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WEB 3.0 APPLICATIONS IN ENTERPRISE STRATEGY

Summary: Web 3.0 trend has recently gained much attention from scientists, researchers and business. Semantic Web technologies make it possible to integrate knowledge from many disciplines to achieve unique solutions. Nowadays Semantic Web applications are not as popular yet as other types of enterprise systems therefore they have potential to bring their early adopters competitive advantage on the basis of differentiation of their services or agility of business operations. The paper presents short characteristic of Semantic Web applications and highlights their strategic power. Two examples of strategic role of semantic applications have been presented from pharmaceutical industry and e-commerce.

Keywords: Web 3.0, Semantic Web applications, enterprise strategy, competitive advantage.

Introduction

The information revolution created by rapid transformations of the Internet has made the World Wide Web deeply rooted in day-to-day actions of the companies. Although the Internet is now very mature and well-grounded medium of communication it is still evolving in terms of technology, range of applications and users' involvement. It is characteristic that as the technology becomes more advanced and complex, the applications become easier to use, and the users' involvement and the range of their activities increase. Every new stage of development of the World Wide Web makes it more intelligent, context-aware, and accessible. Each stage also creates new potentials for individuals and organizations to exchange information between all types of devices, applications and networks. Businesses, governments and individuals strongly rely on the Internet,

therefore early adoption of new solutions can be of great importance to drive relative advantage over competitors.

The new stage of the Internet development is often referred to as Web 3.0, the Semantic Web or the Web of Data. All the aforementioned names are associated with different aspects of the modern Internet. Therefore there is no clear idea of what is the scope of the concept they describe. Semantic Web is the oldest name reaching the origin of the concept introduced by Tim Berners Lee. His definition may be found in the May 2001 Scientific American article "The Semantic Web" [Berners-Lee et al., 2001], that says "The Semantic Web is an extension of the current Web in which information is given well-defined meaning, better enabling computers and people to work in cooperation." This means that the new World Wide Web does not replace the existing one but enhances it in some way. Semantic Web refers to the extension of the World Wide Web via embedding semantic metadata. This aspect focuses on using semantic data modelling techniques such as Resource Description Framework (RDF) and Web Ontology Language (OWL).

The term Web 3.0 in turn refers to the next level of the social web [Harris, 2012] which focuses on the community aspect and collective intelligence. Web 3.0 is most often used to explain the next era of web computing and the new information age it will introduce rather than a set of specific technologies or technical attributes [Shivakumara et al., 2013]. In this context Web 3.0 continues the Web 2.0 social paradigm, extending it with structured approach to collaborative content creating by connecting data, concepts, applications and people.

The term "Web of data" emphasizes the structure approach to data gathering and the data orientation. The ultimate goal of the Web of data is to enable computers to do more useful work and to develop systems that can support trusted interactions over the network [www1]. The concept of the Web of Data refers to the Linked Data paradigm [Frischmuth et al., 2012] where the Internet is treated as a huge database that can be queried using special declarative languages similar to SQL.

There is relatively small number of publications highlighting the strategic aspect of Web 3.0 applications. However, considering far-reaching value of Web technologies, companies should incorporate new objectives into their strategies to excel their competitive strength through innovative using of the Internet.

The aim of this paper is to present selected examples that emphasize the strategic meaning of the Semantic Web applications, which give their owners competitive advantage of some kind.

1. Classification of Web 3.0 applications

In order to clearly define the concept of semantic application it is needed to draw its basic characteristics. First of all it is worth to note that semantics is the study of meaning. The term is commonly used in linguistics, where semantics is the study of meaning as expressed by the words, phrases and sentences of human languages [Cann, 1993]. The terms "semantic technology" and "Semantic Web" are often used interchangeably although that is not always correct. Semantic technology represents a broad category of software applications that have been evolving over a long time with the purpose to help people and machines derive knowledge from different data sources. Some examples of semantic technologies are:

- artificial intelligence (AI),
- data mining (DM),
- linked data (LD)
- natural language processing (NLP),
- semantic search,
- Semantic Web Services (SWS).
- tagging and annotations.

Thus the semantic application is the one that uses various techniques to understand and illustrate the meaning of data it operates on. The Semantic Web application or Web 3.0 application on the other hand is a specific term used to describe a web-based semantic solution that uses some open standards of the Semantic Web, which are RDF, RDFS, OWL, and SPARQL. Semantic Web can be treated as a subset of a broad group of semantic technologies.

The Semantic Web applications can be applied to many problems in today's business and society. The simplest classification can be made regarding the area of implementation. The semantic approach is particularly suitable for scientific domains that profit from large amounts of data from distributed sources published on the Web [Machado et al., 2013].

The origins of Semantic Web standards reach back to markup languages (SGML and XML) used to organize content in digital libraries [Chen, 1999]. Many applications can be found in libraries, archives and museums [Van Hooland, Verborgh, 2014] where the semantics mainly supports effective search.

The Semantic Web technologies can be applied in domains where management and integration of large amounts of data are needed. Semantics is necessary in order to interpret the information and derive knowledge. In chemistry research controlled vocabulary for the classification and labelling of chemical substances, mixtures and the databases of chemical identifiers are exploited [Borkum, Frey, 2014].

Similarly in life sciences Semantic Web technologies are used to deal with particularly complex semantics, resulting from the convergence of different disciplines (e.g.: medicine, clinical research, genetics, biochemistry, etc). Each of the subdisciplines has its proper language and conceptualizations. Biomedical researchers need information from many heterogeneous data sources in order to make decisions and draw conclusions that may lead to important scientific breakthroughs. For this purpose, diverse types of data about drugs, patients, diseases, proteins, cells etc. must be integrated in a way that provides the possibility to query those data sets.

Semantic Web technologies are often implemented in e-learning environments to assist developers, instructors, and learners to organize, compose and personalize educational curriculum [Borkum, Frey, 2014; Pawełoszek, Turek, 2015].

Semantic Web applications are increasingly used to support engineering and manufacturing, there are numerous examples from different industries: in automotive industry [Garcia, 2009], software engineering [www2], metallurgy [Pawełoszek, 2014].

Other classifications of Semantic Web applications can be found, an exhaustive overall analysis is presented by [Nekvasil et al., 2010]. The most important criteria seem to be:

- Semantic knowledge model – the considered applications by their definition use some semantic knowledge model: ontology, taxonomy or at least thesauri. The complexity of data model can be distinguishing criterion of semantic application. There are some applications which use other knowledge models written in example rule based languages, such as SWRL or RIF [Paschke, Boley, 2009].
- Input data structure – semantic applications can process structured or unstructured data. The latter case is a challenge for programmers and an area for exploiting artificial intelligence techniques to extract meaning from free text (for example webpages coded in HTML).
- Data provenance – the semantic applications may use data from other systems or data sources exclusively created for the specific application.
- Manual or automatic data preparation – data for semantic application can be extracted and tagged manually or automatically generated by some applications (for example automatic creation of metadata for a text document or spreadsheet).
- Accuracy of answers – this feature of semantic application is related to adopted formal system of logic. There are two main approaches: closed and open-world assumption. The open-world approach assumes that the system

does not possess complete knowledge about the domain therefore the answer for the question can be "unknown". On the other hand the closed-world approach assumes that if the system does not possess knowledge on a given fact, the fact is not true.

- Reusability of knowledge models and data – the semantic resources (data and knowledge) may be used in other applications in different domains.
- Number and kind of users – semantic applications may be used by unprofessional individual users (not having skills in knowledge engineering), professional users (domain experts), knowledge experts (who know how the application works and have skills to create knowledge models) and management (using Semantic Web applications for decision support). Applications can also be distinguished according to whether they are intended for individuals, working groups or thousands of users in social networks.
- Main functions – the most often are data indexing and searching, data integration and reasoning. These activities are, however, in most cases the means rather than the purpose of application.

Web 3.0 is characterized by a proliferation of various mobile devices, leading to new use patterns of the Web. Apart from smartphones, tablets and smartwatches that is commonly associated with mobile Internet, there is also a broad category of extensions of the Web, that create the Internet of Things. These devices are intelligent endpoints connected via GSM, Wi-Fi or other types of communication networks. Many of these devices are simple electronic sensors that detect motion, temperature, light and other environmental factors, some of them record events (video cameras) or gather data (RFID or barcode scanners). All the aforementioned devices and data they produce can be possibly incorporated into Semantic Web resources and create wide range of new possibilities to extend and enhance context awareness of Semantic Web applications.

2. Place of IT solutions in enterprise strategy

In today's world, the IT solutions are one of the decisive elements in a company's strategy, because they often determine success in many areas. The success can be measured by achievement of specific goals. In many organizations IT constitutes basis for service provision. In such cases IT is an enabler of enterprise strategy, the role of information systems is essential and also the cost of maintenance is significant. Thus the organizational integration as well as the coordination of IT require a systematic approach and overall vision.

It is essential to recognize the role of IT in specific business and its relation to enterprise strategy. If IT can be a strategic enabler but is not, the company may miss market opportunities. On the other hand, if IT is not a strategic enabler but is treated as if it were, the company will unnecessarily overinvest in IT solutions that do not generate business value [Nickolaisen et al., 2007].

Contemporary IT systems are complex solutions offered by specialized vendors who assist in implementation process and offer after-sales services on the basis of service level agreements (SLA). The results of implementation and its strategic success often are dependent on customer-vendor relationship. The role of IT solutions vendor is to assist the customer with understanding possible future developments of the system to use them for future decision planning. The customer-vendor cooperation is very important to combine vendor's knowledge of technology with practical experience of the customer. Together they should predict the way the market will develop (i.e. clients, competitors, suppliers) and how the company will be able to create its IT-based value proposition to secure the long-term strategic success on the market.

For now Semantic Web technology can be one of the key differentiators of the business. Currently in most cases standard IT systems (such as ERP, CRM, e-commerce software) are available for every company on the market at reasonable price or even free of charge (Open Source). Therefore, Semantic Web applications that are not yet so popular can be the special strategic differentiator that the company brings to the market.

3. Examples of strategic Semantic Web applications

In order to demonstrate the possible strategic significance of Semantic Web applications three examples were selected from diverse areas: competitive intelligence in pharmaceutical industry and retail e-commerce.

Competitive intelligence (CI) is a product (findings) and a process of retrieving, analyzing and packaging information to respond to the information needs of the particular decision makers. Companies seek external, objective information on where the market has been, where it is now, and where it will be going in the near future, along with opportunities and potential threats. [Sharp, 2009].

The role of competitive intelligence is to provide more than numbers. It aims to interpret the meaning and significance of the information, to make smarter business decisions. Web-based information resources becoming increasingly important in CI process as the Internet is the environment of many economic activities. Moreover, most of the useful content is available free of charge.

Thus Semantic Web technology is well predestinated to be incorporated into CI applications to extract and analyze potentially valuable information. The example presented hereby describes the case of pharmaceutic industry company. The pharma industry companies have been early adopters of Semantic Web technologies although the previous applications had been built mainly for R&D purposes (describing chemical substances, clinical research effects etc.).

When a pharmaceutical company is at the phase of testing a new drug the development can have big implications on its competitor's plans. An information on this fact can be often found in an online journal or news article. Spotting such information is a major challenge for data analytics. The semantic software combines data from private databases and spreadsheets with data from curated information sources like Thomson Reuters Life Sciences and unstructured data from news stories, press releases, blogs, and scientific journal articles so it is possible to automatically connect, for example, an item from a news article with an item in the company's internal database [Smalley, 2012]. Web resources are analyzed and extracted, and information is presented in a structured tabular way. The software can monitor updates and alert the user about new content on a given subject. The application uses unstructured text as input, exploits natural language processing techniques and domain ontologies to recognize relevant facts. The semantic application for supporting competitive intelligence has strategic meaning for pharmaceutical companies, which are using it because it helps to recognize early market signals about the activities of competitors.

From an e-commerce perspective, the aim of Web 3.0 is to build competitive advantage on the advanced capabilities to exploit the Social Web network. Traditional keyword search on e-commerce websites is no longer innovative or competitive solution. New and enhanced indexing and search methods are applied for interpreting the users' activities and discovering their habits by semantic analysis. With the new semantic tools it is possible to learn more about specific interests of the e-customers and provide them personalized shopping experience. An example of semantic support for e-commerce may be the leading retailer company Walmart (WMT) which is known to sell cheap products. WMT has developed a search engine based on semantic search technology. The new search tools help users find items they want on the Walmart's e-store, but also deliver results based on the customer's interests and intent.

The new search engine called Polaris uses public data on the Web, proprietary data, and social media, to identify interesting entities and relationships and add them to the knowledge base called Social Genome. The Social Genome is a tool that helps Walmart reach their customers by semantic analysis of real time

social media streams [www3]. The semantic capabilities of the Walmart's store are developed on the basis of a social media technology platform (built by Kosmix) that filters and organizes content in social networks such as Pinterest, Facebook, Twitter and Google+ to get relevant information on the users' interests. The semantic search engine uses natural language processing for understanding user's query and base of synonyms to figure out the user's intent and render the best possible results. For example if a user types in the keyword "denim," he gets search results on "jeans" also, while typing-in "chlorine tablets" the search engine returns results related to pool equipment, according to examples provided by the company. Also a banner is displayed with featured items on sale, to help shoppers discover items they may have not considered. After implementing the new search engine, over the last few months, Walmart had already seen about 10 to 15 percent increase in shoppers that complete a purchase after searching for a product using Polaris [Ribeiro, 2012]

From an e-commerce perspective, the detailed knowledge that can be retrieved from Social Web is invaluable. Through semantic methods of interpreting Internet user's activities in social networks it is possible to discover very detailed interests. For example the system detects that a user performed an Internet search for wedding dresses, which in turn results in advertisement of non-specific wedding dresses. In a Web 3.0 scenario targeted advertisements may result in non-traditional wedding dresses for plus size, middle aged women, better fitting the profile of an individual and making these advertisements far more useful, which in turn increases the chances for a sales conversion [www4].

Such semantic search application is able to bring the business a unique strategic advantage. Through the semantic search the company may start to compete not only on price, product availability and rapid delivery. The semantic search capabilities make the customers find more of what they need with less effort. Semantic search makes the business to know its customers better and investing in this knowledge should be an important element of the company's strategy.

Conclusions

The concept of semantics is relatively new field and research dimension within the discipline of creating enterprise strategy. Semantic Web solutions have the potential to become one of the strategic tools for modern enterprises since they are highly reusable due to the separation of knowledge models (ontologies) from data sources. Many existing ontologies and taxonomies as well as ontology building tools are released and can be reused on an Open Source basis.

However semantic solutions are not easy to apply, most often they require individual development project to address the specific needs of the company. A significant factor for the success of Semantic Web applications is cost reduction (expressed in units of time and money) of many business operations, where searching for information and reporting are of key importance.

As the number of ontologies and semantically structured data sources increase the new opportunities to build applications are endless. It is most likely that the global impact of Web 3.0 on business and society will be far more disruptive than in case of Web 1.0.

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APLIKACJE WEB 3.0 JAKO ELEMENT STRATEGII PRZEDSIĘBIORSTW

Streszczenie: Trend Web 3.0 jest ostatnio tematem często podejmowanym zarówno przez naukowców, badaczy, jak i w kręgach biznesu. Technologie semantycznej sieci Web umożliwiają integrację wiedzy z różnych dyscyplin i źródeł w celu budowania unikalnych rozwiązań. Obecnie aplikacje semantyczne nie są tak popularne jak inne typy systemów informatycznych przedsiębiorstw, zatem istnieje możliwość ich wykorzystania do uzyskania przewagi konkurencyjnej przez pionierów ich zastosowań. Mogą one

przyczynić się do wyróżnienia oferty przedsiębiorstwa w oczach klientów oraz usprawnienia wewnętrznych procesów biznesowych. Artykuł prezentuje krótką charakterystykę aplikacji semantycznej sieci Web i podkreśla ich strategiczny potencjał. Aby zilustrować zastosowanie rozwiązań semantycznych, zaprezentowano dwa ich przykłady: w przemyśle farmaceutycznym oraz handlu elektronicznym.

Słowa kluczowe: Semantyczna sieć Web, Web 3.0, aplikacje semantycznej sieci Web, strategia, przewaga konkurencyjna.