Business to Consumer Markets on the Semantic Web

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Abstract. The emerging Semantic Web technologies have the potential to deeply influence the further development of the Internet Economy. In this paper we propose a scenario based research approach to predict the effects of these new technologies on electronic markets and business models of traders and intermediaries. We develop a concrete scenario for the domain of business to consumer electronic commerce and explain its technical realization. Furthermore, we analyse the potential impacts on market participants and highlight a range of technical and organizational obstacles which have to be solved before semantic technologies can be deployed in an e-business context.

1 Introduction

The past 10 years of Web evolution have established electronic markets and led to the rise and fall of the "new economy". The next 10 years may be characterized by the transformation of the Web from a document publication medium intended for human consumption into a medium for intelligent knowledge exchange [14]. This development is led by the W3C Semantic Web initiative with a joined effort of scientific (MIT, Stanford, ILRT etc.) and business institutions (HP, IBM, Nokia etc.). The basic idea of the Semantic Web is to publish—in addition to classic HTML pages—data directly on the Web. The vision is to use the Web as a global distributed database, which could be queried like a local database today. The W3C Semantic Web architecture stack is defining the reference architecture in the ongoing standardization process. The standardization of the basic layers of the architecture is already at a very advanced state. The standardization of the higher layers (security, logic, proof, trust) is just starting. While there are still a lot of technological issues to be solved, the Semantic Web is in a phase in which consensus about its potentials exists.

However, it is unclear what economic effects these new technologies and their applications will have on markets and enterprises:

– How do semantic technologies affect market-transparency in electronic markets?

– How does this affect the business models of market participants and intermediaries?
– How does an increased efficiency of information exchange affect industry specific value chains?

Even if the vision of a global distributed database maintained on a peer-to-peer basis does not become reality in the midterm, Semantic Web technologies provide a huge longterm potential in several application domains [8]:

– *Enterprise Information Discovery and Integration.* Ontology based data integration frameworks will significantly reduce integration costs. Seen from a system architecture perspective, a stronger decoupling of data and applications will become possible. Data could become an independent resource, used by several applications. Semantic Web technologies could also play a major role in the Web Service description, discovery, composition context. Ontology based service description frameworks could push the possibilities of automatically combining services offered by different service providers another step forward [2].
– *E-Commerce.* The development of XML-based e-commerce standards has led to the same problems EDI initiatives ran into in the past: A wide range of competing standards has been developed and is used by different trading communities. Today suppliers often have to maintain their product catalogs in several XML formats for different market places and customers. Semantic technologies could help to solve these problems by offering a framework for standard mapping and to identify entities like products and traders across different standards. Using RDF's URI identification mechanism, the integration of different product descriptions, ratings, and offers from multiple independent sources by a shopping portal or single user agent might become possible. This would enlarge the data basis of shopping and comparison agents and enhance their usefulness. Seen from the market perspective, this could lead to an increase in market transparency and make the business models of a range of trading intermediaries and market places obsolete.
– *Knowledge Management.* Ontology based search engines will offer a direct access to information sources in corporate intranets and on the global Web, which will reduce search costs. In addition, adaptive Web sites could enable a dynamic reconfiguration according to user profiles, and make precisely the information needed available in the personally desired format and on the preferred device. Because semantic knowledge networks are based on language independent ontological concepts, it could be even possible to render a large amount of Web content in the user's preferred language.

Before these potentials can be realized, there is still a range of technical and organizational issues to be solved. There has been an agreement on the basic system architecture, data formats and protocols. In order to integrate data from different sources, there has to be consensus about a set of domain ontologies and mappings between them. Mechanisms to decide which data is trustworthy have to be developed and a relevant amount of data has to be published according to the RDF data model and the ontological vocabularies.

The access to distributed, machine readable and semantically annotated information will widely influence the further development of the Internet economy, if these problems can be solved.

In the following section we propose a scenario based research approach to predict the effects of Semantic Web technologies on electronic markets. In section 3 and 4 we develop an e-commerce scenario based on Semantic Web technologies for the example domain of car accessories. First we explain the current state of technological development in that domain and highlight the major shortcomings. Afterwards we describe the potentials of Semantic Web technologies to solve these problems. In section 5 we analyse the potential impacts on market transparency and the business models of the market participants.

2 Scenarios for the Future Semantic Web

Taking up ideas from [16], we use scenarios as a basis to explore the effects of the deployment of Semantic Web technologies. A scenario is defined in the cited work as "a possible set of events that might reasonably take place" in the future. Scenarios should stimulate thinking in order to enable a management of change. The change which we foresee is a shift from the representation of documents on the Web to data and information in the Semantic Web. The interesting questions from a business perspective are how this change affects current market situations and business models.

Jarke in [16] expands the above definition further into "A scenario is a description of the world, in a context and for a purpose, focusing on task interaction. It is intended as a means of communication among stakeholders, and to constrain requirements engineering from one or more viewpoints (usually not complete, not consistent, and not formal)". Our work will use scenarios to assess the economic potential and effects of the Semantic Web and knowledge nets in value chains.

With our work, we approach the impact of semantic technologies from the business and the technical viewpoint, in order to make predictions about the influence of the new technologies on markets, enterprises and individuals. The results will be the mentioned communication mean amongst stakeholders, but also requirements that might be used in the development of further Semantic Web standards.

We derive our scenarios from two subscenarios. One is a technological scenario that assumes the availability of semantic technologies in a perspective of several years. The second is a deployment scenario which assumes that semantic application specific knowledge is available in machine readable form usable for applications. From the combination of these two projections we derive e-business scenarios, for analysis and experimentation as shown in figure 1. Each such scenario is a projection of todays developments or a forecast of the state of the Semantic Web in five years.

In the current early stage of development this approach allows us to make statements about the implications of the new technology on the participants of the scenario. Who will benefit? Who will lose market positions or will have to change his business model? This analysis of the participant's roles combined with the analysis of technical restrictions allows us to project if a scenario has chances to be realized.

Every scenario will be relative to an application domain. In the domain of electronic commerce, we think that Semantic Web technologies will have different impacts depending on the characteristics of the specific markets. Semantic Web technologies are likely to have the greatest impact if a market fulfills the following set of criteria:

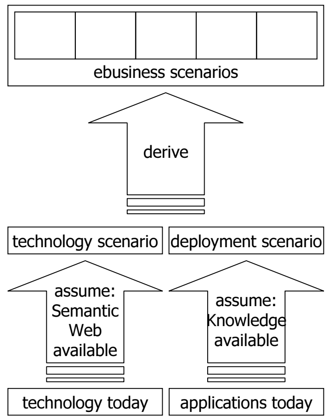

Fig. 1. The scenario based approach

- The application domain must possess a market with multiple suppliers. Integrating data from multiple sources and comparing products and services on a semantic basis are the key capabilities that we expect from the usage of Semantic Web technologies. To reason about its influence, there must be enough sources of products and services that can be compared.
- The suppliers must have similar influence on the market and equal access to it, since in a market without sufficient competition no evolutionary changes can be expected.
- The products and services traded must be uniquely and precisely identifiable, because the Semantic Web relies on the unique identification of things about which statements are made.
- The products and services should already be traded via the Internet, so that customers are already used to this distribution channel.
- To keep things simple, there should be no negotiations involved in a usual business process and the products should be traded at fixed prices.

Following these criteria, consumer markets where medium complex, high involvement products, like video cameras, HiFi, computer or other electronic equipment or car accessories are traded, could benefit most from the usage of Semantic Web technologies. Examples of service markets which could benefit are the travel and the job market. As an example for a first scenario following our approach, we select the car accessories market. It is described in the next section.

3 Current State of the Domain Car Accessories

In order to identify potentials for improving electronic commerce by the use of Semantic Web technologies, this section describes the current state of development in an example domain and highlights weaknesses of the technologies currently in use.

We have examined several online stores which offer car accessories and paid special attention to the way products were presented, classified and identified. As a second focus, we evaluated which sites offer further information relevant to a purchasing decision, how difficult it is to find these information sources and to compare the information about a specific product. We use the example of buying tires to illustrate the different aspects.

The Web sites relevant for our study can be classified into the following groups based on assortment strategy, business models and kinds of information provided (sample web sites in parentheses):

- *Online stores* offering a wide range of products, including a shallow assortment of car accessories, like child safety seats, cleaning supplies or roof racks. *(www.quelle.de, www.neckermann.de)*
- *Online stores* with specialized, deep assortments, offering a wide range of tires or just high performance tires as part of a sports car assortment. *(www.tirerack.com, www.discounttire.com)*
- *Electronic marketplaces and online auctions*, where individuals and companies offer new and used tires. *(www.ebay.com, auctions.yahoo.com)*
- *Specialized search services* for car accessories which lead to both online and offline stores.
- Web sites of *manufacturers* describing their products. *(www.goodyear.com, www.dunloptire.com)*
- Web sites of *car magazines* offering product test and comparisons of different tire types. *(www.caranddriver.com, www.europeancarweb.com)*
- *Rating sites* like epinions.com, where consumers report experiences with a product.

These sources together offer a huge amount of information about a specific tire and a wide range of possibilities to purchase it. The problem for the customer is to find all relevant information sources and to compare the information fragments offered. This problem is aggravated by the fact, that most content of the Web sites is generated dynamically from databases and therefore not indexed by search engines like Google.

Examining the product descriptions on the various stores we noticed that the structure does not diverge much. The main description elements are item short text, detailed item description and price of the item. In the case of tires the description contains at least the brand, the name and the size of the tire. The notation of the size is standardized. For free text item descriptions some sites use a kind of controlled vocabulary, e.g. enhanced wet, dry and snow traction, and differ often in small details. For instance some provide additional information like illustrations or handling characteristics of tires.

The stores usually use their own methods for enumerating products. Therefore different online stores assigned different item numbers to the same product. Many shops do not publish their internal item numbers and use the item short text as unique identifier on their pages instead. The stores examined mostly use a combination of the brand (Goodyear), name (Eagle F1 GS EMT) and size (P245/45ZR-17) for identification purposes.

All shops categorize their items in generalization-specialization hierarchy which is used for navigating through the offers. The average categorization depth is three levels.

Different stores use different hierarchies. In our tire example these hierarchies are based on criteria like brand, size or style.

In conclusion, someone searching for car accessories is confronted with a wide range of information sources offering separate pieces of information about an item and a variety of shops, marketplaces and actions offering the item itself. The main problems using current Web technologies are:

- *Finding* all relevant information sources and online stores for a specific product.
- *Integrating* all information available on the Web, for comparing products and vendors.

Thus buying decisions today are based only on parts of the relevant information available on the Web.

4 Deploying the Semantic Web in the Car Accessories Domain

Semantic Web technologies address the above two issues directly and improve market transparency. The following sections describe how the technologies could be utilized. After an architectural overview we present two typical use cases which show the benefits of the architecture. Next we describe the ontology development, the information provision and the information usage in more detail.

4.1 Architectural Overview

The Semantic Web technologies offer three important building blocks for our e-commerce scenario [18]:

- The use of *URIs as a global identification mechanism* for products and traders.
- The *RDF data model* together with its XML-based serialization syntax for the direct publication of data on the Web.
- The *Web Ontology Language (OWL)* for the definition of common terms and concepts needed to understand RDF data.

In an e-commerce scenario based on Semantic Web technologies, the market participants will have the following roles.

A manufacturer of a product will define a URI for his product which identifies it globally, e.g. http://goodyear.com/eagle_f1/gs_emt/p245/45Zr-17. Based on this URI he will publish product descriptions and additional technical information about the product using the RDF data format. A merchant offering the product then only has to publish his price for the product together with shipment and payment details, referring to the product with the URI. The use of a common identification schema and a common data model will allow shopping portals to integrate all information available on the Web about the item.

The portal will not collect links to Web pages or online shops, it will directly collect the data from the sites. This allows the integration and direct comparison of the content of different sites. A car accessories portal would collect all available information about an item from manufacturers, merchants, test and rating services and integrate them into a personalized offer for customers. Buyers then can use one central portal instead of collecting information fragments from different sites. Under the assumptions that all relevant information providers participate and that mappings between different description schemata are possible, large parts of the information in the market would be available in an open and machine processable manner. Figure 2 illustrates the role model for the scenario and gives an overview about the technical architecture.

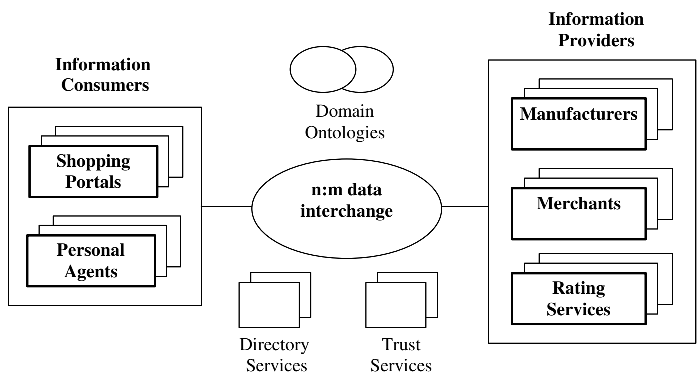

Fig. 2. Architecture Overview

4.2 Use Cases

The following two use cases can illustrate the benefits a shopping portal based on Semantic Web technologies provides for the user. In the first a customer wants to order a particular set of tires knowing the brand (Goodyear), the name (Eagle F1 GS EMT) and the size (P245/45ZR-17). A typical question of interest is: Which shop sells the particular tires for the “best” price and with the “best” conditions? What “best” means depends on the requirements and preferences of the customer.

The customer could also want to know whether there are similar tires in the market which are better or cheaper than a given one. By that, the customer wants to search per article and not per shop. Without Semantic Web technologies the customer has to visit a few stores known to him manually to gather the needed information. Not only is this procedure very time consuming, but it is also unlikely that he eventually finds the best offer available. This is due to different navigation paths, different search mechanisms and different product descriptions in the stores.

Standard search engines are no good either help, since they are unable to search on the *concepts* that describe articles, but only on the words used for naming them. A portal based on Semantic Web technology would have a near global view at the market. It would know nearly all shops and their offers, the manufacturers and their products, and value-added services like rating services. The portal can take the semantic descriptions of the articles and match them with the requirements of the customer.

In the second use case a customer only has a vague picture of the product he wants to buy, e.g. winter tires. The customer knows his car model and finds the allowed tire sizes in his vehicle documents. But there are additional variable properties, for which the customer often does not know the precise technical terms. Here, the customer wants information search per product group instead of search per shop.

For example, the customer needs tires that are safe both at high speed driving and heavy rain. The properties “high speed” and “very good rain behavior” have to be named correcty to formulate a specific query with a standard search engine. It is, however, hardly possible to name every potential member of a product group in such a query.

Using a portal based on Semantic Web technologies, the knowledge included in the domain ontologies could be used to assist the customer to narrow the conceptualization of his vague requirements into the technical terms or specific concepts. Again semantic descriptions and suitable search algorithms would lead the customer to the best matching products.

4.3 Ontology Development

The communication between the market participants is based on a set of ontologies which provide shared terms to describe products, traders, shipment and payment options. Using the tire example again, the market ontology will include the concept of a tire and define several properties like size or rain behavior together with the range of possible property values. The market ontology is the result from the merging of existing ontologies by defining mappings between them.

To create the ontologies needed for the market, a lot of standardization efforts from the EDI community can be reused. Standards like EDIFACT or ebXML define already many of the necessary business concepts and can be converted into ontologies. Examples of such reuses are the RDF versions of the eClass [6] and UNSPSC [17] product classification schema. An overview of the relevant standards can be found in [7].

The existing standards provide the general framework, but have to be complemented with more fine grained domain concepts. Because the manual creation of fine grained ontologies is very costly, different semi-automatic approaches for ontology creation using using text mining and language processing tools are being researched. In our example domain, many concepts and relations between them could be extracted from the existing Web sites and product descriptions. An overview of the different approaches and ontology creation tools can be found in [11].

The experiences from the EDI community show that it is impossible to reach agreement on a single standard for a domain. The Semantic Web approaches this problem by allowing the co-existence and co-usage of multiple ontologies for the same domain. To integrate them, mappings amongst similar or equal concepts in separate ontologies can be defined. In perspective, these mappings lead to ontology convergence. For example the technical term “wet traction” is related to the colloquial superconcept “rain behavior”. There are different manual and semi-automatic approaches being researched [1, 19] to generate mappings between different ontologies.

4.4 Information Provision and Usage

To participate in an electronic market based on Semantic Web technologies, the information providers (producers, merchants and rating services) will map their local data models and identification schemata to an ontology used in the market. Collecting these mappings a network of ontologies is established.

Most product and pricing data is stored today in relational databases and can be easily reused on the Semantic Web. There are different approaches to map relational data into RDF [15, 4]. After the mapping, the RDF data is published using standard Web servers like Apache or specialized query interfaces as in [12, 22].

All the published information will be accessed by potential buyers using either personal agents who collect information for them or using semantic shopping portals which provide the access to the information through a standard HTML interface. A shopping portal which is presenting the published data to the customers will:

- Use a directory service to locate information providers for the car accessories domain.
- Use a robot to collect the data from the different providers.
- Decide which data is trustworthy and shall be used in the portal.
- Use a mapping engine to integrate data published using different ontologies.
- Render the data according to the user's preferences (level of detail, device, language, . . .).
- Provide semantic search services for the customers based on the knowledge included in the ontologies and the available market data [13].

To decide about the trustworthiness of data found on the Semantic Web the portal would use trader independent trust services. These trust services could use trust mechanisms based on information source, context or the authors reputation [21]. There are different technical approaches for a Semantic Web trust architecture being discussed in [10] and [5] using digital signatures together with Web of Trust mechanisms.

Following the above architecture, a portal would have to store huge amounts of collected RDF data and provide easy access to this data for his customers. An overview of specialized databases and query languages to accomplish this task can be found in [3] and [20].

To allow searches on a semantic level [13], the shopping portal will use a reasoning engine which combines the knowledge included in the ontologies with the instance data collected from the Web. Thus vague, similar, or synonym concepts can be matched against the existing information. For example the vague concept "fast" could be matched to a special tire property.

5 Scenario Analysis

Our scenario is based on the new technological foundation defined by Semantic Web standards and raises a couple of interesting economic questions. This section will discuss the possible implications on the business models of the participants and point to open issues, which have to be solved before the technologies can be deployed with success in real markets.

The communication processes between manufacturer, merchant and shopping portal are changed in the Semantic Web scenario. Formerly there were controlled 1:n communication links between them. The manufacturers supplied a known set of merchants with product information. The merchants published this information on their Web sites and forwarded it to the set of marketplaces and auctions in which they participate. Semantic Web technology changes this communication structure. An offer published by a merchant can be used by an unknown number of market places. Formerly controlled 1:n communication links change to an open n:m communication situation.

There are also changes in the kind of information the different parties have to provide. Classically, product description were provided and maintained redundant by every single shop or market place. In the Semantic Web Scenario a merchant would not have to replicate product descriptions to his site, because they are already available from the manufacturer and can be integrated with his offer by the shopping portal.

The application architecture and the possibility of higher market transparency arise new strategic questions for the market participants which will ultimately determine their willingness to participate: Is the architecture in the economic interest of all potential participants? Is it possible to construct an economic win-win situation which would motivate all parties to participate?

For the *customers*, these questions can easily be answered positively. Customers would benefit from the higher market transparency and could make their buying decisions based on a solid, computable information basis. For the *manufacturers* the answers are also positively. They are interested in informing as many potential buyers as possible about the existence of their products. A second advantage for the manufacturers is that they gain more control on the information presented to the customers about their products.

For merchants and shopping portal operators, it is unclear whether the questions can be answered positively. On the one hand it would be much easier to find *merchants* for a specific product if the product is globally identified by an URI. Merchants would also save costs, because publishing data on the Semantic Web is cheaper then maintaining high quality human-readable online stores. But what is likely to weigh more is the fact that merchants are not interested in high market transparency, because in a perfect market their profit margins fall close to zero. Their information advantage would decrease, allowing them to differentiate themselves from other merchants only by additional services.

Shopping portal operators face similar problems. They would all operate on the same information basis. This would allow them to differentiate only in the way they present the information to potential buyers and by additional services like insurances and bonus programs.

Another question is the business model of the *rating services* in the scenario. Today rating services in consumer markets like epinions.com make their profits and are able to pay consumers for their ratings by the revenues they are marking from advertisements on their Web sites and by provisions they are getting from the merchants when a buyer is directed to a shop by the rating service. If the rating data would be published on the

Semantic Web and presented to the buyers together with the product information by the shopping portals, the business model of the rating services would have to change to a pure pay-per-view model.

Before Semantic Web technologies can be successfully used in an e-business context and the scenario described above could be realized, numerous technical and organizational obstacles have to be overcome.

- *Missing ontologies.* Most of the RDF ontologies available for the domain of e-commerce are just research prototypes and hardly fulfill the requirements of real electronic markets. There are a lot of standards, like ebXML or EDIFACT, which could be used on semantic networks. But there is no awareness for potentials of Semantic Web technologies in the communities developing these standards.
- *Missing Identification Schemes*. There are also no commonly accepted identification schema for products, companies, places and people within the Semantic Web community. For integrating information from different sources commonly accepted URI schemata or at least URI mapping mechanisms would be necessary. The identification problem has also been addressed in the EDI community for a long time. So existing approaches like EAN numbers for products, Dun and Bradstreet numbers for companies or UNCOCODES for places could be reused. What would have to be achieved is a consensus about a set of identification schema and ways to publicize product and organizational URIs. If the the Semantic Web grows in the future, it could be common practice to have URIs on business paper and product labels, like it is common practice today with URLs.
- *Security and Trust.* In a distributed environment it is important to know who made which assertion in which context. In our scenario a central enabling factor is the question, whether it is possible to build trust mechanisms which allow shopping portals and customers to decide which data published on the Semantic Web is trustworthy and should be used in buying decisions. When the Semantic Web starts to have an economic impact it is likely that a lot of intended misinformation, for example about competitors, is published and that there are many trust problems arising from the "everybody can say everything about everybody" paradigm. One example of these problems is the question what should happen with true information a merchant publicizes about his more expensive competitor which is not publishing the information himself. It would be useful for a shopping portal to use this information, but hard to discriminate it from false information published elsewhere. Trust and security mechanisms are part of the W3C Semantic Web layer cake, but have to be matured by more research before they can be used in an open e-commerce context.
- *Privacy.* The new possibilities to integrate data from different sources promised by semantic technologies also entail new threats to privacy. The RDF data published on the Web will form an El Dorado for market researchers. Many of the new technical possibilities seem to be illegal with respect to national privacy legislation like the German Datenschutzgesetz.
- *Diffusion strategies*. In order to show the potentials of the Semantic Web and to involve larger communities, seeding application and business cases with clear economic benefits are needed. The Semantic Web is facing a chicken/egg problem

today. Because there is hardly any real world RDF data online [9] it is difficult to demonstrate the benefits of the technology. Because the benefits are unclear, major potential users remain in a waiting position and do not publish RDF data online.

6 Conclusion

In this paper we developed an e-commerce scenario, showing how semantic technologies could influence electronic markets. We described the potentials of the new technologies and the open issues which have to be solved before the scenario can be realized.

Our scenario-based approach is a realistic tool to project today's technology and the deployment of the Semantic Web into a future of about five years. The work presented here is a first step in a series of deeper analysis and experimentations.

The analysis will study the economic consequences of our scenarios on the participants. Experiments will assess, how realistic the technological assumptions are, based on current technologies, and how useful the projected results will be for the deployment context.

The analysis will lead to statements about changed characteristics of markets and value chains. The experiments will showcase future technologies and derive requirements on the future technological development, which then could influence the current standardization processes.

To realize the experiments, we will combine existing software components with our own developments. In the course of our future work this will lead to an evaluation kit for the simulation of our scenarios. The work will be performed in the project *Wissensnetze* funded by the German Ministry of Research BMBF as part of the Berlin Research Centre for the Internet Economy InterVal.

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