SOA, SoBI & EDA – Paradigms for Integration Capabilities of BI Platform

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A Business Intelligence (BI) provider may offer a basic solution, a packed application or a comprising BI platform which integrates components from individual technologies in a synergic system. The providers' tendency is to standardize the instruments offered on a single server platform. The article analyzes the integration capabilities and problems of BI platforms, emphasizes the differences between emergent technologies and suggests integration solutions. The analysis is useful both to the providers of BI solutions – in order to develop some agile platforms, as well as to their users – representing an important factor in selecting the solution. In addition, the conclusions to be drawn will emphasize the tendencies from the BI market and will represent the support in creating some agile platforms.
Keywords*: Business Intelligence, agile platform, integration, metadata management, Service Oriented Architecture (SOA), Event Driven Architecture (EDA).*

1 Introduction

In the present, most enterprises are situated in the incipient phases of BI solutions maturity, but on the market there is a fast increment of the use and development of mature BI solutions.

During its development, BI solutions have turned from information delivery systems to systems of business monitoring and further to automated systems of decision taking seen as BI services concentrated on adding value to the business.

The BI solution offered by providers tends to be an end to end platform which integrates individual components in a synergic system capable of managing the business and to represent a competitive differentiator on the market.

In the last stage of evolution, BI may be seen as a service which is completely integrated with the processes, applications, market strategies of the enterprise, capable of solving business problems and capitalize the opportunities from the market.

Being an integrated service, BI transforms itself from a monolithic IT system into a flexible, agile service, capable of adapting fast to the requirements and changes from the market.

In order to reach the last phase of BI maturity, providers must offer agile end to end platforms that sustain the requirements imposed by the BI service. Thus, providers must orientate themselves towards the latest technologies and instruments that allow them to solve the problems which are confronted with and to value the opportunities from the market.

2. Integration Problems

The identification and analysis of the platform's capabilities, accentuating the differences between emergent technologies capable of solving the same type of problem, accentuating the tendencies represents a necessity in creating some agile platforms. During the maturity process of BI solutions, providers are confronted with problems which shall be shown separately for each capability.

Any user who wants to buy a BI solution must be aware of the strong aspects and the weak ones of technologies, supported platforms, costs associated with the various technologies and to make a balance between cost, scalability, functionality and performance.

Integration at the level of BI platform represents the least mature category of capabilities, for many enterprises this remaining an objective to be achieved and not a reality.

In many enterprises there are distinct instruments, bought or built by different departments of the business which lead to redundancy, errors, costs increase and many times inefficiency. In "Enterprise Business Intelligence: Strategies and Technologies for Deploying BI on an Enterprise Scale", Wayne

Eckerson, states that some large companies use approximately several different BI instruments from 2-3 providers at the same time (Barnes, S., 2005).
Many times, there are instruments which cannot be integrated with others even when they come from the same provider. The solution to this problem is represented by standardizing the BI platform.
Integration at the level of the platform may be analyzed at the level of *a)* infrastructure, *b)* metadata, *c)* development and *d)* work fluxes and collaboration while the tendency is to use architecture which allows integration at all levels.

2.1 Infrastructure

The BI market records modifications both at the level of technologies and products (”performance management” – Cognos, ”business performance management” – SAP, ”pervasive BI” – Microstrategy), as well as at level of forces report (IBM acquires Cognos in 2007, Oracle–Siebel in 2006 and Hyperion in 2007, SAP - Business Objects in 2007). Boris Evelson, analyst at Forrester Research, foresees for the large companies which have acquired providers, some difficulties in fusion (including security and administration and data management instruments), time spent for integration characteristics and less time on innovation.
At the same time, the acquisition of providers of BI solutions may represent an advantage for the users of BI solutions because it simplifies the BI market and minimizes the effort and time necessary to the selection process of the BI solution.
At infrastructure level are generally analyzed security, data protection, metadata, administration, portal integration, inquiry engines, server platforms, operation systems, database management systems, performance instruments and communication facilities.
At enterprise level there must be an adequate management of the BI infrastructure which still remains a challenge because the task belongs to a single group and the access to data and patterns used is different.

2.2 Metadata

Metadata represent the most important capability of the BI platform (Schlegel, K., Sood, K., 2007). Some of the main problems that the BI solutions are confronted with are: non-usage of all the facilities offered by metadata (these being used only at the level of semantics for self-service reporting) and an inadequate management of metadata.
Taking into account the complexity of BI solutions, metadata must offer possibilities of standardizing dimensions, hierarchies, indicatives and performance metrics within the enterprise and of integration with other reporting instruments from other providers. The architecture of the solution must offer *a)* an adequate management of metadata (so that the entire enterprise has access to them and these must be well defined, fragmented and integrated in the development environment), *b)* robust methods of capturing, saving, searching and publishing the objects of metadata, *c)* abilities of promoting and reusing metadata between users and types of different applications, *d)* inference abilities of metadata.
Metadata management becomes an extended problem by the time enterprises implement management initiatives of business processes (BPM- business process management) and SOA because new types of metadata appear and a more focused look on metadata management within the enterprise is needed.

2.3 Development

Depending on the maturity of BI solutions, at the development level are also encountered some problems related to the use of some less interactive development instruments or inadequate application architectures and less developed integration facilities between various applications.
The platform must include instruments of visual development, web services, software development kits for creating BI applications and their integration with business processes or/and with other composite applications. When developing applications, the main characteristics of the types of applications which can be developed must be taken into account.

2.4 Work and Collaboration Fluxes

Within the upper levels of maturity, BI solutions become service-oriented, completely in-

tegrated with the processes and strategies of the enterprise which leads to the necessity of a better integration with work and collaboration fluxes.
The architecture of the solution must offer facilities of:
- communication through public folders or discussion and integration threads of BI results in the context of a specific business process;
- assigning and monitoring the events or tasks assigned to users;
- conceiving and using business rules in order to automates the work flux;
- using the standards.

3. Solution for Solving Integration Problems

When solving the integration problems of the enterprise, both architectural paradigms of database and SOA are useful. While SOA may be efficient at transactional level, data must be integrated in order to support high management decisions. The architectural principals of the two paradigms are not completely compatible.
Mature BI solutions must offer balance between the two paradigms of enterprise architecture, increasing this way the enterprise ability of offering leading capabilities and data added value. Many of the services built for the creation of database such as identifying and authorizing data sources, business rules, data mapping, security rules are already made as part of the SOA design process and information exist in metadata base (Hammack, S., 2008). Some transformation processes may not be necessary anymore because data quality and consistency increases when information is delivered as service.

3.1 Metadata Management

Metadata management is a critical part of the enterprise's information infrastructure and allows optimizing, abstracting and semantics reconcilement of metadata in order to support reuse, consistency, integrity and fragmenting. Metadata management extends in SOA projects with service archives and application development warehouses (Pettey, C., 2007). There are several providers and approaches upon metadata management solutions on the software market: BEA, IBM, ASG Software Solutions, Inxight(R) Software, Esquire Innovations and others.
According to the MIKE2.0 methodology, two ample metadata management solutions may be used, the most advanced being Metadata Driven Integration which also includes the delivery of Metadata Warehouse. Management solutions provide distributed or centralized metadata architectures (table 1 – adapted from Differences, n.d.).

Table 1: Architecture for metadata management solutions.

Architecture / Characteristic	Hub Metadata Architecture	Bus Metadata Architecture
Entry cost	Higher, because it needs more specific software.	Lower, if a central hub product is not required.
Responsibility coordination, data transfer, local mapping and others	Are done without ambiguities/compromises.	Make the environment complex and are harder created.
Roles and responsibilities	Are clear.	May not be as clear.
Development effort management	Is easily done by the metadata architect.	Represents a justified difficulty for the metadata architect, because the development efforts ale multiple and local.
Metadata location	Metadata consolidation in a single foundation offering a "single version of the truth" to which all the users have access to.	Different parts of the detailed level of the metadata solution are scattered on different technological platforms.
Development	The development of new business applications which use metadata becomes easier.	The development coordination between different locations is not too effective. Local development groups are never found in the same place.

Integration and inquiry requirements	Are less complex.	Are more complex.
Information	Offers a single interface between users and the information they need, obtaining easily the information they need.	It is harder obtained.
Solution	It is more difficult to achieve.	It is faster achieved. Each local group has control over designing and resources.

Generally, metadata providers offer persistent (Differences, n.d.) hub architecture, but still existing enterprises which need a "metadata warehouse" of abstracted and consolidated metadata. In *"The Evolving Metadata Repository Market*" are studied more approaches regarding metadata management and it is recommended the most pragmatic approach, that of using multiple federative warehouses and archives (with an optional "metadata warehousing" for selecting abstract levels of metadata in the situation in which the federative approach does not fulfill all the requirements of the users) (Blechar, M., 2007. Blechar suggests that each type of warehouse or registry has to concentrate on specific community of users and have the capability of directing federative inquiries between them. These approaches are more and more popular, but it must not be forgotten these also seek metadata integration and are a challenge for many enterprises.

3.2 SOA

Service-oriented architecture (SOA) may be seen as a paradigm for solving the integration problems of the enterprise at application level. SOA tries to accomplish the enterprise integration by delivering the functionalities of the application as services on final user applications and others.

SOA is based on a conventional request/reply mechanism (figure 1). While the coordinator tends to be unique for a particular application, a service may be reused and fragmented by multiple composite applications. The service coordinator explicitly specifies and invokes the desired services (Woolf, B., n.d.).

In 2007, SOA concentrated more on Business Process Execution Language (BPEL) and Enterprise Service Bus (ESB) components as top of Web Services, and in 2008, on Service Component Architecture (SCA) – which will mark the delivery of composite applications and will reduce the complexity and implementation costs on parts - and Service Data Objects (SDO) – which will put emphasis on the access language to independent data (Trends, n.d.). Definitions, mappings, business rules, information security and other characteristics are stored in a metadata warehouse.

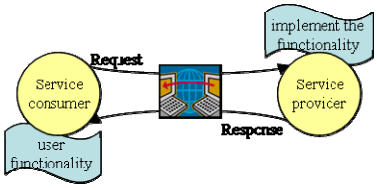

Fig.1. The request/reply mechanism in a SOA.

In order to solve the issues between the SOA approaches, data warehousing and BI, several alternatives were suggested by patricians, such as: SoBI (service-oriented business intelligence), EDA (event-driven architecture) and ESB (enterprise services bus).

3.2.1 SoBI

SoBI represents an attempt of integrating architectural paradigms of SOA and BI, integrating the two approaches at the most adequate architectural level. The SoBI architecture offers availability to BI data from the data warehouse by using a service on other application from architecture. This availability offers applications a better way of accessing centralized data which can support BI requirements. Thus, BI architecture becomes an integrated component of SOA. From the SOA point of view, BI is viewed as a collection of services.

3.2.2 EDA

EDA is a paradigm for communications in SOA, being a SOA in which the entire communication is achieved through events and

all services are processes of reactive events (react to entry events and produce exit events) (Luckham, D., 2007).
On EDA architecture, an application detects an event and issues a notification while other applications have handlers which may receive notifications and may react by invoking the services (figure 2). The detection application doesn't have to know all the services which would have to be invoked as answer to an event (Woolf, B., n.d.).
The main characteristics of the two architectures, as well as the requirements of the BI solution (table 2 – based from Maréchaux, J-L., 2006, Hoof, J., 2006, Covigton, R., 2005) must be taken into account when choosing architectures.

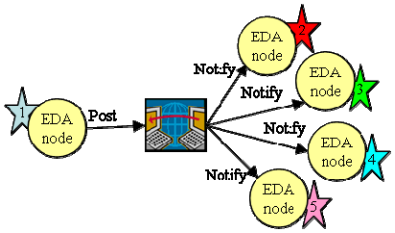

Fig.2. The publish/subscribe mechanism in an Event-Driven Architecture.

Table 2: The main characteristics of the two architectures.

Architecture / Caracteristics	SOA	EDA
Interactions	Weak. Services are independently invoked against technology and place.	Decoupled. Event editors are not concerned about the existence of subscribers to the event.
Communication	Bidirectional one to one. A specific service is invoked by a consumer at a certain moment.	Many to many. Publish/Subscribe messaging where a specific event may have impact upon many subscribers.
Initiation	Started by the client. The control flux is initiated by the service consumer.	Initiation based on event. The control flux is determined by receiver based on a sent event.
Flux	Synchronic, linear through the hierarchy of modules. Replies are resent to the consumer in an asyncronic manner. It allows predictable sequences and the efficiency of the business process.	Asynchronic, parallel, dynamic through the network of modules, using communication through events. Allows asyncronic events, less predictable and many to be created parallel and to initiate a single action.
Concentration	On the present.	On complex relations correlated by events based on past tendencies and future predictions.
Reaction	Closed to the new once the flux of the process has started.	Reacts to the new, the external input reaches unpredictable moments.
Facilities	Improves flexibility with dynamic composite applications and allows data, applications and work fluxes to extend automatically and in real time over enterprises.	The ability of integrating non-traditional events in business processes.
Style	Of command and control. All the phases of processes are under control.	It is appropriate to autonomous and federative processing environments.
Processes	Powerful cohesion between business processes. It supports: - functional request and reply processes such as man machine dialogues, - processes of transactional nature which demand commit and rollback facilities.	There is independence between the phases of business processes. It supports: - types of work fluxes of processes, - processes which cross the acknowledged (B2B) functional organizational borders as well as internal.
Communication	Vertical between the hierarchical levels of the functional decomposition.	Horizontal between levels in a process chain.

In practice, solutions imply a mixture between the centralized and federative approaches. Enterprises must choose adequate instruments or combinations of instruments that satisfy the solution requirements. These are chosen depending on the compatibility

with the existing architectures and the abilities and knowledge regarding a certain approach.
For SME, especially those from new members of EU, the problem suggested for B2B integration was a solution based on federative architecture which proved to be more appropriate for SME than the solutions integrated and unified in a traditional manner. The traditionally integrated models require that each business partner be using the same data formats and protocols. The unified models define a common metamodel and all the partners convert their own data formats and protocols to metamodel in order to obtain a mutual integration. The approach of the federative interoperability does not require to business partners to completely conform to a metamodel. The solution is implementing an ESB based on Universal Business Language (Pataki, B., Kovács, L., 2008).
Using together SOA and EDA offers us a solution which solves the BI requirements. But there are two great challenges of the SOA and EDA approach. One is represented by the fact that there isn't enough experience in using them as BI solution and the other is the fact that it needs more work or even redone. Adding EDA to a SOA solution needs a great effort, but the advantage obtained by creating autonomous services, obtaining data in real time and processing them with the help of CEP (Complex Event Processing), offering the possibility of acting in real time and of manipulating emergent tendencies just as they appear, cannot be offered by traditional mechanisms.

3.2.3 ESB

Enterprise Service Bus is an architectural pattern which facilitates and simplifies business integration through transport services, events and mediation. Today, ESB represents the most effective way of coping with the challenges of complex integration and it is the technical solution which offers greatest business flexibility and efficient connectivity between dissimilar applications.
ESB combines service-oriented approaches and led by events in order to simplify the integration of business units, of platforms and heterogeneous development environments. ESB offers all the capabilities of SOA and EDA paradigms. Existent ESB infrastructures offer a means of communication based on messages and combined with the web services technology.
There are used ESB services which offer at least transport services (delivery of messages between business processes, routes based on content), events (event detection, distribution and initiation capabilities) and mediation (the necessary protocol for integrating heterogeneous systems) in order to facilitate the integration of heterogeneous applications on large scale. ESB offers numerous services, out of which we mention connectivity based on standards, extended and trustworthy integration. ESB unifies SOA and EDA, offering synchronic and asynchronic capabilities, developing the strong aspects and minimizing the failure risks of the federative and integrated solution.

4. Conclusion

The analysis of integration capabilities on BI platform must preoccupy both the providers of BI solutions – in order to develop some agile platforms, as well as their users – representing an important factor in selecting the solution. In conclusion, the last phase of the maturity of BI solutions imposes federative development, BI excellence centers, composite applications, decisions automation, commercialized services and solutions providers must take into account the evolution of enterprise strategies.

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