Semantic databases: a smart perspective for today innovation in e-business

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The purpose of this article is to demonstrate that the e-business domain needs from today, have helped in the apparition of a semantic database, which is more reliable for business purpose. It is already a fact that we live in a digital era where society needs a more usable and accessible web environment. Looking back, we can see that the emergence of the World Wide Web in 1989 had a constructive effect on society. As the world is on a continuous change and the volume of data which became available on-line is increasing over time, there has been a need to introduce semantic technologies, which will make the web domain more efficient. The Internet aspect and semantic technology have helped to publish online all the information contained by an e-business, making it accessible from all over the world without limitation barriers.

1 Introduction

If we look in the past, we can see that the emergence of the World Wide Web has had a constructive effect on our society. Numerous facilities, activities, which until recently were considered traditional, are now available in the web with the help of the current semantic technology. Today, we can automate and facilitate the exchange of information between people without much effort.

Before the appearance of semantic technologies or even the World Wide Web, the e-business concept was already a part of our lives. Everyone was making business as a part of everyday leaving, but in the traditional way.

The appearance of the internet and semantic technology, helped in publishing online all the information an e-business have and make it accessible from all over the world, breaking the limitation barrier.

We can easily see that the semantic web is like an addition to today's World Wide Web and helps people to distribute content without any boundaries from websites or applications. From all the numerously mentions of semantic web we can highlight the following descriptions: 'the Semantic Web is an extension of the existing World Wide Web. It provides a standardized way of expressing the relationships between web pages, to allow machines to understand the meaning of hyperlinked information.'[1]

The semantic web was the one which initiate the creation of semantic technologies, along with all its languages and the related applications. In our days, the idea of semantic technology has greatly spread, being successfully adopted, both nationally and globally.

Along with all mentioned semantic qualities, we must find a way to sustain the relation between information in a business. The constant growth of web environment demands a necessity for new services and used methods that satisfy the user modern needs.

2 The components of semantic technologies

The semantic technologies are based on more than 10 years of researches and are like an extension for web service, along with all its improvements. With the help of semantic technologies, the static web is

evolving to a much friendly user perspective.

The word 'semantics', derived from Greek, is the meaning and signification of some notions. The field of semantics is very complex and abstract, linking knowledge and implementation. Thus, when it comes to semantic technologies, we refer to a suite of languages, accumulated in a single work area that facilitates the integration of business in the web.

The first mention of semantic technologies was in 2001, in an article by Tim Berners-Lee, who stated that 'semantically the web is not a separate web, but an extension of the current one, where the information is well defined and allows for better cooperation between people and computers. '[2]

As far as we know, semantic technologies offer us 'a new approach to managing information and processes, the fundamental principle of which is the creation and use of semantic meta-data'. [3]

What we should know about semantic technologies is that they simplify the relations and the communication between the programs. The semantic technologies help in connecting all the data, has a better integration in the systems, the implementation is much easier and understandable.

According to an article [4] from Economic Informatics magazine, no. 3 (35)/ 2005, written by Sabin Corneliu Buraga, the 'architecture of semantic web is a functional one, because the constitution of the specification is based on its incremental some languages, starting from the lower level (ie the metadata) and reaching higher levels (eg, logic level).'

From the following figure we can see that the most useful and important semantic technologies in the web environment are eXtensible Markup Language (XML) and Resource Description Framework (RDF), but also there can be mentioned the

followings: SPARQL(Simple Protocol and RDF Query Language), OWL (Web Ontology Language), RDFa (Resource Description Framework attributes), JSON-LD (JavaScript Object Notation for Linked Data), SKOS (Simple Knowledge Organization Syatem), RDFS (Resource Description Framework), GRDDL (Gleaning Resource Descriptions from Dialects of Languages), HTML (Hyper Text Markup Language), CSS (Cascading Style Sheets), HTTP (Hypertext Transfer Protocol).[5]
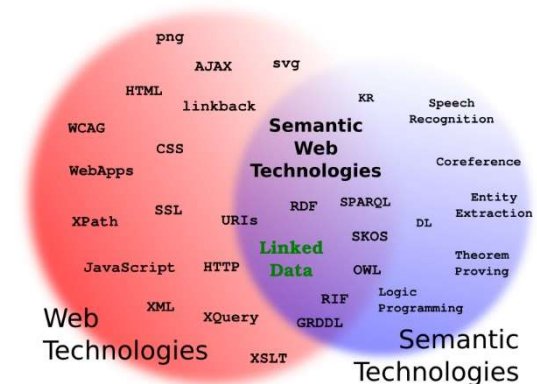

Figure 1. The components of semantic technologies[5]

All of the mentioned languages are a part of semantic technologies and which facilitates the relationship between data and sharing across applications.

The architecture of the web is based on combination of those and the main facility is that the content of a page is easily updated or changed without the necessity of changing the main schema.

They have the role to improve existing web, not by making a change, but by keeping the initial content and adding useful information in the web structure.

With the use of semantic technology, the old way of organizing information and important data is simpler. The web environment has evolved from static way of listing information, to a more interactive and user-friendly way. Also, according to Tim Berners Lee, 'the web was designed as an information space, with the goal that it should be useful not only for human-human

communication, but also that machines would be able to participate and help.'[6] We cannot mention the technologies used by the semantic web without reference to the pyramid created in 2000 by Tim Berners-Lee.
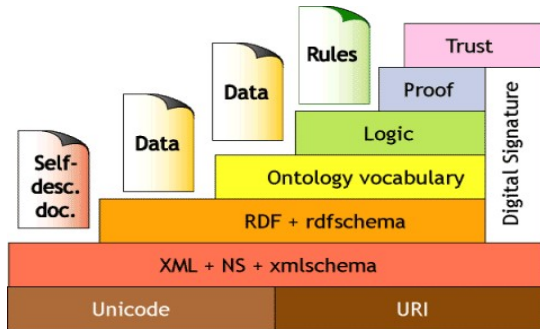

Figure 2. The pyramid of semantic technologies [7]

It details the protocols and challenges behind the emergence of the semantic web, as we can see in the following figure.

At the syntactic level, XML (eXtensible Markup Language) is used. It allows structured web content, accessibility to information is easier due to the way data is stored. XML is very widespread in the web domain and is often used to transfer data over the web.

The simplest example of using XML is the presence on the web of a service provider who offers their services through the internet and wants to be contacted by potential customers.

The next element in the pyramid is the Resource Description Framework (RDF), which appeared in the continuation of XML, to represent metadata in the World Wide Web. Data from the semantic web uses RDF to store the data of a web page modification, content and author details.

RDF, used together with XML, has the role of improving the existing web, not by modifying it, but by adding useful information to the structure of the already existing web, being some of the most used semantic technologies.
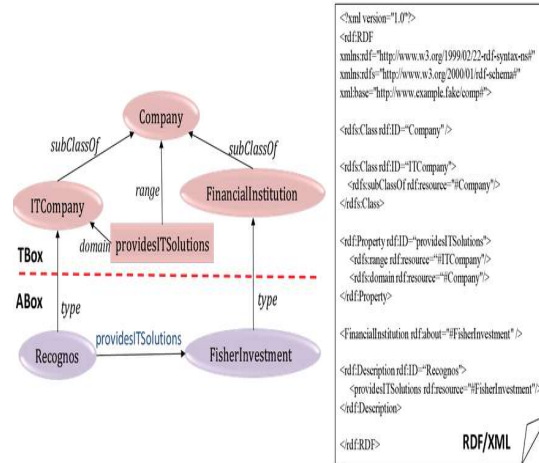

Figura 3. RDF syntax example [8]

The other languages listed: OWL, RDFa, RDFS, etc., are specially designed to help develop complex and rich information sites as well as the relationships between data.

The components of the listed semantic technologies are used to implement and design applications that serve an e-business.

In the article 'Considerations on the Use of Semantic Web Technologies in the Context of e-Business Applications' [4] written by Dr. Sabin-Corneliu Buraga, he defines the use of semantic technology components in application development and data processing of an e-business.

He classifies the use of used language on levels, all from metadata and advancing to the logical level, offering numerous possibilities for the requirements of an application, as follows:

- metadata is based on the RDF language 'which provides the general framework for expressing simple semantic statements' [4];

- schemes, 'provides the possibility of specifying simple ontologies to define a hierarchical description of concepts and properties' [4];

- the logical level includes complex languages, which help to make ontologies for the semantic web.[4]

3 Semantic technologies: where are we now?

The demands of society have led to technological developments, which have helped create a more accessible and usable web environment. It is already a fact that we

live in a digital age where society needs a more usable and accessible web environment.

Today, there is a need to introduce semantic technologies in all the domains, starting from IT, banking, business, etc., which will make the web domain much more efficient. This will simplifie the relationship between existing software products.

Online users rely on the available offers found in a simple search on the internet for the products or services they want. Semantic technologies provide users with a search process based on product or service attributes that best fit their needs, providing relevant information in a timely manner. Selling online products is more efficient with the implementation of semantic technologies.

Tim Berners-Lee claimed that the semantic web is 'a new form of web content that is significant for computers and unleashes a revolution of new possibilities.'[10]

From the following table we can see that semantic technologies are based on more than ten years of research and evolution. The new web 3.0 is viewed as an extension for the current web service, along with all the improvements it assigns.

Table 1. Evolution of web

Used technology	Evolution of semantic technologies
1980-1989 - Windows and PC era - Some basic scripts and web technologies - FTP	- Beginning of computer era
1990-2000 - World Wide Web - Servers - SQL databases - HTML - HTTP	Web 1.0: - Read only web - Non-interactive - Limited web access - Focus on content - Networking
2000-2010 - PHP - JAVA - XML - FLASH - RDF - Media sharing - Social websites - Multimedia - Cloud computing	Web 2.0: - Read and write web - Social software - User interactive content - Sharing knowledge - Interactive sites - Focus on user needs
2010 – Today - Semantic databases - Semantic search - RDF/RDFS - OWL	Web 3.0: - 'Intelligent web' - Semantic technologies - Media technologies - Virtual reality - Big data - More dynamic - Information control - User oriented platforms

If we look closer in the evolution of web table, we can see that everything starting from the bases of web 1.0 and continuing with the evolution of the web 2.0 is evolving step by step. The current web 3.0 is viewed as an extension of the other two, with an impressive evolution and adaptability among businesses.

Web 3.0 attributes numerous improvements to the virtual environment by using semantic technologies, evolving in a more user-friendly way. From day to day, information available online increases as a number, which leads to many unstructured data and a large amount of information in web content.

3 Semantic databases management in e-business

The structured data, which we are already used to, will be much accessible with the used of relational databases. Using the semantics, the business information stored in a database can be used in many ways, besides simple search queries or storing information.

HyperText Markup Language (HTML) is used to build a website to ensure information creation and structuring. This language has been used since the emergence of the web domain, but it is static and provides only a way to present the information. It is very widespread, being used in most web pages due to browser compatibility and reduced integration complexity. 'Many sites are generated from structured data, which is often stored in databases. When this data is formatted into HTML, it becomes very difficult to recover the original structured data. Many applications, especially search engines, can benefit greatly from direct access to this structured data'[11]

One of the big challenge from our days is the need to share and manage the volume of data stored in an e-business. For this, the database should have a semantic approach and make use of SPARQL(Simple Protocol and RDF Query Language), OWL (Web Ontology Language), OIL (Ontology Inference Layer) and RDF (Resource Description Framework) atributes.

For recording data, the databases are using RDF, which has a graph-based model and for describing the relations attributes and creating a set of values, the OWL language is used.

Today the basic architecture for semantic web is easy to understand, as we can see from the following figure, 'the concepts of ontology and of rules are the basis of the data integration'.[12]
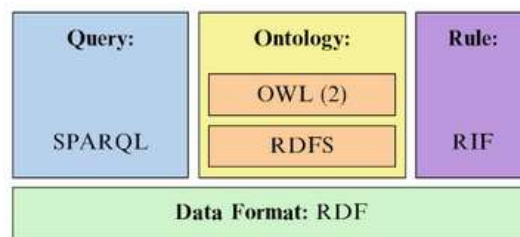
Figure 4. Basic semantic web architecture [12]

The difference between the usual databases and the semantic ones can be seen from the use of semantic query language SPARQL. According to [13], 'semantics is a data model that focuses on relationships, which adds contextual meaning around the data so it can be better understood, searched and shared. By using semantics, leading organizations are integrating their data faster and easier and building smarter applications with richer analytic capabilities.'[13]

To understand better the use of semantic databases in an e-business domain, I have created the following structure, which is an overview of all the important factors which are making use of semantics. The schema describes references and also the relationships between them. A database should always correlate values with the specific references.
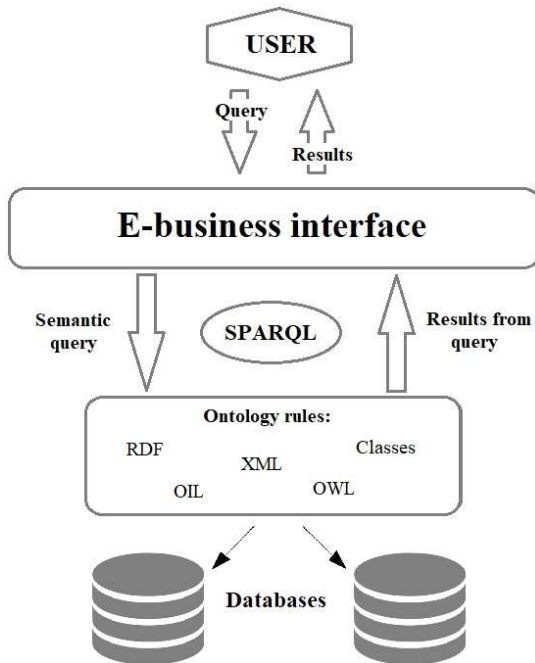
Fig 5. Semantic databases overview

A user will make a simple query, related to his needs, in the interface and expects relevant results. Between the e-business interface and the databases, there must be a SQL query, but as we use the semantic databases, we must use also a semantic search query language, which is SPARQL.

According to article Database-to-Ontology Mapping Generation for Semantic Interoperability, 'when an SPARQL query is received by a data provider service, it is translated to an SQL query using the mappings between the database and the local ontology. The SQL query is executed in the database and its result is encapsulated as an SPARQL response and returned to the query web service. The query web service then collects the responses returned from data provider services and recomposes them in one coherent response which will be sent to the visualization web service.'[14]

If a database is based on semantic relational data and is making use of ontologies, this kind of query can extract more information from a database, than the one based only on simple SQL language.

Also, 'when a query is submitted to the system, it is analyzed by this service and decomposed into a set of modular queries s. Then using the mapping directory in the knowledge base, the query web service redirects the single queries to the suitable data provider services.'[14]

The old way of organizing data and information becomes more advanced with the use of semantic technologies

We can say that 'by exposing the semantics of the data, machines can then utilize the information in more interesting ways than just storing it or displaying it.' [11]

4 The advantages of using semantic databases

Is well known that semantic database technologies deliver a lot of benefits, that businesses of all types should be making use of.

At high level, semantic databases offer five main benefits[15]:
- they work with your existing relational databases;
- they align with Web technologies;
- their underlying technology speeds integration of multiple databases;
- they're based on data structures that are flexible by design;
- they can help enterprises big data challenges.

A business model is constantly changing due to the dynamic environment of the business market. When the market changes and the business model has to adapt to maintain the viability of the company and, of course, the level of profit.

Using semantic technologies in existing business models, customers can access the information they need for products or services more quickly, purchase products, pay online, etc.

By integrating semantic databases into the chosen business model, companies can have a broader view of the products or services they offer.

'By preserving semantic structure, we can query the database at different levels of semantic meaning, from very specific to

very general. When we query the database, we don't just get back a list of records – we get back fully "rehydrated" semantic types'. [11]

5 Example of business which are making use of semantic technologies

Semantic technologies are scalable, leading to application in all areas of an e-business. Analyzing the current state of use of semantic technologies in e-business, one can notice that large software companies such as IBM, Oracle, Microsoft have already begun to introduce semantic technology into their platforms.

The article 'Advanced Technologies in e-Tourism' [16] highlights the application of semantic technologies in e-tourism. This branch of e-business is the ideal environment for application of semantic technologies, due to the dynamic information that must be contained: maps, tourist routes, accommodation and transport information, etc.

By integrating web technologies, a better search of information, better promotion of tourist packages and services is made. Typically, tourists search for vast information without a well-defined context, so semantic technologies filter information as useful as possible, providing relevant information. The application of semantic technologies in e-tourism is constantly developing due to the diverse level of information.

Another model of use of semantic technologies would be in the field of e-learning. The way of learning has evolved considerably, anyone can access the data needed to learn from anywhere and from any mobile device. In the article 'Evolution of eLearning based on web 3.0 and semantic technologies' [17], it is emphasized that the semantic web revolutionized the learning environment, access to education being quick and diversified, depending on the needs of users. The e-learning field has evolved with the help of semantic technologies

from the static to interactive stage, now including various services, such as downloading course documents, uploading projects, interactive tutorials, evaluating online knowledge, etc.

Another example of using semantic technologies is the supercomputer created by IBM, called Watson, 'combining artificial intelligence and sophisticated analysis software for optimal performance as a machine for answering questions.' [18]
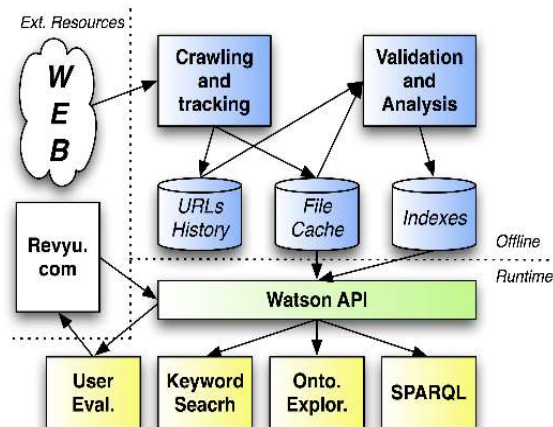

Figure 6 – Watson architecture[18]

With the help of semantic technologies, in combination with today's large data volume, Watson has access to an impressive amount of information and develops methods to 'structure search based on ontological relationships.' [18]

There are lots of systems that use semantic technologies as a way of searching, but the Watson concept is different. We can say that, 'Watson is the only tool that provides the required level of service, for applications to dynamically exploit web semantic data.' [19]

The Watson architecture helps to gather semantic content available on the web, analyze it in detail, and find ways to easily access the data found.

A more recent integration of semantic technologies would be in cloud computing, according to the article 'Semantic Technologies for Enterprise Cloud Managemen' [20]. The cloud service appeared with Web 3.0 and is the way that the storage space has moved into the web. It

works like an internet computer and provides the ability to access information stored anytime and anywhere. Large software companies have entered the business market with data storage capabilities on virtual servers.

6 Conclusions

In my opinion, the e-business domain is about the strategy of a business and the improving the efficiency with the use of semantic technologies. Implementing, adding or changing something in e-business is easy with semantic technologies. All the e-business components combined with a web interface, results a very strong and sustainable company, improving the hole business process.

The semantic technologies can shape the virtual space and make it more affordable and reachable for e -business domain. The world is evolving along with the semantic technologies and the e-business domain gets all the advantages and benefits from implementing all the technology in the needed tools.

The semantic technologies offer better interoperability of information and better integration, once it is used in e-business domain.

The internet aspect and semantic technology have helped to publish online all the information of an e-business, making it accessible from all over the world without limitation barriers.

More and more companies adopt global semantic technology, to capitalize on the opportunities it offers. At the local level, e-business offers small business development opportunities and semantic technologies are being implemented.

The importance of this article is amplified by the use of semantic technologies in the databases used in an e-business.

Thanks to semantic technologies, we can see that the e-business field takes full advantage of all the advantages offered by the web.

Once a business is online, it is much easier to promote its interests and brings a wealth of benefits to the company.

Semantic databases are successfully adopted and represent an important part of business models, participating sustainably in their development and integration.

By using the databases described above, we obtain an appropriate basis for tools that enable understanding, sharing and communicating, changing, measuring, and simulating business models.

References

[1] *Semantic web*. Available at: http://semanticweb.org/wiki/Main_Page.html.

[2] Cody Benson, *Introduction to the Semantic Web Vision and Technologies*. Available at: http://www.semanticfocus.com/blog/entry/title/introduction-to-the-semantic-web-vision-and-technologies-part-1-overview/, 2007.

[3] John Davies, Rudi Studer, Paul Warren, *Semantic Web Technologies: Trends and Research in Ontology-based Systems*. Accesible at: https://books.google.co.uk/books?hl=ro&lr=&id=ePCrymWkcl0C&oi=fnd&pg=PR1&dq=semantic+web+technologies&ots=wvs6oA054W&sig=-ebY7DPZcS3URb9JePmrOE0jTc0&redir_esc=y#v=onepage&q=semantic%20web%20technologies&f=false; 2006.

[4] Sabin-Corneliu BURAGA, *Considerations Regarding the Use of Semantic Web Technologies in the Context of E-business Applications*. Article published in articol publicat in Economic Informatics Magazine, nr. 3(35)/2005.

[5] *Want a semantic web/ linked data job?* Available at: http://afterglowlee.blogspot.co.uk/2011/07/want-semantic-web-linked-data-job.html

[6] Greg Ross, *An Introduction to Team Berners-Lee's Semantic Web*. Available at: http://www.techrepublic.com/article/an-

introduction-to-tim-berners-lees-semantic-web/, 2005

[7] *From Data Federation Pyramid to the Semantic Web 'Birthday Cake'.* Available at: http://www.mkbergman.com/231/from-data-federation-pyramid-to-the-semantic-web-birthday-cake/

[8] Alina Dia Miron, *Semantic web scurta introducere.* Available at: http://www.todaysoftmag.ro/article/82/semantic-web-scurta-introducere

[9] Tim Berners-Lee, *The Semantic Web - A new form of Web content that is meaningful to computers will unleash a revolution of new possibilities.* Article published in Scientific American, May 2001

[10] Mark Clifton, *Semantic Database: Concept, Architecture and Implementation,* Available at: https://www.codeproject.com/Articles/832959/Semantic-Database-Concept-Architecture-and-Impleme, 24 October 2014

[11] Sven Groppe, *Data Management and Query Processing in Semantic Web Databases,* Available at: https://books.google.co.uk/books?hl=en&lr=&id=HdVZ2MhzP_4C&oi=fnd&pg=PR3&dq=semantic+databases&ots=KXmqlEMtun&sig=wFex7oniKC98qMvKC248wJwjgBM#v=onepage&q=semantic%20databases&f=false, 2011

[12] *Gain context for your data with semantics.* Available at: https://info.marklogic.com/semantics

[13] Raji Ghawi, Nadine Cullot, *Database-to-Ontology Mapping Generation for Semantic Interoperability.* Available at: file:///C:/backup/virtual/de%20pe%20desktop/docs/InterDB07-Ghawi.pdf, September 23-28, 2007

[14] *Semantic Databases: Destiny Or Distraction?* Available at: https://www.informationweek.com/database/semantic-databases-destiny-or-distraction/d/d-id/1107587, 29 November 2012

[15] Pavel Cech, Vladimír Bureš, *Advanced Technologies in e-Tourism.* Available at: http://www.wseas.us/e-library/conferences/2009/genova/ACS/ACS-12.pdf

[16] Fayed Ghaleb1, Sameh Daoud1, Ahmad Hasna2, Jihad M. ALJa'am2, Samir A. El-Seoud3 si Hosam El-Sofany. *E-Learning Model Based On Semantic Web Technology.* 15 May 2006

[17] *IBM Watson supercomputer.* Available at: http://whatis.techtarget.com/definition/IBM-Watson-supercomputer

[18] Jérôme Euzenat, INRIA Grenoble Rhône-Alpes. *Watson, more than a Semantic Web search engine.* Available at: http://www.semantic-web-journal.net/sites/default/files/swj96_1.pdf

[19] Peter Haase, Tobias MathaB, Michael Schmidt, Andreas Eberhart, Ulrich Walther. *Semantic Technologies for Enterprise Cloud Management.* Available at: http://www2.informatik.uni-freiburg.de/~mschmidt/docs/iswc10.pdf

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