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Service Oriented Enterprise Architecture For Processing Big Data Applications In Cloud

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Abstract

This paper emphasizes the trend of service orientation in the management and control of processes in manufacturing enterprises and big data applications in cloud. Applications with Service-oriented Enterprise Architectures in the Cloud are emerging and will shape future trends in technology and communication. Enterprise Services Computing is the current trend for powerful large-scale information systems, which increasingly converge with Cloud Computing environments. Here, a combination of architectures for services is made with cloud computing. A proposal for a new integration model for service-oriented Enterprise Architectures is made on basis of basic service-oriented enterprise architecture classification framework, with MFESA - Method Framework for Engineering System Architectures for the design of service-oriented enterprise architectures, and the systematic development, diagnostics and optimization of architecture artifacts of service-oriented cloud-based enterprise systems for Big Data applications.

Keywords: Big data, Service oriented architecture, cloud computing, service oriented big data application, method framework for engineering system architecture.

Introduction

In the last two decades, the continuous increase of computational power has produced an overwhelming flow of data. Big data is not only becoming more available but also more understandable to computers. The flood of information from the internet, sensors, and image capture holds untapped opportunities for companies looking to improve the bottom line. But when confronted by the reality that much of this data exists in large volumes or streams at extremely high data rates, the prospect of extracting useful business value becomes less fathomable. As demands for better value from more information stretch and will eventually exceed the capabilities of traditional computing platforms, big data processing promises to overcome current limitations by using massively parallel, distributed architecture to capture, store and iteratively sift through raw data on a large scale. There are a diverse set of technologies which will provide new tools and techniques that shift the way companies use information to compete. In the arena of consumer sentiment, big data processing applications are emerging to mine transitory market intelligence. Big data processing technologies can mine information about product and customer movements, allowing retailers to understand what is being purchased where with greater accuracy, and gain insight as to why with greater speed.

As these technologies continue to mature, organizations can position themselves to capitalize on future opportunities by taking a business-value-oriented approach to incorporating big data techniques into their enterprise architecture. It requires that IT avoid the temptation to view big data as a point solution in its own silo.Enterprise architects lead their organization's thinking by:

a) Assisting the business in opportunity recognition

Use a business capability map to foster dialogue about opportunities to extract value from sets of data thought too large and cumbersome to handle. Develop powerful stories using business scenarios, then drill through to affected processes and metrics. Business scenario analysis creates a narrative of the people, processes and technology changes required to get from where the business is to where it wants to be.

b) Maintaining a holistic approach to information architecture;

Update your information architecture strategy considering the special characteristics of candidate big data sets. Define metadata to understand key

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attributes required for analysis and develop a sourcing strategy to answer important questions about where the data will come from how fast it must be captured; how good it is; and where it will be maintained. Ensure data governance processes are adequate for the volume, velocity and content of proposed big data sets. Security, liability, and intellectual property are important issues as well - understand how information in large data sets is different, especially after analytics produce consolidated knowledge.

c) Valuating how applications will integrate knowledge via BI, PA and SOA

Use your understanding of potentially large data sets to develop BI and PA integration patterns to create a healthy service-oriented architecture (SOA) capability. Consider how knowledge from large data sets can be used to drive processes via event-driven SOA and complex suppliers to provide big data processing capabilities where possible when the data is appropriate to outsource.

d) Updating your infrastructure technology road map and watch list

Plan to enable horizontal scale by updating your technology road map with virtualization infrastructure technologies and quickly put them in place when required. Evaluate data management technologies and be ready to test these in proof of concepts in support of business case development. Place big data application processing technologies on your watch list and monitor their maturation in the context of valid business scenarios.

Service oriented architecture

Service-oriented architecture is a set of principles and methodologies to design and develop software in the form of interoperable services. Services are usually built in the form of components that can be reused for different purposes than originally intended. SOA's primary goal is to provide agility to businesses, allowing them to adapt quickly and cost-efficiently to changes in the marketplace. Data sharing between different applications is the heart of SOA business applications. Systems located in the same enterprise, as well as different ones, achieve business process integration while adhering to a standardized business process model. The SOA repository is a database containing metadata, or large amounts of data, which is interactive and constantly changing. This repository allows business-to-business communications through Web services. Benefits of SOA include:

- Increase customer satisfaction and loyalty
- Speed time to market and lower development costs
- Improve IT s adaptability and agility
- Reuse existing resources and assets
- Reduce the complexity of integration
- Minimize risk of data downtime or outages
- Minimize risk of project overruns
- Support compliance and reduce risk

Several developments, such as the success of cloud-computing show that not the ownership of IT resources but their management is the foundation for sustainable competitive advantages.

Enterprise architecture

Enterprise Engineering allows deriving the Enterprise Architecture from the enterprise goals and strategy and aligning it with the enterprise resources as shown in Figure 1. Enterprise architecture aims (i) to understand the interactions and all kind of articulations between business and information technology, (ii) to define how to align business components and IT components, as well as business strategy and IT strategy, and more particularly (iii) to develop and support a common understanding and sharing of those purposes of interest.

Enterprise architecture is used to map the enterprise goal and strategy to the enterprise's resources (actors, assets, IT supports) and to take into account the evolution of this mapping. It also provides documentation on the assignment of enterprise resources to the enterprise goals and strategy. There are different paradigms for creating enterprise architecture. The most important is to encapsulate the functionalities of IT resources as services, as shown in Figure 2. By this means, it is possible to clearly describe the contributions of IT both in terms of functionality and quality and to define a service-oriented enterprise architecture (SoEA). SoEA easily integrates wide-spread technological approaches such as SOA or emerging ones as cloud computing .The enterprise goals and strategies are mapped to a SoEA, as shown in Figure 1.

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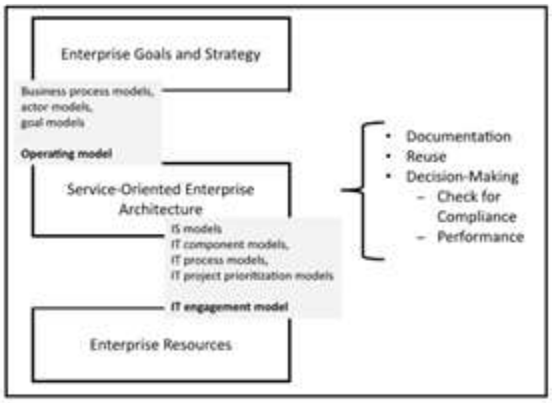

Figure 1. Service Oriented enterprise Engineering

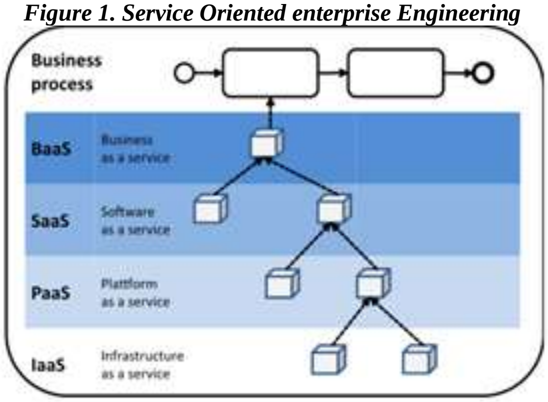

Figure 2. Service Oriented enterprise Architecture

SoEA differentiates four layers of services, as shown in Figure 2. Thus, its scope is much broader than the scope of SOA and also includes services not accessible through software such as business and infrastructure services. Services of different layers may be interconnected in service nets to provide higher level services.

1. Business services are services, which directly support business processes. Business processes can also be developed dynamically using business services which are available in a repository for a given business domain

2. Software services exist as two types: (i) human-oriented applications, which are provided as Software as a Service, (ii) application services which are part of so-called SOA3 that are a popular paradigm for creating enterprise software.

3. Platform Services provide support of the development of applications. They provide services for the execution of applications, middleware stacks, web servers etc.

4. Infrastructure services are more hardware-flavoured services, which are provided using computers. They may have a human addressee but contain many infrastructure services such as providing computing power, storage etc. They are an important topic in management and practice collections such as ITILV34 or standards such as ISO/IEC 20000 have gained a high popularity.

Data Services in SOA: Maximizing the Benefits in Enterprise Architecture

Leading enterprises are increasingly identifying and implementing application functionality as services that can participate in orchestrated business processes. These services are often vertical in nature, specific to a business function. The value obtained from this flexibility, however, is gated by the quality of the data that flows through these services. Therefore, the value of such services is significantly enhanced by taking a wider perspective when viewing corporate data.

Service-oriented architecture is a business-centric architectural approach that supports integrating business data and processes by creating reusable components of functionality, or services. Traditionally, the identification of services has been done at a business function level. This architecture supports an agile business. When a division's operating model changes or a new division is added, the business process can readily be changed without a large implementation effort.

Data in SOA

Historically, the focus has been on data. More recently, the focus has been on SOA. A data-centric SOA allows enterprises to leverage new and existing IT investments to support business requirements, transition between applications, and deliver trusted business information. To achieve the business benefits expected from SOA initiatives, organizations must include a strong data-oriented perspective in their work. Focusing only on the modularization, reuse, and composition of application logic is not enough – SOAs also demand that firms address data issues. Data issue is a broad term that comprises data management, data quality, and data movement. Without a focus on data, a SOA is little more than an improved design pattern for integrations. With a focus on data, a SOA enables a company to have high-quality, consistent data at the right place at the right time. In addition, it pushes the concepts of SOA into the data tier, creating reusable data services that can be leveraged in a business process orchestration or a composite application.

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The Value of Data Services

Data services extend the value of business services in a SOA. Data content and access is consistent and trusted. It removes the complexities of accessing heterogeneous data.

The advantages to the business community include the consistent implementation of data management rules across the data domains, control of data access and security, and provisioning of data to the right application at the right time. These services are the basic building blocks of achieving customer intimacy, a single view of the customer that enables a high-quality, seamless customer experience. This benefits not only the business users but also the customers and partners with whom the business regularly interacts. Data quality is ensured, and data accessibility is optimized.

Data services reduce risk and redundancy in the technology landscape. The creation of data services ensures that there is one source of truth for both data access and data management. Data management code is not duplicated throughout the applications. In addition, SOA governance provides invaluable tools with the mapping of relationships and dependencies of services, processes, policies, and applications. Adding data services to the topology gives a clear picture of the alignment of the business, data, and application layers. Moreover, service performance and compliance is reportable across the landscape.

Data Services for Master Data in a SOA

Data quality services. Data quality services use algorithms and predefined business rules to clean, reformat, and de-duplicate low-quality business data. Traditionally, data quality processing has taken place when data is moved between the online transaction processing (OLTP) application and a data warehouse or mart before being made available to a BI environment. This approach is not optimal for the following reasons:

1. Poor quality data exists, and will continue to exist in the OLTP applications
2. Improved data in the data warehouse is inconsistent with data in the OLTP application. This results in discrepancies between transactional reporting sourced from the applications and BI-based reporting sourced from the data warehouse.

By incorporating data management services into data entry and business processes, data is improved in the source application. The data becomes more valuable and usable at the source and is clean and consistent with the data warehouse.

1. Master data is captured in the various front-end and back-end business applications.
2. Before writing to the application's database, the master data can be passed into a business process that will define one or more data quality services to be consumed to clean, de-duplicate, reformat, and/or enhance the master data.
3. After the data is improved, the business process will then consume a data distribution service to write the data to the proper data repositories.
4. Rejected master data can be passed to another business process that can include human workflow steps to correct the data so that it can be distributed to the defined data stores.

With the construction of data quality services, the business rules for cleansing and enhancing data can be incrementally enhanced without affecting the business applications that rely on quality data.

Big data management

The phenomenon of big data is forcing numerous changes in businesses and other organizations. Many struggle just to manage the massive data sets and non-traditional data structures that are typical of big data. This empowers them to automate more business processes, operate closer to real time, and through analytics, learn valuable new facts about business operations, customers, partners, and so on. The result is big data management (BDM), an amalgam of old and new best practices, skills, teams, data types, and home-grown or vendor-built functionality. BDM is well worth doing because managing big data leads to a number of benefits. BDM also has challenges, and common barriers include low organizational maturity relative to big data, weak business support, and the need to learn new technology approaches. Despite the newness of big data, half of organizations surveyed are actively managing big data today. For a quarter of organizations, big data mostly takes the form of the relational and structured data that comes from traditional applications, whereas another quarter manages traditional data along with big data from new sources such as Web servers, machines, sensors, customer interactions, and social media. A quarter of surveyed organizations have managed to scale up preexisting applications and databases to handle burgeoning volumes of relational big data. Another quarter has gone out on the leading edge by acquiring

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new data management platforms that are purpose-built for managing and analyzing multi-structured big data. Many more are evaluating such big data platforms now, creating a brisk market of vendor products and services for managing big data.
The Hadoop Distributed File System (HDFS), Map Reduce, and various Hadoop tools will be the software products most aggressively adopted for BDM in the next three years. Others include complex event processing (for streaming big data), No SQL databases (for schema-free big data), in-memory databases (for real-time analytic processing of big data), private clouds, in-database analytics, and grid computing. Organizations are adjusting their technical best practices to accommodate BDM. Most are schooled in extract, transform, and load (ETL) in support of data warehousing (DW) and reporting. Preparing big data for analytics is similar, but different. Organizations are retraining existing personnel, augmenting their teams with consultants, and hiring new personnel. The focus is on data analysts, data scientists, and data architects who can develop the applications for data exploration and discovery analytics that organizations need for getting value from big data. This report accelerates users' understanding of the many options that are available for big data management (BDM), including old, new, and upcoming options. The report brings readers up to date so they can make intelligent decisions about which tools, techniques, and team structures to apply to their next-generation solutions for BDM.

Service Oriented Modeling Framework in Enterprise Architect

SOMF is a model-driven engineering methodology whose discipline-specific modeling language and best practices focus on software design and distinct architecture activities, employed during various stages of the software development life cycle. Moreover, architects, analysts, modelers, developers, and managers employ SOMF to tackle enterprise architecture, application architecture, service-oriented architecture (SOA), and cloud computing organizational challenges. The framework provides a technology-independent notation that encourages a holistic view of enterprise software entities, treated as service-oriented assets, namely services.

SOMF in Enterprise Architect

Implemented as a profile in Sparx Systems Enterprise Architect, SOMF facilitates model-driven analysis, design, and architecture disciplines whose best practices support asset reusability, consolidation, expenditure reduction, and time-to-market. Moreover, the SOMF modeling notation provides an intuitive approach to visualize "used-to-be", "as-is" and "to-be" states of the enterprise service portfolio.
Support for SOMF is built directly into Enterprise Architect, as part of a suite of capabilities that facilitate visualization of enterprise services and subsequent model-driven generation of service-oriented artifacts such as XML schema, WSDL and BPEL scripts.

Disciples and Models

SOMF offers a 360º view of any software development life cycle, starting at the conceptualization phase, supporting design and architecture activities, and extending modeling best practices for service operations in a production environment. To achieve these underpinning milestones, six distinct software development disciplines offer corresponding models whose language notation guide practitioners in designing, architecting, and supporting a service ecosystem:

1. Conceptual Model
2. Discovery and Analysis Model
3. Business Integration Model
4. Logical Design Model
5. Architecture Model
6. Cloud Computing Toolbox Model

Chief Modeling Theme: Software as a Service

SOMF supports a service model whose holistic vision embodies any organizational software asset that is subject for modeling. In other words, as apparent in the image on the far left, the term "service" may represent any enterprise entity: software system, software application, software model, software component, software library, business process, repository, middleware product, or system software. Therefore, according to SOMF, the concept "everything is a service" fosters software reuse, asset consolidation, time-to-market acceleration, and organizational expenditure reduction. Ultimately, this universal approach to software modeling reduces design complexities and promotes architecture loose coupling.

Cloud Computing Model

One of the latest additions to SOMF is the Cloud Computing Modeling Notation (CCMN). This model identifies a cloud as a structural and a contextual entity that can be modeled like any other service in the enterprise. The cloud of services concept in SOMF is driven, yet again, by the driving theme "Everything as a Service", as shown in the far right image. Moreover, according to SOMF, the services that a cloud offers fall under many categories. The chief classifications are software-as-service (SaaS), infrastructure-as-a-service (IaaS), and platform-as-a-service (PaaS). This holistic modeling view enables practitioners to model a cloud-computing environment and ease its adoption in the enterprise.

Method Framework for Engineering System Architectures

MFESA is a method engineering framework based on situational method engineering, which provides a method for developing appropriate, project-specific system architecture engineering methods. It enables system architects and process engineers to effectively and efficiently create methods for engineering system architectures. MFESA can also be used to create methods for engineering the associated software architectures of the system, for major subsystems and its software architectural components.

The primary goal of MFESA method framework is to help architects effectively and efficiently engineer consistent and high quality architecture for a system of systems, a single system, and/or a system's subsystems, whereby the architecture meets the architecturally significant acquirer and derived product and process requirements that are allocated to the system and subsystems.

MFESA consists of the following four primary parts (Figure 3):

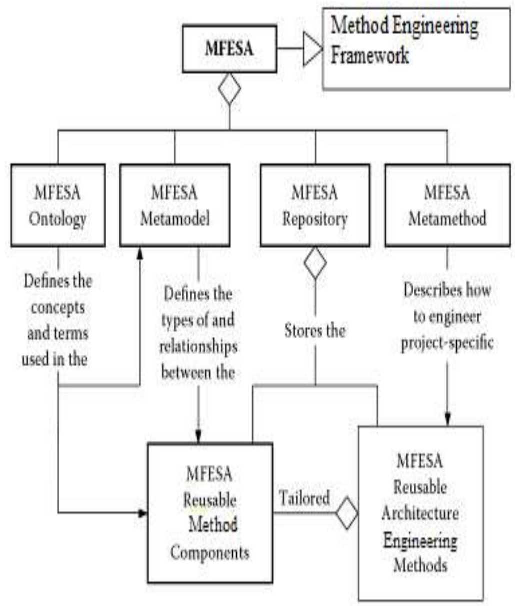

Figure 3. The four components of MFESA method engineering framework

- **Ontology** defining the key concepts of system architecture engineering and their relationships
- **Metamodel** defining the foundational abstract super types of method components for engineering system architectures including architectural.
  - Work products including architectures and architectural representations such as models and documents
  - Work units including activities, tasks, and techniques for producing the work products
  - Producers including system architects, architecture teams, and architecture tools that perform the work units to produce the work products
- **Repository** of free, open-source, reusable method components for creating situation-specific system architecture engineering methods
- **Metamethod** for creating situation-specific system architecture engineering methods by selecting appropriate method components from the repository, tailoring them as appropriate, and integrating them to form the new architecture engineering method.

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Result

SOA starts with a simple idea – the concept of service. This makes it possible to introduce other ideas, such as service bus, service composition, and service virtualization, each of which can be applied to the architecture of an enterprise to deliver benefits (figure 4). The vision behind service-oriented computing is extremely ambitious and therefore also very attractive to any organization interested in truly improving the effectiveness of its IT enterprise. A set of common goals and benefits has emerged to form this vision. These establish a target state for an enterprise that successfully adopts service-orientation. Service oriented enterprise architecture proves to be the best for big data applications in cloud.

Figure 4. SOA Features, Benefits and Infrastructure

Feature	Benefits	Supporting Infrastructure
Service	Improved information flow Ability to expose internal functionality Organizational flexibility	
Service Re-use	Lower software development and management costs	Service repository
Messaging	Configuration flexibility	Messaging program
Message Monitoring	Business intelligence Performance measurement Security attack detection	Activity monitor
Message Control	Application of management policy Application of security policy	PDPs and PEPs

Conclusion

With the rapid growth of emerging applications like social network analysis, semantic Web analysis and network analysis, a variety of data to be processed continues to witness a quick increase. Effective management and analysis of large-scale data poses an interesting but critical challenge. Recently, big data has attracted a lot of attention from academia, industry as well as government. The Service Oriented Architecture represents a technical architecture, a business modeling concept, an integration source and a new way of viewing units of

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control within the enterprise. Business and process information systems integration and interoperability are feasible by considering customized products as "active controllers" of the enterprise resources – thus providing consistency between the material and informational flows within the enterprise. Service orientation in the manufacturing domain is not limited to just web services, or technology and technical infrastructure either; instead, it reflects a new way of thinking about processes that reinforce the value of commoditization, reuse, semantics and information, and create business value. If SOA is the conceptual framework for service orientation of manufacturing enterprise processes, then Service Oriented Computing (SOC) represents the methodology and implementing framework for embedded monitoring and control systems in Service Oriented Enterprise Architectures. The development of SOA applications integrates Enterprise Architecture and Management with Architectures for Services & Cloud Computing, Web Services, Semantics and Knowledge-based Systems, Big Data Management, among other Architecture Frameworks and Software Engineering Methods. In the present work in progress research, we explore Service-oriented Enterprise Architectures and application systems in the context of Big Data applications in cloud settings. Using a Big Data scenario, we have investigated the integration of Services and Cloud Computing architectures with new capabilities of Enterprise Architectures and Management. This architecture reference model can be used to support semantic analysis and program comprehension of service-oriented Big Data Applications.

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