Preface

INTRODUCTION

The Semantic Web is what the World Wide Web was initially intended to be by its inventor, Tim Berners-Lee:

*The first step is putting data on the Web in a form that machines can naturally understand, or converting it to that form. This creates what I call a Semantic Web, a Web of data that can be processed directly or indirectly by machines.* (Berners-Lee, 2000)

However, due to the Web deployment challenges, this very ambitious vision was simplified in order to facilitate its take-off. Then, why this vision is being retaken now? And why is this important for e-business?

The Semantic Web is not just for the World Wide Web. It represents a set of technologies that work equally well on internal corporate intranets because it tries to solve several key problems in current information technology architectures.

In the context of e-business, the key contribution of the Semantic Web is integration. The Internet and the World Wide Web have made it possible to interconnect information systems worldwide. The result is a global market where enterprises have the potential of carrying out business with any partner by electronic means.

However, exploiting this potential is difficult due to the communication barriers among information systems, e.g. different operating systems, legacy systems, proprietary information schemes, etc. The key to break these barriers is integration. A lot of effort has been invested to achieve it and two initiatives can be highlighted due to their tight relation to the Web and their impact in the e-business world: XML and Web Services.

The former provides a common data model and the latter the global channel through which systems can communicate. Both constitute a good foundation for systems integration but something more is needed if we want to scale it to a worldwide framework. Each system has its own history, development team, etc., which make they lay on different conceptual models that impede a meaningful communication among them, though they might all be based on XML and Web Services. In other words, there is a common syntax but disparate semantics, i.e. meanings, and computers do not have the means to manage them.

Manual intervention might lower the semantic barrier. In any case, it is not sustainable if developers are forced to analyse each potential conversation and develop a particular adapter that makes it understandable. There are also standardisation efforts that establish common frameworks that facilitate communication in concrete domains. However, they have proliferated so much and are based on the same syntactic-level interoperability principles that, in most cases, they have just moved the barriers slightly down.
The Semantic Web focuses on interoperability at the conceptual level. It provides the building blocks that facilitate establishing connections among the meanings of the things managed by computers. These connections tell computers simple facts such as that two pieces of data refer to the same thing or, more complex ones like that everything of one kind is accompanied by something of another kind so, when something of the first kind is seen, it can be assumed that the accompanying thing is from the second kind.

Computers are not able to deduce these connections on their own; it is still necessary that we teach them the roots from which they can start integrating data automatically. However, although this implies a great initial effort, it scales to Web wide environments. In fact, as more and more connections among concepts are added, computers have more paths to follow as they try to realise if two pieces of data match or the kind of product an invoice is referring to.

The research community has placed great efforts in the Semantic Web initiative and we are starting now to see its practical benefits in many domains, especially in one with great impact that is e-business. The main opportunities are anticipated in information systems interoperation and range from inter to intra-organizational links. The question is then if the Semantic Web will help the takeoff of a webbed economy where, in spontaneous inter-organizational relations, the involved parties share data and integrate their internal business processes in a transparent and trustful way.

Mill Davis strongly supports this idea in his Semantic Wave report (Davis, 2007). He anticipates that semantic technologies are going to carry multi-billion dollar opportunities in the next decade. For instance, it is foreseen a 50 billion dollars market of information and communication semantic technologies. It also estimates that the R&D investment in semantic technologies will reach more than 2 billion dollars per year by the end of the decade.

The objective of this book is also to provide more evidences about the Semantic Web takeoff in e-business, but from an innovative point of view compared to existing related books. The approach is to present a compendium of business cases that show the application of Semantic Web technologies in e-business problems. Business cases allow considering not only technological issues, as it is common in other Semantic Web and e-business books (Salam, & Stevens, 2007). Other issues that are relevant from the business point of view are also covered, such as strengths, weaknesses, opportunities and threats analysis (SWOT).

The aim of this combination of technological and business perspectives is to make the book also appealing to IT managers and decision makers that. Apart from technological and methodological issues, the book also sketches costs and benefits analysis showing that the Semantic Web is prepared to do business. Consequently, in addition to Semantic Web researchers and developers, the intended audience of the book is also IT professionals, IT researchers, business executives, consultants and students (undergraduate, graduate, PhD and MBA).

Thanks to this cross-discipline approach, the hope is that this book will encourage and facilitate the transfer of technologies and methodologies from the Semantic Web to the e-business world. The next section provides a small introduction to Semantic Web technologies together with some pointers for further reading. Then, Section presents the business case structure followed by each case description chapter and Section details the contents of the book with a small summary for each chapter. Finally, there is a conclusions section that ends this preface.

**SEMANTIC WEB TECHNOLOGIES OVERVIEW**

The Semantic Web is rooted on a data model, a way to represent data, geared towards interoperability. It is based on a directed graph, i.e. a set of nodes connected by edges with a direction, from node A to
node B. This graph model constitutes the first building block for semantic interoperability because a
graph can be used to represent many other kinds of data structures.

For instance, it is easy to model a tree using a graph -it is just a graph without cycles- or a table -each
row is represented by a node that is connected to the different row values by edges labelled after each
column name. This makes it easier to integrate data coming from XML documents or relational data-
bases into the Semantic Web. Moreover, it easier to mash-up data from disparate sources into a graph
because the result is always a graph.

The Semantic Web graph model is named RDF, Resource Description Framework (Tauberner, 2008).
However, this is not enough. We can put it all into a graph but, how do we tell the computer that one part
of the graph can be joined to another part because they refer to the same thing? And, what is even more
important, how do we put restrictions on how the graph is built in order to make it model interesting
things and avoid that it becomes a messy bunch of nodes?

It is possible to accomplish these features using schemas and ontologies. First of all, they guide graph
construction by providing restrictions on how nodes are connected to other nodes using different kinds
of edges, called properties. For instance, it is possible to say that a node represents a person and that it
is related through properties called “name”, “e-mail” or “friend” to nodes providing the corresponding
values for them.

RDF Schema is the simplest tool that allows modelling these restrictions (Daconta, Obrst, & Smith,
2003). It provides primitives similar to those from object oriented programming so it is possible to de-
fine classes with defined sets of properties and appropriate values. Classes are then used to categorise
the things represented by nodes, called the resources, in order to apply the corresponding restrictions
to them.

For instance, there is a class “Person”, associated to the relevant properties for persons, which is
applied to a node representing a given person. From this point, it is possible to guide how that person is
described by the graph and, more importantly, the computer can interpret a description for that resource
following the guidelines provided by the “Person” class.

Ontologies also provide ways to restrict how the graph is modelled, and how it should be interpreted
by the computer (Fensel, 2004). They are a more sophisticated way to do so and are based on logic
formalisms. This makes it possible to use logic reasoners in order to deduce new things about the data
being managed. These kinds of deductions are a key feature in order to enable scalable data integration
by computerised means. Computers use the clues and rules captured by ontologies in order to make
sophisticated data integration at the semantic level, such as realising that two pieces of data match to-
gether or the kind of product that an invoice is referring to, e.g. from what the ontology says about the
invoice, the customer, etc.

The Web Ontology Language (OWL) is used in order to define Semantic Web ontologies (Lacy, 2005).
There are three sublanguages with different levels of complexity, which require increasing computation
power but provide more expressive ways to pose restrictions. The simpler is OWL Lite and the more
complex and expressive OWL Full. In the middle there is OWL DL, which is based on Description Log-
iccs (Baader, Calvanese, McGuinness, Nardi, & Patel-Schneider, 2003) and provides a trade-off between
complexity and expressiveness.

The technologies previously described provide the means for semantic interoperability at the data
level. Additionally, interoperability is also required at the operational level and, nowadays, Web services
are the common approach to solve this issue. However, the foreseen Web of services where applications
can be built from the combination of services published all over the world in an almost automatic way
has not yet come true.

The barrier continues to be the difficulties to integrate the disparate data models that services proc-
ess and the different ways to describe their functionality. It might be the case that two services that can
be used interchangeably, but the different terms used to describe what they do make it impossible for the computer to realise that one can be used in place of the other. The Semantic Web approach for this problem is also to use semantic descriptions of the services, called Semantic Web Services (Cardoso, 2007).

There are some approaches (Yu, 2007) to Web services description that allow to say what they do, how they do it, what kind of data they get as input and what is the output, etc. The simpler way is to put semantic annotations into the Web Service Description Language (WSDL). This proposal is called semantic annotation for WSDL (SAWSDL). There are also two Web Services Ontologies that provide richer ways to describe them, an OWL-based Web Service Ontology (OWL-S) and the Web Service Modelling Ontology (WSMO).

All these technologies are put into practice in the different Semantic Web in e-business application scenarios included in this book. The reader can follow the references provided in this section in order to get deeper into Semantic Web technologies. Each chapter also provides relevant references and additional readings that help getting into the details.

**THE BUSINESS CASE STRUCTURE**

In order to make the book more practical and appealing for IT decision makers, chapters follow a business case structure. The idea is to make it easier to read for the managers that would at last decide to put Semantic Web technologies into practice in enterprises. Many information systems managers are used to business cases and they are a common teaching resource in management masters (e.g. MBA).

The objective is to make more people aware of the benefits that Semantic Web technologies can carry to e-business information systems, focusing on the people that would have the last word in this process. There is still room in the case for the technical details, but it is also important to highlight the opportunity or problem and to make the benefits of the proposed solution clear and justifiable from a costs and benefits point of view.

This approach pretends also to make chapter more practical and less theoretic. Each business case presents a current e-business situation where Semantic Web technologies are being applied producing some benefits and opportunities that justify the cost.

Some question business cases should answer are:

- Why the project is needed? Existing issues and opportunities.
- How will the effort solve the issues or opportunities facing the organisation?
- What is the recommended solution(s)?
- How does the solution address the issues or opportunities (benefits)?
- What are the risks if the issues or opportunities are not faced?
- Qualitatively, how much will all this cost? Is it worth compared to the benefits?

The proposed business case is shown in Table 1. Authors have used it as the starting point for organizing their chapters, though authors have adapted it to their particular needs.

A part from the abstract, chapters begin with a description of the current situation. The scenario is described paying special attention to how the things were before Semantic Web methodologies and technologies are applied. Then, from the previous situation description, the current problem is highlighted. This statement should make it clear that there are issues that are limiting how e-business is conducted and that there is an opportunity for the Semantic Web.
Once the opportunity has been signaled, there is the description of the proposed solution. First of all, the objectives of the proposed solution are stated and an overview of the solution is given. Then, we get into details and the technicalities of the proposed solution are presented, i.e. approach, architecture, components, implementation, etc.

Then there are the alternatives. This is a related work section that introduces some alternative solutions, either based on the Semantic Web or not. In other words, this section shows the competitors of the proposed solution.

Next, the costs and benefits are analyzed. The idea is to provide an overview of the costs associated to the solution. There is no need to enter into detailed economic costs, just some sketches of the implications associated to development costs, additional infrastructure requirements, etc. compared to the current situation. The objective is to make clear that the proposed solution has benefits that surpass the costs, but from a qualitative perspective, i.e. operational savings, improved customer and employee satisfaction, etc.

Another section also related to business aspect is risk assessment. The aim of this section is to document the critical assumptions that have been made in order to develop the solution, e.g. technical assumptions about scalability or future evolution of Semantic Web technologies. This section also includes a discussion of the proposed solution strengths, weaknesses, opportunities and threats (SWOT). Finally, the risks associated with implementing and not implementing the solution are presented.

The chapter ends with the future trends and the conclusions. Trends provide insight about the future of Semantic Web and e-business from the perspective of the business case topic. The closing conclusions reiterate the key issues that caused the solution to be proposed and restate the solution at a high-level. The overall benefits of the solution are also reminded, together with the main risks of doing nothing and
continuing with a Semantic Web agnostic situation. Finally, the authors highlight the conclusions the reader should draw from the business case and the proponents’ recommendations for next steps.

**SEMANTIC WEB E-BUSINESS CASES**

Now, it is time for an overview of the book structure. All chapters but the first one present different Semantic Web and e-business application scenarios. The first chapter presents an overview of the penetration of Semantic Web technology in industry. The authors report on the ongoing work in the cross-fertilization between industry and academia. In particular, they present a collection of application fields and use cases from European enterprises which are interested in the promises of Semantic Web technology. The chapter ends with the presentation of the current state of the technology and future trends as seen by prominent actors in the field.

Chapter II presents the European MYCAREVENT research project, which brought together European vehicle manufacturers, vehicle repair organisations, diagnostic tool manufacturers and IT specialists, including Semantic Web technologists, to study how to link together the wide range of information sets they use to identify faults and repair vehicles. Information is integrated and accessed through a service portal by using a ‘shared language’ for the project, a reference terminology to which the disparate terminologies of organisations participating in the project can be mapped. This shared vocabulary is materialised as a Semantic Web ontology.

The next chapter describes an approach to support operational support systems (OSS) integration across organisation boundaries. The requirement for such business-to-business (B2B) interfaces is expected to increase as is the need to carry out integration in much more flexible way. Existing approaches for integration tend to be implementation specific, operate at the syntactic level and are realised by programme code. Consequently they are inflexible due to their highly coupled nature and are costly to setup and maintain. An approach to decouple B2B interfaces is introduced, which allows them to be flexibly coupled as required with the use of scalable, semantic mediation.

Chapter IV deals with one of the most difficult problems dealing with applications interoperation, protocol mediation. This kind of mediation is concerned with non-matching message interchange patterns in applications interaction. The proposed solution focuses on solving the interoperation issues between two heterogeneous logistic provider systems, which use two different standard protocols: RosettaNet and EDIFACT. It includes an ontology for interaction choreography description and the software that implements the bridging mechanisms between these two protocols based on the knowledge captured by the ontology.

In the next chapter, authors report their practical experiences in building an ontology-based e-Recruitment system. This case study confirms previous findings in ontology engineering literature. First, to build ontology-based systems is still a tedious process due to the lack of proved and tested methods and tools supporting the entire life cycle of an ontology. And second, to reuse existing ontologies within new application contexts is currently related to efforts potentially comparable to the costs of a new implementation. These findings are used to further elaborate existing best practices towards a list of recommendations for the e-Recruitment domain.

Chapter VI also presents a European Research project, SEEMP. This project promotes increased partnership between labour market actors and the development of closer relations between private and public Employment Services. The need for a flexible collaboration gives rise to the issue of interoperability in both data exchange and share of services. SEEMP proposes a solution that relies on semantic services based collaboration among public and private Employment Services. Each actor in the marketplace has
to care only about integrating with the marketplace and the Reference Ontology. The marketplace will offer services to support the interaction with other actors.

Chapter VII presents an ontology for customer complaint management, which has been developed in the EU funded project CCFORM, with the aim of establishing a European customer complaint portal. The objective is that any consumer can register a complaint against any party about any problem, at this portal. The portal should be multilanguage and sensitive to cross-border business regulations. A customer complaint ontology, which underpins the CC portal, makes all these features possible. The CContology comprises classifications of complaint problems, complaint resolutions, complaining parties, complaint-recipients, “best-practices”, rules of complaint, etc.

In the following chapter, authors face the problem of the growth of e-commerce using software agents to support both customers and suppliers in buying and selling goods and services. The diversity of the actors involved leads to different conceptualizations of the needs and capabilities, giving rise to semantic incompatibilities between them. Authors propose an ontology-based information integration approach, exploiting the ontology mapping paradigm, by aligning consumer needs and the market capacities, in a semi-automatic mode and based on Semantic Web technology. The approach is improved by the application and exploitation of the information and trust relationships captured by the social networks.

Chapter IX studies the case of media convergence in newspaper media houses, which are evolving to highly dynamic and multi-channel communication mediums, where the different channels converge into a unified news editorial office. In order to cope with the new requirements arising from this change, machines must be aware of a greater part of the underlying semantics. Ontologies are a clear candidate to put this semantics into play, and Semantic Web technologies a good choice for Web-wide information integration. However, newspapers have made great investments in their current systems so a smooth transition is preferred. The chapter proposal is to build an ontological framework based on existing journalism and multimedia standards and to translate existing metadata to the Semantic Web.

The next chapter describes the OERN ontological extension to RosettaNet and shows how this extension can be used in business integrations to resolve data heterogeneities. RosettaNet is an industry-driven e-business process standard that defines common inter-company public processes and their associated business documents. The usage of Web ontology languages in RosettaNet collaborations can help accommodate partner heterogeneity in their set-up phase and can ease back-end integrations, enabling for example more competition in the purchasing processes.

The authors of the following chapter present the development of a formal representation, based on an OWL Semantic Web ontology for the Resource Event Agent (REA), which is a business ontology for ontology-driven enterprise system development. The objective is to overcome the limitation of the current specification, which is neither sufficiently explicit nor formal, and thus difficult to use in ontology-driven business information systems. The chapter discusses the choices made in redesigning REA and illustrates how this new formal representation can be used to support ontology-driven supply chain collaboration.

In Chapter XII, semantic extensions for Web services are presented as a mean to overcome business processes interoperability limitations due to purely syntactic approaches. Another drawback is that services cannot be discovered and composed dynamically by other semantic enabled systems slowing down the process of interaction between business partners. OWL-S is a suite of OWL ontologies and can be used to describe the compositions of Web services on the basis of matching semantics as well as to expose semantically enriched interfaces. The aim of this chapter is to describe an approach and its implementation that can be used to enable business processes for semantic based dynamic discovery, invocation and composition by translating BPEL process descriptions to the OWL-S suite of ontologies.

The authors of Chapter XIII analyse how telecommunications operators can improve their partnership networks and provide new services by solving the interoperability limitations of service-oriented
architectures (SOA). The idea is to use Web services technology to create service providers federations and ontologies to support advanced matchmaking mechanisms based on a semantic metadata store. In particular, the proposal includes a Service Registration Authority that controls and enforces annotation policies in order to avoid the lack of uniformity in service descriptions. Furthermore, this solution enables enhanced service/component discovery and validation, helping software engineers to build services by composing building blocks.

The case study presented in Chapter XIV is about how networked ontologies satisfy the needs of such a knowledge intensive sector as the pharmaceutical one. The use of semantics helps bridging the gap between the different representations that different stakeholders have. The problem arises when the ontologies used to model the domain become too large and unmanageable. Networked ontologies can solve these problems. The particular case scenario considered by this chapter is the nomenclature of products in the pharmaceutical sector, which is currently under development in the EC funded FP6 project NeOn in order to develop a common Reference Ontology about drugs.

The authors of the next chapter highlight one of the key problems that the software industry has been facing due to the lack of alignment between the curricula offered by Universities and other kinds of education and training centres and the professional profiles demanded by companies and organizations. The chapter proposal is to provide a set of mechanisms and an intermediary system that allows companies to define and express their competency gaps and, at the same time, allow education centres to analyse those gaps and define the training plans to meet those needs.

In Chapter XVI an e-Banking case is presented, concentrating on how to offer a public access to efficient transactional stock market functionalities. Traditional service oriented architectures (SOA) succeed at providing reasonable good Web-based brokerage solutions but may lack on extensibility possibilities. By introducing Semantic Web Services (SWS) as a way to integrate third party services from distributed service providers, authors propose an innovative way that combines ontologies and SWS in order to allow different users to define their own stock change strategies regardless of the provider of information.

The last chapter presents a large-scale data integration and transaction management system for media rights, called OntologyX. Previous versions of this system have utilized lightweight schema and conventional Semantic Web technologies such as OWL. The current version employs formal ontology development in the SUO-KIF logical language and involves reuse an extension of a large formal ontology, the suggested upper merged ontology (SUMO). In particular, authors argue that extending from a large ontology will give the model greater coverage of more domains and expand business opportunities to expand into supporting more kinds of transaction management applications.

CONCLUSION

To sum up, the book includes a nice overview of the Semantic Web in e-business and a compendium of comprehensive business cases that illustrate, from a practical point of view, how Semantic Web is growing inside organizations. The call for contributions had a great success among enterprises that are leading Semantic Web research and development, chapters have been contributed by authors from Articulate Software, ATOS Origin, Bankinter, British Telecom, CSW Informatics, Diari Segre, France Telecom, Intelligent Software Components, Le Forem and Motorola. There has been also a great participation of academic and research institutions, in some cases coauthoring with authors coming from the industry.

On the other hand, an unintended outcome is a clear bias towards the European Semantic Web scenario, though the call for contributions was distributed worldwide. The reason does not seem to be a
more evolved market of Semantic Web solutions in Europe, thought the European Framework Program for research funding is playing an important role in supporting many projects pioneering Semantic Web in e-business scenarios. In fact many of the business cases come from European Framework Program research projects.

On the contrary, the European bias seems to be due to the editor’s origin. This fact is also supported by the impressive participation of Spanish authors. At the end, it seems that we have not become as global as the World Wide Web and the Internet might make us think we are ;-) 

REFERENCES


Roberto Garcia, Editor