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Towards a Corporate Semantic Web

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Abstract: Corporate Semantic Web aims at bringing semantic technologies to enterprises for gaining, managing, and utilizing knowledge as one of the critical resources for their success in a quickly changing and highly competitive world. It provides solutions in three main application areas for semantic technologies, namely semantic engineering, semantic search, and semantic collaboration in cooperations. It does not only address the technological aspects, but also the organizational and pragmatic aspect of actually using semantic technologies in enterprises, which includes learning and training aspects as well as economical considerations in the sense of entrepreneurial usages of Semantic Web technologies. This paper discusses the applications, objectives, challenges and realization of the vision of the Semantic Web in controlled environments of corporations.
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1 Introduction

Today, pure creation, storage and retrieval of information is no longer a challenge. With highly scalable and efficient Intranet solutions and Web information systems ideal infrastructures for distributed information management exist. Huge amounts of business data are accessible - at every time, distributed from any place, and via standardized service interfaces - however, not necessarily meaningful and pragmatically useful. Here the Semantic Web, which provides machine-readable meaning of information offers promising solutions for corporate knowledge management, but also poses new challenges.

Corporate Semantic Web (CSW) aims at establishing semantic technologies in enterprises. The expected results are an advantage in competition for enterprises. Focusing on the controlled environment in contrary to the global public Semantic Web it avoids facing unresolved problems of the Semantic Web like scalability, broader adoption of commonly shared ontologies, and trust issues.

Aiming at describing the work in progress of the CSW working group at the Free University Berlin[1] this paper is organized as follows. Section 2 introduces application scenarios and objectives we have identified in close cooperation with our industrial partners. Based on these we derived real world gaps (challenges)

[1] (http://www.corporate-semantic-web.de)

towards the adoption of a Corporate Semantic Web in Section 3. In Section 4 the three research areas of CSW are introduced that aim at closing the identified challenges and bringing semantic technologies to enterprises. Finally, section 5 presents a conclusion and an outlook on our ongoing research.

2 Application Domains for a Corporate Semantic Web

Derived from interviews with our industrial cooperation partners we see two major application domains for corporate semantic technologies in the enterprise area:

1. Automated Semantic (Business) Processes Management

   The assumption behind Business Process Management (BPM) is that the uniqueness of an enterprise lies in the way how it manages and executes its business processes. Accordingly, business processes are the most valuable asset of an enterprise. Modern BPM often directly builds IT Service Management (ITSM) which describes the change of information technology (IT) towards service and customer orientation, and IT Infrastructure Management (ITIM) which focuses on planning and efficient and effective delivering of IT services and products while meeting quality of service and security requirements. Corporate Semantic Web (CSW) technologies for semantic business process management (SBPM) provide scalable methods and tools for the machine-readable representation of knowledge, especially rules as a means for declaratively describing business rules and IT policies, and ontologies as a means of capturing a domain of discourse such as a business vocabulary which, for example, might be used in semantic business processes and Semantic Web Services (SWS).

2. Knowledge Management

   In particular in the realm of corporate collaboration tools, Semantic Web technologies will support semi-automatic knowledge evolution and dynamic access to and integration of distributed, heterogeneous information sources and knowledge consolidation – for example, for trend, enterprise structure, and problem recognition. This will enable the mapping from corporate data and human expert information into explicit knowledge and finally into corporate wisdom stored e.g. in semantic organizational memories supporting e.g. sophisticated semantic search for organizational knowledge.

From our interviews we have identified the following common applications and objectives for the utilization of corporate semantic technologies:

– Intelligent Semantic Search
  Objectives:

- improved relevance of search results with higher precision and recall
- processing of relations between different search results
- determining of non explicit unknown correlations
- automated navigation structures, e.g. for visual navigation of research results in the ontology graph
- personalized and contextual semantic search

– Declarative Knowledge Representation
Objectives:
- separation of concerns by separating content from meaning and presentation
- declarative processing decoupled from the application logics
- overcome problems of heterogeneous information integration
- (automated) linking to other relevant information
- (end) user control including personalization and customization

– Knowledge Transfer and Dissemination
Objectives:
- right knowledge at the right time, at the right place / for the right person(s)
- capture expert and organizational knowledge (organizational memory)
- collaborative work supported by shared knowledge
- detection of relevant information and situations and triggering of adequate reactions
- reuse and utilization of knowledge (e.g. in departments, with partners, for customers)

– Advanced Agile Enterprise IT Service Management and Business Process Management
Objectives:
- enhanced automation in discovery, configuration and composition of appropriate process components, information objects, and services
- automated mediation between different heterogeneous interfaces and abstraction levels via business ontologies

- targeted complex queries on the process space and flow
- higher quality of service through improved semantic IT Service Management, e.g. by semantic web services and rule-based SLA monitoring
- much more agile business process management via (business) rules

While declarative knowledge representation technologies and tools, such as semantic tagging, wikis, blogs, and collaboration platforms, help collaborating and structuring shared distributed content, companies are also seeking more capable approaches for gaining, managing, and utilizing knowledge required for their agile business processes and dynamic enterprise service networks. Often this requires integration of knowledge-intensive workflows and human activities. Typically, this is problematic due to the purely syntactic functional interface descriptions. For instance, there is a semantic gap between the two worlds - human / knowledge representation vs. automated services and processes management. Corporate Semantic Web technologies allow discovering and transforming existing information into relevant knowledge of practical consequences, trigger automated reactions according to occurred complex events/situations, and derive answers and decisions from distributed information sources. Hence, these technologies are means to bridge between the two worlds.

3 Challenges for a Corporate Semantic Web

Early manifestations of Semantic Web technologies which have their roots in the realm of artificial intelligence and inference systems were complex, expensive to run and maintain and not very business-user friendly. Improved technology providing enhanced usability, scalability and performance, as well as less costly maintenance and better understanding of the underlying inference systems makes the current generation of Semantic Web technologies more usable for its application in enterprise settings. However, there are still a number of challenges that have to be taken into account when employing a semantic technologies.

In [Hepp 2007] four bottlenecks causing seldom use of ontologies on the web have been identified and [Delteil et al. 2007] describes several general "Semantic Web Business Gaps" which hinder the broad adoption of the Semantic Web. From our interviews we found out that the four major challenges for realizing the Corporate Semantic Web are:

(G1) Academic orientation gap: Ontologies are mainly considered as the background artifact of Semantic Web applications instead of flexible means for knowledge representation and data integration in processes. Tools for ontology creation only address developers with academic background, but rarely the usability needs of non-expert end-users. There are only few early adopters which

allow the construction of real-world use cases. But, lasting developments and advanced outreach to industry [Delteil et al. 2007] have not taken place, yet. This is partially caused by the lack of ongoing financial support after project funding periods, so that research results are not used in industrial innovation.

(G2) Application maturity gap: In consequence of G1 only very few tools reach a mature development state and become ready for productive use which explicitly address end-user requirements. Additionally, transparent benchmark standards with adequate evaluation criteria and comparability / compliance levels for mature tools are missing (see e.g. [Bizer and Schulz 2008]). This leads to reasonable suspiciousness against the computational performance of large-scale semantics applications in the enterprise world.

(G3) Engineering gap: Most current ontology engineering methodologies focus on ontologies developed for the public Web (e.g. [Sure and Studer 2002], [Pinto et al. 2005], [Fernandez-Lopez et al. 1997], [Surez-Figueroa et al. 2008]). They do not cover cost-effective creation and management of knowledge in small and mid-size companies and neglect the existing applications and organizational structures during ontology development. Agile engineering methodologies for ontologies and rule bases are needed which respect this existing enterprise landscaped, structures and software engineering processes. Several case studies try to prove the applicability of existing methodologies [Tempich et al. 2007] in general but do not specifically address problems in the corporate context.

(G4) Cost-benefit-estimation gap: There is a strong need for companies to estimate the cost-benefit-ratio of developing semantic-based enterprise information systems. Implementing such applications is a difficult time and resource consuming task since the necessary semantic knowledge such as ontologies and rules need to be engineered first. Building comprehensive enterprise ontologies for only one single application can hardly valorize the effort and decision makers need to be supported here by precise cost-benefit ratios.

4 Corporate Semantic Web

Corporate Semantic Web addresses both the consumer and the producer side, where consumers and producers might be humans as well as automated services, for example, in business processes and enterprise service networks. This also includes the adequate engineering, modeling, negotiation and controlling of the use of the (meta)data and meaning representations in a (collaborating) community of users or services in enterprise settings where the individual meanings as elements of the internal cognitive structures of the members become attuned to each others view in a communicative / interaction process. This allows dealing with issues like ambiguity of information and semantic choices, relevance of information, information overload, information hiding and strategic information

selection, as well as positive and negative consequences of actions (for example, in a decision making process).

Corporate Semantic Web has two intended meanings:

1. (Collaborative) workflows/processes, communication and knowledge management based on an infrastructure for enterprise networks which uses Semantic Web technologies.
2. Corporate = entrepreneurial usages of Semantic Web technologies (also with respect to total costs and return on investment)

Corporate Semantic Web aims at delivering innovative concepts and solutions for the management of knowledge in electronically organized enterprise environments. It focuses on the development and application of semantic technologies in controlled environments as well as the propagation of novel solutions for knowledge acquisition, provision, and management in corporate contexts (cf. Fig. 1).

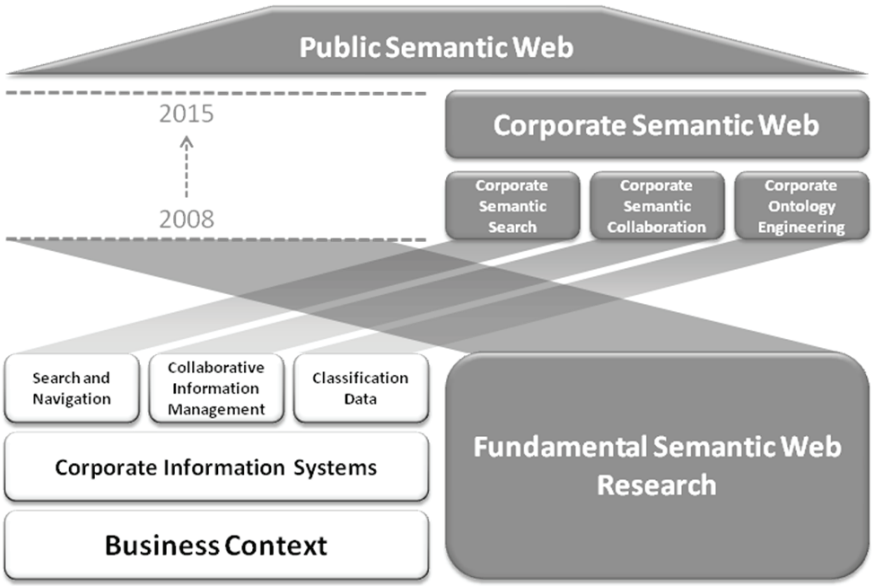

Figure 1: Evolution of the public Semantic Web based on results from Corporate Semantic Web research

The challenges (gaps) are addressed by three research areas:

1. Corporate semantic engineering improves the facilitation of agile ontology engineering to lessen the costs of ontology development and, especially, maintenance.

2. Corporate semantic collaboration focuses the human-centered aspects of knowledge management in corporate contexts.

3. Corporate semantic search is settled on the highest application level of the three research areas and at that point it is a representative for applications working on and with the appropriately represented and delivered background knowledge.

All three parts work together in an integrative Corporate Semantic Web life cycle loop where (1) semantic information is extracted from the existing corporate data (Semantic Search), (2) semantic knowledge such as corporate ontologies or business rules are engineered from this information and semantic-enriched information objects are created (Semantic engineering), and (3) used in collaborative processes and in knowledge-intensive decisions (Semantic Collaboration). These collaborative processes are again semantically analyzed to produce further information bits and in a new loop (1-2-3) are, for example, used to personalize the search and collaboration context.

Corporate Ontology Engineering aims on closing the gaps G3 and G4 by realizing ontology engineering in an evolutionary, aspect-oriented and cost-effective way which respects the agility and various aspects of the knowledge engineering and business processes. It comprises investigation on methodologies and tools regarding versioning, modularization and integration of ontologies and rule bases. While modular reuse and integration of existing ontologies reduce the cost and the time to deployment, efficient versioning allows for evolutionary improvement and refinement.

The goal of *Corporate Semantic Collaboration* is to close the gap G1 and G4 by extending the ontology engineering process to domain experts as well as knowledge managers. The evolution of ontologies is enabled by modeling knowledge in a collaborative way using easy-to-use collaborative modeling tools. Mining user activities additionally extends the corporate knowledge by observing users and deriving new knowledge from their workflows.

Finally, the third research area is *Corporate Semantic Search* which aims at closing gap 2. It investigates easy information discovery in both semantic as well as non-semantic data. Utilizing innovative semantic search techniques to facilitate deep analysis of available information by analyzing complex relationships in non-semantic data (i.e. trend mining) as well as providing users with personalized access to corporate information, results of this research will prepare the ground for various semantic-based applications.

5 Conclusion and Outlook

Nowadays, companies seek more capable approaches for gaining, managing, and utilizing knowledge, and the Semantic Web offers promising solutions. While the global Semantic Web remains an unfulfilled vision for the present, the Corporate Semantic Web idea, which we presented in this paper, aims at bringing semantic technologies to enterprises. The expected results are an advantage in competition for enterprises using semantic technologies. In this paper we have discussed promising application domains of Semantic Web technologies in enterprises. In terms of a gap analysis we have introduced the main four challenges towards a Corporate Semantics Web and have identified the three corresponding research areas which address these challenges. Our ongoing research activities in this areas, focusing on the application of semantic technologies within controlled environments, contribute to the further maturing of Corporate Semantic Web technologies.

However, the Semantic Web technology has not arrived in the corporate world, yet. Incentives need to be provided to encourage in-house adoption and integration of these new Corporate Semantic Web technologies into the existing IT infrastructures, services and business processes. Decision makers on the operation, tactical and strategic IT management level need to understand the impact of this new technological approach and its adoption costs and return on investment.

Therefore, companies will have in mind the economical justifiability of the deployment of new technologies. One of the next steps in the Corporate Semantic Web project will be to develop methods for cost estimation of ontology development processes, ontology use, and ontology maintenance that are adaptable to different corporate environments.

Furthermore, methods for evaluating existing ontologies with regard to enterprise relevant usage criteria are needed. Early adopters deploying application-oriented solutions for improving their competitive advantages through enhanced knowledge management of semantically rich data will demonstrate incentives for further corporations to follow and thereby accelerate the realization of a global Semantic Web.

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