THE SEMANTIC E-BUSINESS VISION

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Abstract:

Much work is required to understand how the conceptualizations that comprise business processes across the extended enterprise can be captured, represented, shared, and processed by both human and intelligent software agents. This effort will ultimately lead to transparent and secure information and knowledge flows in service and supply chains to increase economic efficiency in the digital economy.

Article:

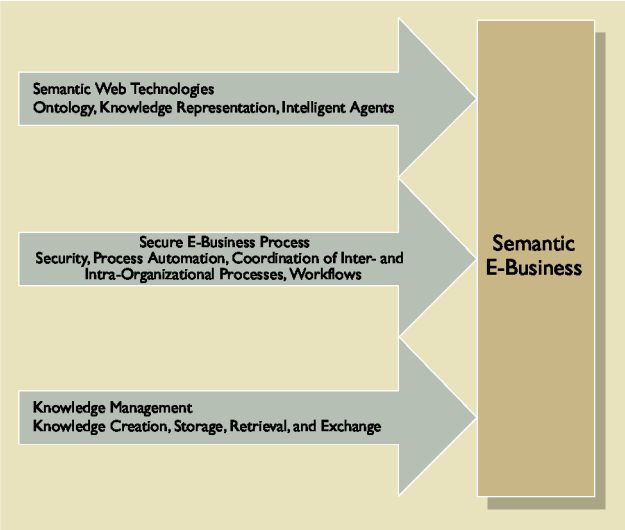
Tim Berners-Lee's Semantic Web vision [1] provides a foundation for semantic architecture supporting such information and knowledge exchange among collaborating e-business organizations in the digital economy engaged in co-creating value for the marketplace. In this vision, ontologies provide standard, shared vocabulary that represents the meaning of entities; knowledge representation provides structured collections of information and inference rules for automated reasoning; and intelligent agents interpret and exchange semantically enriched knowledge for users [2].

Developments in semantic technologies make Semantic Web content unambiguously computer-interpretable and amenable to agent interoperability and automated reasoning techniques [3]. Built on Resource Description Framework (RDF) and Description Logics (DL), the Web Ontology Language (OWL) is a W3C standard for semantic knowledge representation. Web Services and Web Services Architecture provide envelope and transport mechanisms for information exchange. Together, these technologies provide semantic knowledge representation and exchange mechanisms for collaborations in Semantic E-business processes.

We define Semantic E-business as *an approach to managing knowledge for the coordination of e-business processes through the systematic application of Semantic Web technologies* [6] . Semantic E-business is founded upon three active streams of research: *Semantic Web technologies*, including ontologies, knowledge representation, and intelligent software agents; *knowledge management*, including the creation, storage, retrieval, and exchange of machine interpretable and useful information upon which action can be taken or advised; and *secure e-business processes*, including process automation, enterprise systems integration, and the coordination of workflows and activities within and across organizations.

Application of Semantic Web technologies provides organizations the means to design collaborative and integrative, inter- and intra-organizational business processes, and systems founded upon the seamless exchange of knowledge among trusted business partners. Tallman et al. [7] examine the role of knowledge exchange for competitive advantage and note that simpler, codified, and less tacit component knowledge, including skills and technologies, consumer behavior, and product knowledge is amenable to knowledge exchange. Singh and Salam [4] decscribe an integrative view of secure semantic e-business process that incorporates simultaneous management of component knowledge, process knowledge, and security knowledge for inter-organizational e-business processes.

Semantic E-business architectures enable information and knowledge exchange and intelligent decision support to enhance e-business processes. It can also help organizations fill the chasm that exists in the adaptation of emerging technologies to enable and enhance business processes through the use of distributed heterogeneous knowledge resources.



The Semantic E-business vision is founded upon foundations in Semantic Web technologies, knowledge management, and e-business processes literature.

Organizations can benefit by developing descriptions of their business processes and business rules using semantic knowledge representation languages, such as OWL, in a format allowing for reasoning by intelligent software agents. Business processes consist of workflow descriptions that describe individual tasks at an atomic transactional level. At this level, the individual services offered by organizations can be described using semantic languages. In addition, product ontologies and resource meta-ontologies can be used to describe the relationships between the various resources utilized, required, or created by an organization within and across the Semantic E-business network.

Developments in the availability of content and business logic on-demand, through technologies such as Web services, offer the potential to allow organizations to create content-based and logic-driven information and knowledge-value chains in the digital economy. In this important research area, Jos de Bruijn et al. discuss the Web Service Modeling Ontology (WSMO) framework for the description of Semantic Web Services that can enable flexible and cost-effective business integration through formal descriptions, maximal decoupling of components, and strong mediation support. Ejub Kajan et al. present a B2B Ontology-Oriented Middleware (B2BOOM) approach to building a semantically interoperable open framework for bridging the complexity of heterogeneous environments for flexible mediation between business partners.

Developments on these dimensions are critical to the design of semantically enabled knowledge management systems (KMS) and intelligence-driven Semantic E-business processes in the digital economy. As the focus toward semantic-enabled KMS becomes increasingly prominent, concerns for enhanced security within the realm of shared knowledge domain will be critical and need to be addressed. While Bhavani Thuraisingham discusses directions for security and privacy for Semantic E-business applications, Jinkyu Lee et al. describe how security technologies can help organizations protect their knowledge in Semantic KMS.

Ever-growing competition forces organizations to improve the efficiency and effectiveness of their business processes across the extended enterprise. Complexities in coordinating e-business processes and increasing customer demands for complete solutions require knowledge-driven coordination with intelligent support to determine decision authority and knowledge sources in a value network. This places an increased onus on business and systems managers in organizations to develop systems incorporating emergent technologies that support the seamless and transparent availability of information and knowledge among partners in the

organizations' value chains. Manoj Thomas et al. present a Semantic Web architecture to monitor the performance of business processes. Their architecture is overlaid upon a business process, where agents communicate to monitor business process performance from business activities within a workflow.

While the Semantic E-business vision helps enhance business processes and business information exchange, there are complex business activities underlying these high-level processes that cannot be automated and are not well integrated with formal processes. Thomas P. Moran et al. present an OWL ontology of Unified Activity to include support for informal non-automated business activities. This management approach provides a unified way to represent business activities, enabling different systems to interoperate and integrate with formally modeled business processes. Juhnyoung Lee, in the final article in this section, discusses a model-driven business transformation approach that uses a multilayer model approach to link business and IT semantics.

As research in the foundation technologies for the Semantic Web develops, the application of these technologies to enable Semantic E-business is of increasing importance to the professional and academic communities. For example, the Association for Information Systems hosts special interest groups (SIGs) such as Semantic Web and Information Systems (SIG-SEMIS; www.sigsemis.org), Agent-Based Information Systems (SIG-ABIS; www.agentbasedis.org), and Ontology Driven Information System (SIGODIS; aps.cabit.wpcarey.asu.edu/sigodis) to help foster activities that support researchers and practitioners realize the Semantic E-business vision.

Aside from research on the developments in technologies and architectures that support this vision, we need increasing research efforts to understand how to manage these knowledge-based organizations where knowledge resources are distributed across human and software systems. The effort to realize Semantic E-business will be fruitless without concomitant effort on our part in understanding the human systems at the center of any knowledge-driven activity. It is the human systems that decide what is and is not knowledge. Moreover, in not so distant future, the W3C's Semantic Web research initiatives create policy-aware infrastructure and trust languages for the Semantic Web to represent complex and evolving relationships will help foster knowledge communities on the Web. In these communities consumers and businesses will co-create value through exchange of knowledge and experience.

REFERENCES

1. Berners-Lee, T., Hendler, J. and Lassila, O. The Semantic Web. *Scientific American 284*, 5 (May 2001), 34–43.
2. Hendler, J., Agents and the Semantic Web. *IEEE Intelligent Systems* (Mar./Apr. 2001), 30–37.
3. McIlraith, S., Son, T.C. and Zeng, H. Semantic Web Services. *IEEE Intelligent Systems* (Mar./Apr. 2001), 46–53.
4. Singh, R. and Salam, A.F. Semantic information assurance for secure distributed knowledge management: A business process perspective. *IEEE Trans. Systems, Man and Cybernetics (Part A).* A special Issue on Secure Knowledge Management (Forthcoming, 2006).
5. Singh, R., Salam, A.F., and Iyer, L.S. Agents in e-supply chains. *Commun. ACM 48*, 6 (June 2005), 109–115.
6. Singh, R., Iyer, L.S. and Salam, A.F. Semantic eBusiness. *International J. Semantic Web and Information Systems 1,* 1 (Jan–Mar. 2005), 19–35.
7. Tallman, S. Jenkins, M., and Henry, N., and Pinch. S. Knowledge clusters and competitive advantage. *Academy of Management Review 29*, 2 (2004), 258–271