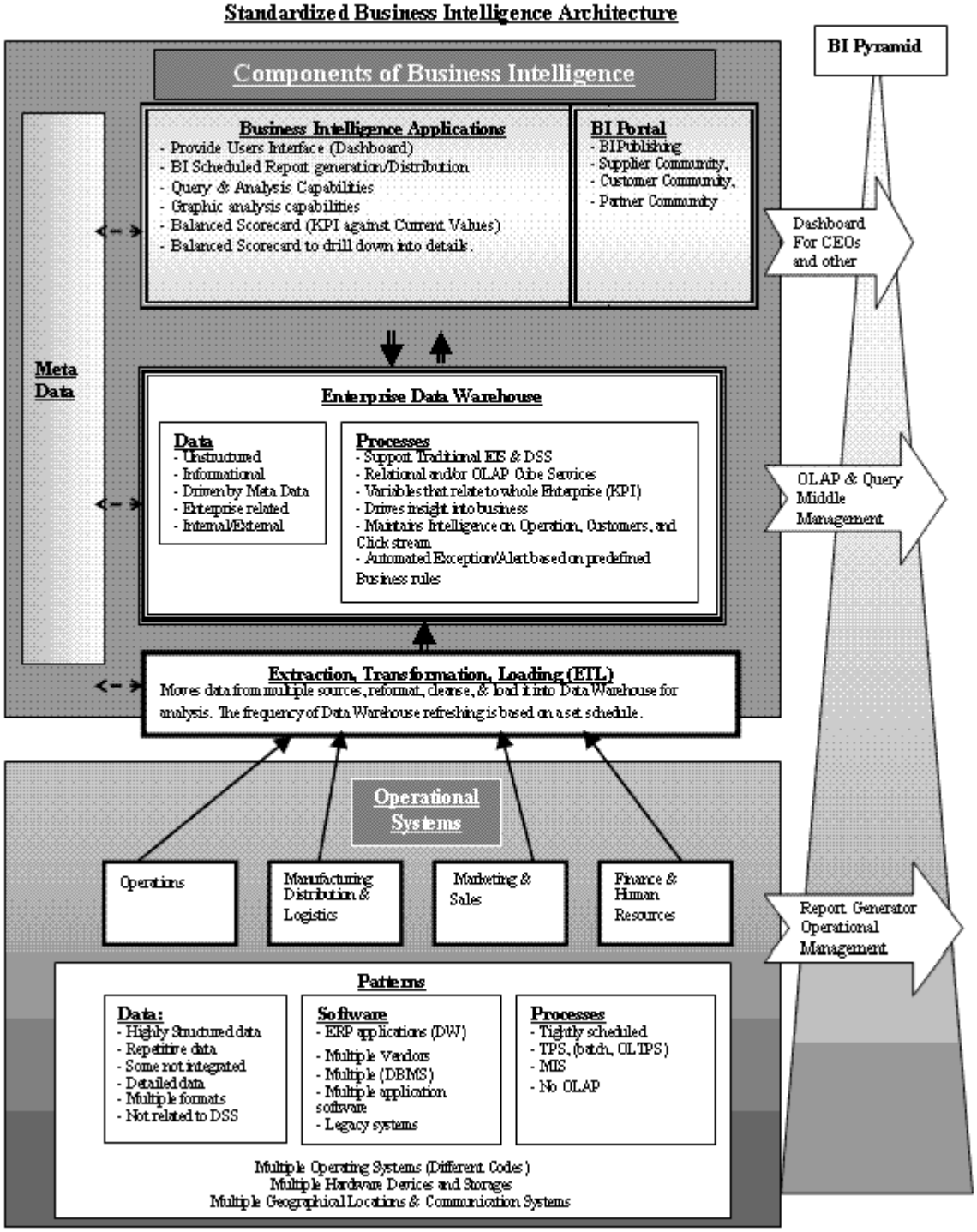

Table 1
BI Component Elements

Operational Systems	
Processes	Supports the day-today working activities of the organizations' lower level and partially middle level managements.
	Supports decision problems that are structured and/or semi-structured.
	Are tightly scheduled (routine processes)
	Deal with general application software; operation, manufacturing distribution and logistics, sales and marketing, and finance and human resources.
	Are transaction oriented systems that might be Batch mode or On-line.
Data:	Highly structured and repetitive
	Detailed form and possibly scattered
	Not integrated for organizational view
	Multiple formats with multiple names given to the same data field
	Designed for Transaction Processing Systems (TPS)
Software	Traditionally designed for Data Processing (DP) and TPSs.
	Are combination of; in-house software, customized software, prepackaged software, and in multiple Database Administration Systems (DBMS) environments
	Acquired from or developed by multiple vendors
	Might have one or more applications of Enterprise Resource Planning (ERP) with or without ERP Data Warehouse (DW).
Extract, Transform, Load (ETL)	
ETL is a major component of Data Warehouse	
Processes	Reads data from operational systems that are in multiple formats, locations, and multiple patterns
	Transform the data using rules to format, combine, and aggregate them
	Cleanse the data using rules and guidelines stored in Meta Data
	Convert the data into information
	Load the cleaned and consistent data onto data repository of the DW or another database
Data:	Maintains ETL tables that provides rules for data cleansing, combining, and aggregating
	ETL interfaces with data maintained in Meta Data
Software:	ETL is a generation of software referred to as middleware
	Usually DW vendors provide ETL middleware customized for specific environment or industry.

As Figure 1 shows, the basic components of BI architecture are: Operational Systems, ETL, Data Warehouse, BI Applications, and BI Portal. Table 1 (see Table 1 below) describes the component elements in terms of Processes, Data and Software.

CONCLUSION

BI technology has become a very popular globally among enterprise executives, IT professionals, and BI vendors. Enterprises have compiled huge volumes of disparate data stored and accessible from a variety of information systems that have evolved since the 1960s. None of the traditional information systems architecture has been totally integrated into the whole enterprise. In other words, the Standardized Business Intelligence Architecture is the first to objectively incorporate industry standards along with basic management practices. BI technology's objective is to bring all of the enterprise data systematically together, and provide the strategic, tactical, and

Table 1
BI Component Elements (Continued)

Data:	Data warehouse and Meta Data, Multidimensional Databases, KPI variables, Scorecards, external parameters and variables
Software:	Variety of user interface software to deliver complex functionality through a simple easy to manage, and deploy information on broad scales. The user interface software interacts with applications, presentations, analysis, statistical, and other desktop software.
BI Portal	
The Business Intelligence Portal is deployed either as an integral part of an enterprise portal or is more restricted and has its own portal.	
Processes:	Provides internal (Intranet) and external (Extranet) users with a single, secure, web-based interface to personalized, integrated business intelligence (reports, query, cube, dashboard, scorecards tools, and etc.)
	Integrates BI application software with the portal framework.
	Interacts with desktop operating systems (Windows)
Data:	Is structured (OLAP and Relational) and/or unstructured (Document and URL)
Software:	Includes a wide variety of tools and application packages; workgroup systems, office suites and other applications..
	Is open standard software interfacing with OLAP, Relational, XML, SQL, URL and office suites.

operational management with information (intelligence) required for decision-making.

Prior to Figure 1 being introduced, a number of BI illustrations were offered that contained different components abstracted at many different levels of conceptualization, and a variety of references (names) were assigned to the components and their respective elements. There are several issues with the information technology literature and popular press' approaches to discussing BI architecture. The major ones are: 1) BI is a fast growing technology, 2) BI involves complex operations with regard to traditional information systems, and 3) BI involves numerous vendors offering a variety of BI functions and products.

We invite practitioners and scholars alike to review, scrutinize, and improve upon the Standardized Business Intelligence Architecture Model offered in Figure 1. We also suggest that the standardized architecture will provide executive management with an improved prospective of BI technology. The model enables executive management, IT professionals, and vendors to have a common perspective in the acquisition, planning, implementation and maintenance of BI technology for today's firms.

The model can be summarized as accomplishing the following. First, the model accommodates the most popular architectures at a level of abstraction that clearly identifies the major components of BI technology. Second, the model highlights the functional (processes) dependencies of operational systems, ETL, Data Warehouse, BI applications, and the BI portal. Finally, and maybe most importantly, it describes the data (information) types involved in each of these components, and identifies the software categories involved with each area. In other words, the model gives corporate executives a specific overview of a popular, complex, and costly business topic.

REFERENCES

"Business Intelligence: The Way It Should Be," Retrieved June 22, 2005, from http://whitepaper.intelligententerprise.com/cmpintelligententerprise/search/viewabstract/76286/index.jsp.

Fuchs, Gabriel (2005), "Reality IT: Big Myth about BI," Retrieved November 13, 2005, from http://www.dmreview.com/article_sub.cfm?articleID=1016223.

Gartner Group (September, 1996). Retrieved November 12, 2005, from http://www.innerworx.co.za/products.htm.

Raynolds, D.G. (2006). "Business Intelligence," Retrieved March 12, 2006, from http:// blogs.ittoolbox.com/bi/confessions/.

Shariat, Mohammad and Hudson Nwakanma (2006), "Enterprise Resource Planning and Its Future Relationship to Decision Support Systems," *Journal of Business and Economic Research*, 4(12), 91-95.

Zaman, Mukhles (2005), "Understanding Business Intelligence and Your Bottom Line," Retrieved July 19, 2007, from http://sageproerp.com/products/businessintelligence/Sage_Accpac_BI_White_Paper.pdf.