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Model-Driven Business Transformation and Semantic Web

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The backbone of the World economy has shifted from agriculture to manufacturing to information. It is now entering a new phase known as an innovation-based economy [1, 4] where value will be created in *services* we provide with information to improve business, government, education, and people's daily workspace. Accordingly, the focus of computing and IT is shifting to the application of technologies to help enterprises, governments, and other organizations improve and transform their current practices. To facilitate the business transformation process, the service-led economy requires the development of new business methods and the technology supporting those methods. Industry and academia, to cope with this paradigm shift in the role of technology, forms a new discipline called *service sciences* [2] by converging ongoing work in related fields of computer science, industrial engineering, operations research, management sciences, and social and legal sciences. Services science would merge technology with an understanding of business processes and organization. It would transform business by recognizing an organization's pain points and apply technologies to correct them.

Among the emerging methods and the supporting technology for business transformation in the service-led economy is the *model-driven business transformation*, which utilizes a multi-layer model approach to linking business and IT semantics [3]. The upper layers of the model represent business semantics in the terms familiar to business executives, business managers and analysts such as business processes, activities, key performance indicators, operational metrics, value drives, and governance. The lower layers of the model represent IT architecture comprising a wide range of services implemented in IT infrastructure such as service-oriented architecture. The vision of this multi-layer model is to enable IT solutions to accurately reflect and be driven by business intent. Figure 1 illustrates the multi-layer model approach to business transformation.

The key to this multi-layer model is that the layers are linked in meaningful ways, so changes in one layer can ripple through other layers. The representation and enforcement of the semantics of the different layers and also of the connections between the layers is essential to the model-driven approach and also is an application area of the semantic Web technology. This model-driven approach provides a convergence of the business and IT models using a multi-layer model, which tightly couples the business and IT models. In many ways, this vision is not new. Technologists have been working towards generalized business process integration and automation for many years. However, this approach is different from the traditional technology-oriented business integration, because it provides a top-down business perspective which enforces a business-orientation of business transformation.

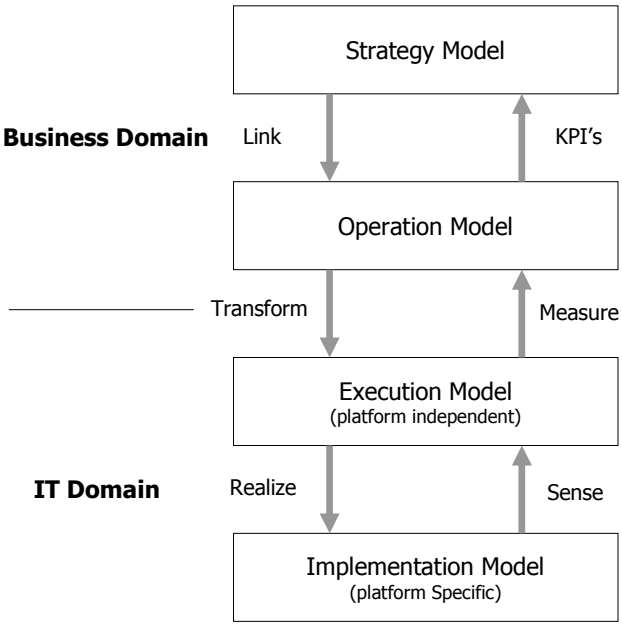

Figure 1 Model-driven business transformation

Once equipped with end-to-end tools for the model design, connection and transformation, this approach has the potential to reduce the time-to-value of business solution implementation. It would replace the manual creation of unstructured business documents and informal business models with a guided transformation of a structured multi-layer model. The IT solutions generated by this approach would accurately and precisely reflect the original business semantics and are directly deployable and executable in a service-oriented architecture. This model-driven business transformation approach is a significant step towards closing the infamous "business-IT gap" achieving maintainable alignment between business design and IT solutions.

Recent trends in componentization and modeling of IT and business would boost this model-driven approach as a prominent methodology for the service-led economy. In recent years, enterprises componentize into discrete services to achieve operational efficiency, flexibility, and to sharpen their focus. Also, the consulting industry increasingly utilizes sophisticated modeling techniques to understand and transform businesses. In the IT domain, software modeling technologies and methodologies such as the Object Management Group's *Universal Modeling Language* [6] and *Model-Driven Architecture* [5] are widely adopted and studied in both industry and academia. In addition, W3C's *Web services* [10] and related technologies accelerate the shift towards *Service-Oriented Architectures* [11] which fit the model-driven business transformation approach. The trends in componentization and modeling of business and software effectively converge to provide new layers of business understanding and responsiveness.

Traditionally, a model has been used to represent things in various contexts including studies of physics, mathematics, statistics, economics, geology, psychology, computer science, to

name a few. A model often dominates the understanding and solution to the given problem in the domain. Additionally, the language used to specify a model often impacts on (either assists or limits) the thinking process with the model. The most important component of the model-driven business transformation approach is the model, i.e., the representation of the semantics of business and IT resources. With the multiple layers in the model, another key component is the representation of the meaning of the links across different layers. It is crucial to this model-driven approach how we represent in a language and enforce the semantics of the layers and also of their links.

W3C's *Semantic Web* [8], which intends to create a universal medium for information exchange by giving semantics, in a manner understandable by machines, to the content of resources, provides an appropriate option to address this modeling requirement of the model-driven approach. The Semantic Web is comprised of the standards and tools of markup languages including OWL [9] and RDF [7]. These XML-based languages would be used to specify ontological representation of models including the business and IT models and their connections. An *ontology* or a *semantic model* is similar to a dictionary, taxonomy or glossary, but with structure and formalism that enables computers to process its content. It consists of a set of concepts, axioms, and relationships, and represents an area of knowledge. Unlike taxonomy or glossary, a semantic model allows modeling arbitrary relationships among concepts, representing logical properties and semantics of the relationships (e.g., symmetricity, transitivity and inverse), and logically reasoning and querying about the relationships.

The semantic markup languages would be used to specify the convergence of business and IT models, and more importantly, their metamodels. The ontological representation of the metamodel of a constituent model enables reasoning about the instance model, which enables a dependency analysis to deduce unknown or implied relationships among entities within the instance model. The analysis would be extended across multiple layers of models. The semantic model-based dependency analysis would reveal which entity has an impact on which entities (e.g., business components and processes, performance indicators, IT systems, software classes and objects, etc.) of the multiple layers of the model. This semantic model-based analysis would be applied to a model that provides an introspective view of the business within an enterprise. Also, it would be applied to a value network which yields an extrospective view of businesses in an ecosystem.

In addition to its use in the model-driven business transformation, the semantic model approach is also useful in business information and process integration. Suppose a business solution requires integrating a number of data sources (or application interfaces for process integration) which provide different but overlapping conceptual models. An approach to integrating them would be using a global semantic model which essentially maps the data sources based on their meaning. The data sources are defined as views into this global model, although there is no guarantee of completeness. A query to the data sources would be expressed in the global semantic model. The result set for the query would be constructed by finding all conjunctive queries over the views that are contained in the top-layer query. A semantic model-based approach to process integration would require a similar set of steps over a set of overlapping application interfaces.

The model-driven business transformation approach proposes a new business method and the supporting technology by coupling business and IT models. It provides a top-down business perspective which enforces a business-orientated business transformation. It has the potential to provide a number of benefits over the traditional technology-oriented approach, including business-IT alignment, reasoning about business design and transformation, real-time visibility into business operation, improved business performance management, rapid and repeatable IT solution implementation, and adaptive IT solution implementation. The key to this model-driven approach is that the layers are linked in meaningful ways, and that the semantics of the links are effectively represented and reasoned. Therefore, changes in one layer can accurately ripple through other layers. The semantic Web technology is an enabler to fulfill the modeling requirements in representation and enforcement of the semantics of the multi-layered model. It poses a key enabling technology for the emerging service science, which will meld technology with an understanding of business processes and organization.

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