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A Design Theory for Secure Semantic eBusiness Processes (SSeBP)

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Abstract

The goal of this dissertation is to develop a design theory that utilizes emerging technologies to solve semantic conflict issues, to prevent unauthorized access to resources, to foster knowledge exchange, and to integrate heterogeneous information systems. The proposed design theory will provide practitioners with the meta-design and the design process, including the system components and principles to guide the crafting of secure eBusiness processes that are semantically rich, highly coordinated and seamlessly integrated. Basically, this research attempts to answer the question "How can eBusiness processes be designed and built to enable organizations in a value chain to seamlessly share information and knowledge resources within and across organizations, in a secured and coordinated manner, to achieve common business goals?"

Keywords: Access Control, Semantic Technologies, Design Theory, Business Process, Knowledge Representation

Introduction

Businesses operate in a knowledge-driven economy and increasingly function as knowledge-based organizations (Holsapple and Whinston, 1987). New organizational structures that focus on knowledge resources share the conceptualization of organizations as knowledge-producing and exchanging subsystems (Levitt and March, 1988; Nonaka, 1994). Inter-organizational processes allow collaborating organizations to provide complementary services through networks of collaborating organizations (Sawhney and Parikh, 2001; Dyer, 2000). In this context, the resource-based view of firms with focused capabilities is replaced by a network of organizations with a focal enterprise that coordinates resources of collaborating organizations to execute eBusiness processes (Sawhney and Parikh, 2001). Collaborating organizations require that their business processes can exchange information and knowledge resources in a coordinated and secure manner. Specifically, this research attempts to answer the question "How can eBusiness processes be designed and built to enable organizations in a value chain to seamlessly share information and knowledge resources within and across organizations, in a secured and coordinated manner, to achieve common business goals?"

As organizations become increasingly distributed, their reliance on inter-organizational information flows with partner organizations is integral to any eBusiness processes. Cooperative inter-organizational knowledge sharing can increase partners' knowledge base and competitiveness. This view is consistent with the knowledge-based theory of the firm (Grant, 1996). For this research, the view that information and knowledge sharing occurs in a Business Process context is adopted (Raghu and Vinze, 2007; Singh and Salam, 2006). However, organizations engaged in collaborative inter-organizational

processes continue to deal with several issues related to the seamless flow of information and knowledge resources in an eBusiness Process. For instance, fragmented and heterogeneous IT infrastructures negatively affect the information flows and activity coordination among business partners (Rai et al., 2006; Barua et al. 2004; Sambamurthy et al. 2003). Moreover, in establishing an agenda for IT research in heterogeneous and distributed environments, March et al. (2000) recognize the complexity involved in sharing knowledge in business organizations and explain that semantic interoperability is one of the most important research issues and technical challenges. Likewise, it has been recognized that information security and system integration are among the key issues for IT executives (Luftman et al., 2005). Unfortunately, those issues still remain open and prevent organizations from realizing the benefits of knowledge sharing. Here, the proposed design theory is aimed at providing guidelines to design and develop business processes that allow for solving semantic conflict issues, preventing unauthorized access to resources, fostering knowledge exchange, and integrating heterogeneous information systems through the application of semantic web technologies.

Coordinating complex inter-organizational processes requires knowledge-driven coordination structures to determine knowledge sources and decision authority (Anand and Mendelson, 1997). Likewise, a central issue in inter-organizational knowledge sharing is the nature of the knowledge exchange, including what knowledge is to be shared and under what conditions (Loebecke et al., 1999). Given the risks associated with knowledge sharing, it can only take place in a secure environment. Research on security of distributed business processes lacks of an integrative business process perspective on secure information and knowledge sharing (Oh and Park, 2003). Local security policies are not designed for distributed resource sharing. Global policies do not consider impediments to local access control of resources (Sandhu et al., 1996). Centralized mechanisms fail to capture the distributed nature of systems support required for inter-organizational business processes. Extant literature does not *explicitly* consider or systematically represent *component knowledge* of resources such as nuanced descriptions of product knowledge and skills; *process knowledge* including process workflow models and coordination structures; and *security knowledge* of authorized access for activities to resources within and across organizations. A holistic consideration of these in the design of information systems to support secure and coordinated business processes is critical to inter-organizational eBusiness processes. In order to solve the issues mentioned and to fill this gap, this dissertation is aimed at crafting and evaluating a *Design theory* that allows for designing and developing secure and coordinated semantically rich business processes.

The dissertation will be organized following design science research guidelines (Hevner et al., 2004; Walls et al. 1992). The first section will present the theoretical foundations including the description of the research method, and the kernel theories from the problem domain and the IS application domain. In the second section, the conceptual meta-design of the design theory for Secure Semantic eBusiness Processes (SSeBP), based on the kernel theories, will be developed. In the third section, the evaluation design for assessing the utility of the design theory will be presented. Finally, the limitations, conclusions, and future research directions will be discussed.

Literature Review

eBusiness is an approach to achieving business goals where information and knowledge exchange technology enable business activities in and across organizations and support decision making underlying these activities (Holsapple and Singh 2000). eBusiness involves connectivity, transparency, sharing, and integration of the extended enterprise knowledge across partners, suppliers, and customers (Hackbarth and Kettinger, 2000). As organizations become increasingly distributed, their reliance on inter-organizational information and knowledge flows with partner organizations is integral to eBusiness processes.

In developing this research, theoretical foundations from the application domain will be combined with relevant IS Domain knowledge to design our design theory. Specifically, the meta-requirements of the proposed design theory will be identified from the following kernel theories:

- i) Theories of business process and Inter-organizational workflow (van der Aalst and Kumar, 2003; WfMC, 1996);
- ii) Coordination theory (Malone et al., 2003; Kishore et al., 2006; van der Aalst and Kumar, 2003);
- iii) Access control (The National Institute of Standards and Technology (NIST), 2004; Oh and Park, 2003, Sandhu et al., 1996);
- iv) Agency theory (Jensen and Meckling, 1976); resource based view of the firm (Wernerfelt, 1984);
- v) Value chain and networks of collaborating organizations (Porter, 1985; Sawhney and Parikh, 2001); and
- vi) Knowledge based view of the firm (Grant, 1996).

The applications of Semantic Web technology have been recognized as a new and potentially rich area of inquiry. Research that helps IS researchers and practitioners to understand and apply this technology, in a proactive way, is needed (Srinivasan et al. 2005). The Semantic Web vision aims at enabling partner organizations to seamlessly share information and knowledge. In this context, to develop the meta-design of the proposed design theory, semantic web technologies will be applied. Those technologies include:

- i) Ontologies, which represent structured and codified knowledge about the concepts, relationships and constraints for a domain of interest;
- ii) Knowledge Representation (KR) for structured collections of information and inference rules for automated reasoning in a single system; and
- iii) Intelligent Agents to collect content from diverse sources and exchange data enriched with semantics (Berners-Lee et al., 2001).

Research Methodology

To address the research question, a design science approach will be adopted to develop a design theory for Secure Semantic eBusiness Process (SSeBP) that guides the design of eBusiness processes where information and knowledge resources are exchanged in a secure and coordinated manner. Design science is a problem-solving paradigm that enhances understanding of a problem domain by developing purposeful design artifacts that address important and relevant organizational problems (Hevner, et al., 2004). In SSeBP, information and knowledge resources are expressed in standardized, computationally-feasible knowledge representation languages. Semantic technologies including Description Logics (DL) and Web Ontology Language (OWL) provide computationally-feasible knowledge representation (KR) mechanisms for business processes. SSeBP explicates mechanisms for the systematic representation of *component knowledge* (Tallman et al, 2004), *process knowledge* (van der Aalst and Kumar, 2003) and *security knowledge* (Sandhu, 1996).

In addition, a design artifact is evaluated for its quality and utility in solving relevant problems in the problem domain (Hevner et al. 2004). The proposed design theory will be evaluated through a multi-method evaluation approach that includes observational, analytical, and descriptive evaluation. Specifically, to illustrate the applicability of the proposed design theory, the principles and knowledge representation mechanisms of it will be applied to industry standards and real world case studies to map core business processes of organizations to resolve semantic conflicts and enable the exchange of component, process and security knowledge.

Preliminary Work

Based on a comprehensive literature review of kernel theories, the meta-requirements for the IT artifact and the resultant design theory have been identified. In addition, atomic concepts in the design theory and their semantics have been defined and a preliminary meta-design has been conceptualized. Specifically, Business Enterprise Intelligent Agents; Business Activities; Information and Knowledge Resources; and Organizational Roles, represent the atomic concepts in the design

theory that will be developed in this research. Furthermore, the T-Box knowledge representations (Baader et al., 2003; Gomez-Perez et al., 2004) for the atomic concepts and their relationships have been developed using Description Logics, and validated for consistency, using automated validation tools such as Racer-Pro (www.racer-systems.com).

Due to the importance that business processes have in this research, business process models from industry standards such as Rosettanet; Collaborative, Planning, Forecasting, and Replenishment (CPFR); and SCOR; and business process models from the academia, such as the *MIT process handbook*, have been analyzed to determine how they can be used to validate the proposed meta-design. Currently, CPFR demand forecasting processes have been mapped and enhanced by applying the proposed meta-design. Interestingly SCOR and the *MIT process handbook* do not address security and workflow aspects of information and knowledge sharing in a value chain; so they could be enhanced as well by applying the proposed design theory.

Industry standards lack of the nuances of real world; therefore, in order to verify the applicability of the proposed design theory, the researcher has interviewed Supply Chain and IT senior managers from two large manufacturing organizations in the retail and semiconductor industries. Core business processes that require high level of coordination and secure and transparent knowledge sharing within and across the organizations have been identified. Preliminary analyses of those business processes reveal several issues. First, several business activities are conducted manually, which could lead to several errors and delays in the generation of the outputs of the business processes. Second, inconsistencies with buyers' orders arise due to the existence of various semantic conflicts derived from the use of multiple codes and descriptions of products. Third, the information is dispersed amongst several heterogeneous information systems and data sources, which hinders the seamless sharing of relevant information and integration of business processes. Finally, the enforcement of security policies is difficult to attain given the dispersed information systems and manual activities. Here, the researcher plans to apply the proposed design theory to guide the design of Secure Semantic eBusiness Processes that address the issues mentioned above.

Contributions and Implications of this Research

Specific contributions of this research are to develop and validate a design theory for eBusiness processes (SSeBP) that presents a novel and holistic approach that contributes to the IS knowledge base. The goal of the proposed design theory is to utilize emerging technologies to solve semantic conflict issues, to prevent unauthorized access to resources, to foster knowledge exchange, and to integrate heterogeneous systems. The proposed design theory will provide practitioners with the meta-design and the design process, including the system components and principles to guide the crafting of secure eBusiness processes that are semantically rich, highly coordinated and seamlessly integrated.

Even though the scope of this dissertation is the design and evaluation of a design theory, the applications and extensions of it are numerous. For instance, the proposed design theory might be applied in the areas of e-supply chain, B2B/B2C e-Marketplaces, semantic matchmaking, contract formation, collaborative forecasting, workflows management, business process reengineering, business process automation, and semantic security policies.

Key References

- Anand, K.S. and H. Mendelson "Information and Organization for Horizontal Multi-market Coordination," *Management Science*, (43:12), 1997, pp. 1609-1627.
- Berners-Lee, T., Hendler, J. and Lassila, O. "The Semantic Web," *Scientific American*, May 2001, pp.34-43.
- Grant, R. "Toward a Knowledge-base Theory of the Firm," *Strategic Management Journal*, (17), 1996, pp. 109-122.

- Hevner, A., March, S.T., Park, J., and Ram, S. "Design Science Research in Information Systems," *MIS Quarterly*, (28:1), March 2004, pp. 75-105.
- Holsapple, C., and Singh, M. "Toward a Unified View of Electronic Commerce, Electronic Business, and Collaborative Commerce: A Knowledge Management Approach," *Knowledge and Process Management*, (7:3), Jul/Sep 2000, pg. 159.
- Loebecke, C., van Fenema, P. and Powell, P. "Co-Opetition and Knowledge Transfer," *Database for Advances in Information Systems*, (30:2), 1999, pp. 14-25.
- Luftman, J., Kempaiah, R., and Nash, E. "Key Issues for IT Executives 2005," *MIS Quarterly Executive*, (5:2), 2006, pp. pp. 81-99.
- Malone, T. and K. Crowston "The Interdisciplinary Study of Coordination," *ACM Computing Surveys*, (26:1), 1994, pp. 87-119.
- Malone, T. W., Crowston, K., and Herman, G. A. editors, *Organizing business knowledge: the MIT process handbook*, MIT Press, Cambridge, Massachusetts, 2003.
- March, S., Hevner, A., Ram, S. "Research Commentary an Agenda for Information Technology Research in Heterogeneous and Distributed Environments," *Information Systems Research*, (11:4), 2000, pp. 327-341.
- March, S.T., and Smith, G. "Design and Natural Science Research on Information Technology," *Decision Support Systems*, (15:4), December 1995, pp. 251-266.
- Oh, S. and Park, S. "Task-role-based Access Control Model," *Information Systems* (28:6), 2003, pp. 533-562.
- Raghu, T.S. and A., Vinze "A Business Process Context for Knowledge Management," *Decision Support System*, 2007, In press.
- Sandhu, R.S., Coyne, E.J., Feinstein, H.L., and Youman, C.E. "Role-Based Access Control Models," *IEEE Computer*, (29:2), February 1996, pp. 38-47.
- Sawhney, M., and D., Parikh "Where Value lies in a Networked World," *Harvard Business Review*, January 2001, pp. 79-86.
- Singh, R. and Salam, A.F. "Semantic Information Assurance for Secure Distributed Knowledge Management: A Business Process Perspective" *IEEE Transactions on Systems, Man and Cybernetics*, (36:3), 2006, pp. 472-486.
- Srinivasan, A., March, A., and Saunders, C. "Information Technology and Organizational Contexts: Orienting Our Work Along Key Dimensions," in *Proceedings of The Twenty-Sixth International Conference on Information Systems*, Las Vegas, NV, USA, 2005, pp. 991-1001.
- Tallman, S., Jenkins, M., Henry, N., Pinch, S. "Knowledge, Clusters and Competitive Advantage," *Academy of Management Review*, (29:2), 2004, pp. 258-271.
- van der Aalst, W.M.P. and Kumar, A. "XML Based Schema Definition for Support of Inter-Organizational Workflow," *Information Systems Research*, (14:1), 2003, pp.23-46.
- Walls, J.G., Widmeyer, G.R., and El Sawy, O. A. "Building an Information System Design Theory for Vigilant EIS," *Information Systems Research*, (3:1), 1992, pp. 36-59.
- Wernerfelt, B. "A Resource-Based View of the Firm," *Strategic Management Journal*, (5:2), 1984, pp. 171-180.

A complete list of references is available upon request