The Potential Business Impacts of Semantic Web for System Integration

by

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Submitted to the MIT Sloan School of Management
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Abstract

This thesis presents research about the potential business impacts of the Semantic Web. The concept of the Semantic Web is an expansion of the Web for computers, enabling them to comprehend the meaning of information. In addition, Semantic Web Services (SWS), the emerging convergence of Web Services with the Semantic Web, is the next major generation of the Web (and of the Internet), in which e-services and business communication become more knowledge-based and agent-based.

The study arose out of a technology review of the Semantic Web and its current adoption. Following further analysis and research into business cases involving Semantic Web applications, the author focused specifically on the system integration business in an effort to understand the potential business impacts of the Semantic Web for system integration. In the system integration field, there are various trends for companies thinking about adopting the Semantic Web into the real business world. In this thesis, I offer answers to two questions: Why do system integrators need the Semantic Web, and how they should go about adopting it?

Thesis Supervisor: Professor Michael A. Cusumano
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Akio Saita
Cambridge, MA
June 2004
Currently, when people use the Web, they give orders to computers where the required information exists. Then computers show only the information stored at the place. Computers do not understand the meaning of the information. People sometimes request computers to search for information, but computers can only search for text data by requested words, which also means computers do not examine the meaning of text data. In this situation, the Web is for people to read and to write various information.

The concept of a *Semantic Web* indicates an expansion of the Web whereby computers comprehend the meaning of information (Berners-Lee, 1999; Berners-Lee et al., 2001). Semantic Web Services (SWS), the emerging convergence of Web Services with the Semantic Web, is the next major generation of the Web (and of the Internet), in which e-services and business communication become more knowledge-based and agent-based ( Parsia, 2003). In both B2C and B2B business fields, there are several potential applications of the Semantic Web for companies.

In this thesis, I begin by researching the Semantic Web from the technological point of view in order to judge its feasibility and impact on current technologies. Then I answer the questions: “How will the Semantic Web affect current business?” I consider the impacts on e-business models and research several actual business applications of the Semantic Web in order to gain further understanding of current business opportunities that make use of the Semantic Web. Finally, I focus on the specific domain to examine the business impact and application of the Semantic Web.

I will also answer the question: “How should system integrators apply the Semantic Web to their business?” From a system integrator’s point of view, I regard the combination of Semantic Web and Web Services as an enabling tool that will enable further expansion of their business. Figure 1 shows the structure of this thesis.
Figure 1 Structure of the Thesis
Chapter 2  Technological Overview of the Semantic Web

This thesis focuses on the business applications of the Semantic Web. However, some basic explanation is helpful for understanding what the Semantic Web is and what kind of technologies it requires. This chapter introduces the Semantic Web.

In the following sections, I discuss the technological background of the Semantic Web, followed by an overall description of the Semantic Web and the current standardization process. Then I will explain the technological relationship between Web Services and the Semantic Web. Finally, I touch on the current situation surrounding the adoption of Semantic Web technology in the real world.

2.1 Background

According to Gartner Research, the size of the Web doubles every six months. As the Web grows, Web searches return a lot of unwanted information, and people spend more time searching for relevant information than they did in the past. In addition, those who are familiar with technology can obtain information more easily and utilize it effectively, but those who are not tech-savvy find it harder to obtain information. Some are apprehensive that this situation may make the so-called “digital divide” even greater. To solve these problems, Semantic Web technology is attracting considerable attention as the next-generation Web technology.

Since 1990, people have created the Web by using HTML (Hyper Text Markup Language), and in 1998, XML was defined and has become the standard data format used today.
2.2 Overview of the Semantic Web

In 1999, Tim Berners-Lee, inventor of the Web and Director of the World Wide Web Consortium (W3C), wrote: “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” (p.177).

On the Semantic Web, agents process information and solve various problems on behalf of users. Those who have various specialties, such as Internet, document processing, database, and artificial intelligence (AI) have engaged in research on the Semantic Web so that computers not only store documents written by humans but also understand their meanings and can restructure them.

The goal of the Semantic Web is to define a standard procedure for expressing the meaning of data, not to establish standard expressions that can apply to anything. Thereafter, everyone is able to build his/her own vocabulary based on the standardized procedures of the Semantic Web. However, such diversified vocabularies also have the possibility of hindering the expandability of the Semantic Web. Therefore link rules, such as “subClassOf” or “sameAs” are also defined as part of the network of data meaning, similar to URL links on the Web. Computers can process, infer the meaning of the data, and perform as an autonomous agent in the virtual world on our behalf. The enabling technology is regarded as the Semantic Web.

The Semantic Web is built on a series of layers, as shown in Figure 2, and these layers help us to understand how the Semantic Web is built technologically. The lowest and second-lowest layers, Unified Resources Identifier (URI), Unicode, XML, and Namespace, represent the existing technology layers, and they are already standardized and in common use. Semantic Web layers occupy the upper layers above the third-lowest layer, RDF M&S (Resource Description Framework Model & Syntax).
The basic concept underlying the Semantic Web is RDF metadata, which is expressed by the lowest of the Semantic Web layers, “RDF M&S.” RDF metadata represents the meanings of documents. Generally HTML documents are human-readable, but not machine-readable even if using natural language processing technology.

RDF must follow a strict format in order to be machine readable. The subject is described by a predicate and object. The RDF model can be illustrated by a node and directed-arc diagram, in which each triple is represented as a node-arc-node link. And resources in the triple must be identified by URI. For example, the subject in Figure 3 represents the following:

http://www.business.org/ontology/#Monkey
The layer above RDF M&S, "RDF Schema," defines the meaning of this RDF metadata. RDF Schema prescribes which kind of properties the nodes and predicate have and what type of value these properties have. Furthermore, it sets the class hierarchy among these properties. Preparing an RDF Schema before creating RDF metadata from HTML documents is commonly done.

The RDF Schema can be defined separately by different people, and then the metadata created by different people is likely to have no relation to each other. As a result, the RDF metadata is never understood by others. To solve this problem, the "Ontology" layer directly above RDF Schema defines the relation among the independently built RDF Schema. Since Ontology prescribes the linkage of properties and the transformation rule of values between one schema and another, RDF metadata in one site can be comparable to other RDF metadata in another site by applying the prescription to the transformation of metadata. This transformation avoids any controversy about pre-authorization of unified Schema. It allows us to build our own schema freely.

The layers above Ontology are "Rules" and "Logic Framework." These layers enable a computer agent to process a complicated task on our behalf. This complicated task is represented by using a logic formula instead of simple words. On the Semantic Web, people have to input their problem in written form using logical expressions to the agents, and then the agents solve the problem utilizing Ontology, RDF Schema, and RDF metadata. The results are presented by human-readable HTML documents, not RDF metadata.

Again, since it is difficult to pre-authorize unified logical expressions for processing all requests, the Rules layer defines some logical expressions as common infrastructure and the Logic
Framework layer allows us to define independent logical expressions according to each case. We can affirm each result by examining its proof based on the Rules layer.

The upper layer above Logic Framework is the “Proof” layer, which enables us to review results from agents by tracing back the way in which the agent processed the problem and the reason(s) why the agent arrived at the solution. If someone doubts the results provided by agent, he/she can examine the process through which the agent passed. If the process is acceptable, the result is also accepted. On the Semantic Web, this layer contributes to building a trust relationship between agent and agent or agent and human. Various commercial transactions are expected to be feasible because of this layer and the relationships it creates. I have summarized each layer’s role in the following Table 1.

### Table 1 Layers of the Semantic Web

<table>
<thead>
<tr>
<th>Layer</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trust</td>
<td>Based on context, proof, encryption, and digital signature, judging trusty of agent who return the result.</td>
</tr>
<tr>
<td>Proof</td>
<td>Presenting evidence to lead the result, such as process history and process reasoning of agents</td>
</tr>
<tr>
<td>Digital-Signature Encryption</td>
<td>Using description logics such as first order logic, expressing knowledge and enabling agent processing</td>
</tr>
<tr>
<td>Rule</td>
<td>Defining the logic as a common infrastructure which enable query and filtering</td>
</tr>
<tr>
<td>Ontology</td>
<td>Defining more precise vocabulary and realizing the deduction which enables association of multiple schemes and fusion of them</td>
</tr>
<tr>
<td>RDF Schema</td>
<td>Providing the procedure of the expression of data meaning</td>
</tr>
<tr>
<td>RDF M&amp;S</td>
<td>Representing metadata which is processed by machines</td>
</tr>
<tr>
<td>XML/Namespace</td>
<td>Providing the mechanism which defines distinction of easy processing description language (XML) and multiple vocabularies and enables them co-existing</td>
</tr>
<tr>
<td>URI/Uniqe</td>
<td>Identifying a resource globally and representing data universally, independent from implementation</td>
</tr>
</tbody>
</table>

Source: Author, 2004
2.3 Current Standardization Process

The standardization process of Semantic Web technology is advancing based on the stack shown in Figure 2 above. Among the layers, standardization of RDF M&S, RDF Schema, and Ontology has made progress. However, the layers above the Logic layer have not been well developed.

Standardization of the Semantic Web is defined by specifications provided by the W3C (Miller & Swick, 2003). Currently, W3C publicizes twelve specifications regarding the Semantic Web, as listed below.

1. RDF/XML Syntax Specification (Revised) — This document defines as XML syntax for RDF called RDF/XML in terms of Namespace in XML, the XML Information Set and XML Base.

2. RDF Vocabulary Description Language 1.0: RDF Schema — This specification describes how to use RDF to describe RDF vocabularies.

3. RDF Primer — This Premier is designed to provide the reader with the basic knowledge required to effectively use RDF as an introduction for beginners.

4. Resource Description Framework (RDF): Concepts and Abstract Syntax — This document defines an abstract syntax on which RDF is based, and which serves to link its concrete syntax to its formal semantics.

5. RDF Semantics — This is a specification of a precise semantics, and corresponding complete systems of inference rules, for the RDF and RDF Schema.

6. RDF Test Cases — This document describes the appropriate use of RDF by using good and bad examples.

7. Web Ontology Language (OWL) Use Cases and Requirements — This document specifies usage scenarios, goals and requirements for a web ontology language.

8. OWL Web Ontology Language Reference — This specification contains a structured informal description of the full set of OWL language constructs and is meant to serve as a reference for OWL users who want to construct OWL ontologies.

9. OWL Web Ontology Language Semantics and Abstract Syntax — This specification contains a high-level abstract syntax for both OWL DL and OWL Lite, sublanguages of OWL.

10. OWL Web Ontology Language Overview — This document is written for readers who want a first impression of the capabilities of OWL.
11. OWL Web Ontology Language Test Cases — This document describes the correct usage of the Web Ontology Language and the formal meaning of its constructs by using test cases.

12. OWL Web Ontology Language Guide — This document demonstrates the use of the OWL language to formalize a domain by defining classes and properties of those classes, define individuals and assert properties about them, and reason about these classes and individuals to the degree permitted by the formal semantics of the OWL language.

Until recently, specifications 7 to 12 were part of a working draft. However, on February 10, 2004, these specifications were published as recommendations. W3C standardization activities will continue to focus primarily on the upper layers above Logic in the future. This standardization process is articulated in Figure 4.

![Figure 4 Semantic Web Wave](image)

Source: Berners-Lee, 2002

2.4 Web Services and the Semantic Web

15
Today we frequently hear the words "Web Services" in the IT business field. Since Web Services are based on current Web technologies, the dissemination of Semantic Web technology cannot help but affect Web Services as well. In this section, I describe the relationship between the Semantic Web and Web Services from a technological point of view.

The term "Web Services" has two definitions. One is: "A framework for creating services for use over the World Wide Web." The other is: "Software applications that can be discovered, described, and accessed based on XML and standard Web protocols over intranets, extranets, and the Internet." The former definition refers to any services on the World Wide Web, and this is not a descriptive definition. The latter definition is widely used in the IT business field. In this thesis, I will use this definition for Web Services.

Web Services architecture is illustrated in Figure 5.

---

Figure 5 Web Services Architecture

Web Services consist of three functions—Publish, Find, and Bind. “Publish” means that the provider of Web Services describes all of the details necessary to interact with the service, including message formats that detail the operations, transport protocols, and location using a standard, formal XML notation, called Web Services Definition Language (WSDL). The provider then publishes the service with a service registry using a standard called the Universal Description, Discovery, and Integration (UDDI) specification.

“Find” means that the requester of Web Services can find the service via the UDDI interface. The UDDI registry provides a service requester with a WSDL service description and a URL (uniform resource locator) pointing to the service itself. The service requester then uses this information to directly bind to the service and invoke it. Semantic Web and Web Services have a lot in common, especially their basic technology. Both use XML to describe metadata, as shown in Figure 6.

![Figure 6 Comparison of technology stacks for Web Services and the Semantic Web](image)

Source: Berners-Lee, 2002, adapted by author

While standardization for the Semantic Web focuses on machine-readable resource descriptions and develops RDF Schema, Ontology, Logic Framework, Rules, and so forth, the
standardization activity for Web Services defines service and application interface descriptions (WSDL) and messaging protocol descriptions (e.g., SOAP: Simple Object Access Protocol). WSDL defines the way to describe the service provided by software applications, and SOAP prescribes how to access the services. Another relevant technology for Web Services is UDDI, which enables software applications to discover where necessary services exist on the Web. However, more adaptable descriptions of services and more sophisticated ways to locate the necessary services can be provided by using Semantic Web technologies such as RDF and Ontology ( Parsia, 2003).

In 2001, the DAML Web Services (DAML-S) Joint Committee developed the Semantic Web Service (SWS) to deal with the challenges of Web Services in the context of the Semantic Web. SWS recently introduced an OWL-based Web Service Ontology, OWL-S as well as supporting tools and agent technology to enable automation of services on the Semantic Web.

W3C also established its own W3C Web Services activity in January 2002 to develop standards for SOAP and WSDL. W3C coordinates its activities with the Semantic Web activities. In October 2003, W3C started a SWS Interest Group to discuss Web Services topics oriented toward the integration of Semantic Web technology into ongoing Web Services work at W3C. These trends indicate that while Web Services and the Semantic Web are being developed independently, they will merge naturally and strengthen each other. Tim Berners-Lee’s said it best: “While Web Services meet immediate need, Semantic Web has exponential growth potential” (WC3, 2003).

2.5 Adoption of the Semantic Web

The Web actually began in a research center called CERN (the European Organization for Nuclear Research) in 1989, and quickly spread all over the world, and its growth continues. Given that situation, the Semantic Web requires RDF metadata to be generated for each document that is already defined or will be created in the future. It is unrealistic to expect that people will meet this requirement immediately, and it would be painful to maintain the RDF metadata in addition to the
original document. Therefore, a method for generating the RDF metadata automatically from the original document has been the focus of research. Concerning this point, Tim Berners-Lee (2004) made the following comment:

*We can generate RDF metadata automatically using kinds of wrappers for existing functions which generate HTML from databases. If we have to count the existing web pages that are not generated by using outputs from databases, currently we have to use less-reliable methods such as extraction from XHTML. Anyway, by using these kinds of approaches, RDF metadata is automatically generated, and it will not become a burden for producers of web content and RDF metadata.*

Berners-Lee has a blueprint for the evolution of the Semantic Web. The Semantic Web enables distributed data on the Web to form a unique and massive database. There a highly automated process combines agent technologies with huge amounts of semantically homogeneous data. To understand this, an infrastructure-like expressway on which the RDF data can be transferred back and forth is needed. The expressway has already been realized, i.e., the Internet, and the “rules of the road,” such as the standardization of RDF and Ontology, are being promoted by W3C recommendations. The remaining need is to increase the number of drivers who use this expressway. To do this, a main road must be established which converges onto the expressway. Those who construct the main road are the individuals and companies who use the Semantic Web (see Figure 7).
Figure 7 Transformation of Business Integration

Source: Berners-Lee, 2003, adapted by author

Just as the Web has prevailed and grown through grassroots-level activities, so will the Semantic Web grow with the accumulation of every individual’s or company’s efforts. And as the Semantic Web expands, more variety and more convenient services will become available. At the first glance, this argument looks like the classic ‘chicken and egg.’ However, in the real world, some enterprises begin by providing services using the Semantic Web, then providing an easy and reliable way to facilitate generation of RDF metadata. This trend pushes a reinforcing loop to adopt the Semantic Web even further and leads to exponential growth in the adoption of the Semantic Web.

As an example, Figure 8 shows the results of a survey among IT managers in various Japanese companies (Koshiba, 2003). It shows that the current adoption of RDF data among Japanese companies, with 13% of respondents currently using or planning to use RDF data in the future. Tracing this number in the future will tell us whether the reinforcing loop is working or not.
Figure 8 Adoption of RDF among Japanese Companies in 2003

Chapter 3  Analysis of Semantic Web Technology

This chapter is divided into three main parts. First, I introduce the notion of disruptive and sustainable innovation. Then I use the current Web to examine the technological positioning of the Semantic Web. Finally, I analyze the Semantic Web and Web Services from an innovator’s point of view.

3.1 Disruptive or Sustainable Innovation

This section explains the concepts of disruptive innovation and sustainable innovation, and introduces the litmus tests for defining whether Semantic Web technology is a disruptive or sustainable innovation.

In Schumpeter’s theory of economic development (1939), innovation is closely related to development. Economic development is driven by the discontinuous emergence of new combinations that are economically more viable than the old way of doing things. Schumpeter’s innovation concept covers five areas: (1) the introduction of a new good (product innovation); (2) the introduction of a new method of production, including a new way of handling a commodity commercially (process innovation); (3) the opening of a new market (market innovation); (4) the conquest of a new source of supply of raw material or intermediate input (input innovation); and (5) the carrying out of a new organization of industry (organizational innovation). Schumpeter also talked about “creative disruption” by entrepreneurs.

Christensen (1997) defines the distinction between disruptive and sustaining innovation. Disruptive innovations refer to those large technological or organizational breakthroughs that revolutionize business in a market or entire industry. This notion relates to Schumpeter’s notion of
“creative disruption.” Sustaining innovations are defined as innovations that add incremental improvement to the performance of existing products or services.

Christensen explained that a disruptive innovation is not accepted into an existing market in the beginning stages of the innovation because its performance is too low to penetrate the existing market in terms of existing measurements defined by existing market needs. Disruptive innovation must be financially sustainable until the market recognizes the value of the innovation and establishes a new performance measure. As long as a disruptive innovation falls behind an existing technology in terms of performance level, and/or the performance level needed by customers is higher than the innovation’s present level, then it will do nothing but target low-end customers and retain a low price. This is one of the main reasons why successful companies fail to prepare for a disruptive innovation. All firms, especially successful ones, welcome sustaining innovations because such innovations tend to bring more profit.

Christensen emphasized that successful companies often fail due to their own management practices that have enabled them to become industry leaders. Those practices make it extremely difficult for them to develop or adopt the disruptive innovation that ultimately steals away their markets. The dilemma is, companies fail for the same reason they succeed.

In their latest book, Christensen and Raynor (2003) have further evolved Christensen’s first concept about disruptive innovation and sustainable innovation. They explain a new definition using the ideas illustrated in Figure 9. Disruptive innovation is categorized in two parts, Low-End Disruption and New Market Disruption. A low-end disruption means that the innovation provides lower performance as measured by existing criteria and lower cost than a current product or service. If the performance of the current product or service exceeds customers’ needs, or as the new low-cost product or service improves its performance to the degree that customers are satisfied, it can gradually deprive customers from an existing product or service.

On the other hand, a new market disruption means that the innovation creates a new market by establishing new performance criteria. At the early stage of an innovation, the new product or
service does not compete with the current product or service. However, as the performance of the new product or service becomes good enough to pull customers away from the original market for a new one, the innovation will compete with the current product or service head-to-head.

![Diagram showing different strategies for innovation]

**Sustaining Strategy**
Bring a better product into an established market

**Low-End Disruption**
Address underserved customers with a lower-cost business

**New Market Disruption**
Compete against non-consumption

Figure 9 Third Dimension of the Disruptive Innovation Model


The authors ask three sets of questions that they use as litmus tests for determining whether an idea has disruptive potential. The first questions confirm whether the technology will lead to new market disruption:

- Is there a large population of people who historically have not had the money, equipment, or skill to do this thing for themselves, and as a result have gone without it altogether or have needed to pay someone with more expertise to do it for them?
- To use the product or service, do customers need to go to an inconvenient, centralized location? (p. 49)
The second test explores the potential for a low-end disruption. The authors suggest the following questions for this test.

- Are there customers at the low end of the market who would be happy to purchase a product with less (but good enough) performance if they could get it at a lower price?
- Can we create a business model that enables us to earn attractive profits at the discount prices required to win the business of these over served customers at the low end? (p. 50)

The final test is to check competitors’ tolerance of the disruptive innovation. If the innovation appears to be sustaining one or more significant players in the industry, then the odds will be stacked in that company’s favor, and the entrant is unlikely to win. They offer this question:

- Is the innovation disruptive to all of the significant incumbent firms in the industry?” (p. 50)

They conclude that a technology that passes these three tests is disruptive.

In considering the Semantic Web, what kind of products or services should be regarded as already existing? First I picked up the current Web according to Berners-Lee: “The Semantic Web is an extension of the current web.” In the following sections, I survey the current situation of the Web. Then I research the current adoption of Web Services by businesses and examine the relationship between Web Services and the Semantic Web from an innovator’s point of view.

3.2 Current Status of the Web

When we consider the current Web, the following three measures can be used as a performance index:

- volume of information
- speed of delivering information
- cost of obtaining information
The *volume of information* is measured by the amount of content and data, the number of hosts, and so forth. Figure 10 shows the increasing number of hosts on the current Web. This figure indicates the exponential growth of the number of hosts on the current Web.

![Internet Domain Survey Host Count](source: Internet Software Consortium [www.isc.org](http://www.isc.org))

**Figure 10 Number of hosts on the Internet**


The *speed of delivering information* has improved since the availability of broadband Internet services. The International Telecommunication Union Telecommunication Standardization Sector (ITU-T) called the year 2003 “The Birth of Broadband.” The upper chart in Figure 11 indicates the worldwide growth of broadband services. The lower chart in Figure 11 shows that in some countries (e.g., Korea, Hong Kong, and Canada), one out of ten people who currently use the Web are broadband users.
How can the cost of obtaining information be measured? In order to define measurement parameters, I assumed that all Web users have the same information technology literacy, which enables them to find relevant information on the Web within relatively the same amount of time. Under this assumption, the cost of obtaining information depends on the speed of information delivery and the line cost. Using ITU-T figures, the line costs by country in 2002 are summarized in
Table 2. The line cost decreases in countries such as Japan and Korea where there is greater prevalence of broadband networks.

Table 2 Broadband prices per 100 kbit/s, top 30 as % of monthly income

<table>
<thead>
<tr>
<th>NO</th>
<th>Country</th>
<th>Subscription/month (US$)</th>
<th>Price per 100 kbit/s (US$)</th>
<th>Subscription as % of monthly income</th>
<th>100 kbit/s as % of monthly income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Japan</td>
<td>$24.19</td>
<td>$0.09</td>
<td>0.87%</td>
<td>&lt;0.01%</td>
</tr>
<tr>
<td>2</td>
<td>Korea (Rep.)</td>
<td>$49.23</td>
<td>$0.25</td>
<td>5.95%</td>
<td>0.03%</td>
</tr>
<tr>
<td>3</td>
<td>Belgium</td>
<td>$34.41</td>
<td>$1.15</td>
<td>1.78%</td>
<td>0.06%</td>
</tr>
<tr>
<td>4</td>
<td>Hong Kong, China</td>
<td>$38.21</td>
<td>$1.27</td>
<td>1.85%</td>
<td>0.06%</td>
</tr>
<tr>
<td>5</td>
<td>United States</td>
<td>$52.99</td>
<td>$3.53</td>
<td>1.81%</td>
<td>0.12%</td>
</tr>
<tr>
<td>6</td>
<td>Singapore</td>
<td>$33.18</td>
<td>$2.21</td>
<td>1.92%</td>
<td>0.13%</td>
</tr>
<tr>
<td>7</td>
<td>Netherlands</td>
<td>$51.55</td>
<td>$3.36</td>
<td>2.58%</td>
<td>0.17%</td>
</tr>
<tr>
<td>8</td>
<td>Canada</td>
<td>$32.48</td>
<td>$3.25</td>
<td>1.75%</td>
<td>0.17%</td>
</tr>
<tr>
<td>9</td>
<td>Norway</td>
<td>$46.16</td>
<td>$6.56</td>
<td>1.46%</td>
<td>0.21%</td>
</tr>
<tr>
<td>10</td>
<td>Macao, China</td>
<td>$38.34</td>
<td>$2.56</td>
<td>3.20%</td>
<td>0.21%</td>
</tr>
<tr>
<td>11</td>
<td>Germany</td>
<td>$33.93</td>
<td>$4.42</td>
<td>1.80%</td>
<td>0.23%</td>
</tr>
<tr>
<td>12</td>
<td>New Zealand</td>
<td>$40.61</td>
<td>$2.71</td>
<td>3.55%</td>
<td>0.24%</td>
</tr>
<tr>
<td>13</td>
<td>Austria</td>
<td>$45.20</td>
<td>$5.89</td>
<td>2.32%</td>
<td>0.30%</td>
</tr>
<tr>
<td>14</td>
<td>United Kingdom</td>
<td>$32.59</td>
<td>$6.37</td>
<td>1.55%</td>
<td>0.30%</td>
</tr>
<tr>
<td>15</td>
<td>Switzerland</td>
<td>$57.84</td>
<td>$11.30</td>
<td>1.83%</td>
<td>0.36%</td>
</tr>
<tr>
<td>16</td>
<td>Italy</td>
<td>$73.59</td>
<td>$6.13</td>
<td>4.66%</td>
<td>0.39%</td>
</tr>
<tr>
<td>17</td>
<td>Sweden</td>
<td>$44.56</td>
<td>$8.91</td>
<td>2.15%</td>
<td>0.43%</td>
</tr>
<tr>
<td>18</td>
<td>Slovenia</td>
<td>$79.54</td>
<td>$3.88</td>
<td>9.73%</td>
<td>0.48%</td>
</tr>
<tr>
<td>19</td>
<td>France</td>
<td>$51.46</td>
<td>$10.05</td>
<td>2.81%</td>
<td>0.55%</td>
</tr>
<tr>
<td>20</td>
<td>Luxembourg</td>
<td>$91.77</td>
<td>$17.92</td>
<td>2.84%</td>
<td>0.55%</td>
</tr>
<tr>
<td>21</td>
<td>Australia</td>
<td>$50.56</td>
<td>$9.87</td>
<td>3.07%</td>
<td>0.60%</td>
</tr>
<tr>
<td>22</td>
<td>Ireland</td>
<td>$61.69</td>
<td>$12.05</td>
<td>3.10%</td>
<td>0.61%</td>
</tr>
<tr>
<td>23</td>
<td>Iceland</td>
<td>$73.66</td>
<td>$14.39</td>
<td>3.16%</td>
<td>0.62%</td>
</tr>
<tr>
<td>24</td>
<td>Denmark</td>
<td>$51.82</td>
<td>$20.24</td>
<td>2.05%</td>
<td>0.80%</td>
</tr>
<tr>
<td>25</td>
<td>Portugal</td>
<td>$39.64</td>
<td>$7.74</td>
<td>4.39%</td>
<td>0.86%</td>
</tr>
<tr>
<td>26</td>
<td>Cyprus</td>
<td>$58.03</td>
<td>$9.07</td>
<td>5.65%</td>
<td>0.88%</td>
</tr>
<tr>
<td>27</td>
<td>Finland</td>
<td>$57.36</td>
<td>$22.41</td>
<td>2.93%</td>
<td>1.14%</td>
</tr>
<tr>
<td>28</td>
<td>Malta</td>
<td>$53.34</td>
<td>$10.42</td>
<td>6.96%</td>
<td>1.36%</td>
</tr>
<tr>
<td>29</td>
<td>Venezuela</td>
<td>$49.72</td>
<td>$4.86</td>
<td>14.59%</td>
<td>1.42%</td>
</tr>
<tr>
<td>30</td>
<td>Spain</td>
<td>$47.63</td>
<td>$18.61</td>
<td>3.96%</td>
<td>1.55%</td>
</tr>
</tbody>
</table>

Source: ITU, Sep. 2003

Looking at the performance of the current Web from the three points of views, it is clear that the Web is still developing.

To judge whether it overshoots actual customer needs or not, I considered how the Semantic Web is positioned in terms of the three performance measures. I found there was no difference
between the current Web and the Semantic Web in terms of the speed of delivering information and the cost of obtaining information, since they both depend on the same network technology.

Then I analyzed the volume of information based on the performance index here. In the first litmus test defined by Christensen, I examined whether there is a large population of people who are unable to access the Web because they lack money or skill.

Figure 12 shows the countries in which more than 50% of the population are Internet users. I believe there is a large number of people who cannot access the Web, especially in China, Africa, and a number of less-developed countries. I found that it is caused not just by lack of money and skill but also by lack of information infrastructure.

Figure 12 Web Penetration Rate by Country, 2002

Source: Clickz.com, 2004
However, the true nature of the problem lies in the technology for Internet access, not in the Web itself. Thus, this opportunity for a New Market Disruption is controlled by the technologies for Internet access, such as Internet TV or cell phone Internet, which allow people to access the Web easily and from a variety of locations. I found that the Semantic Web will do nothing to advance this opportunity.

In the second litmus test, are there current Web users at the low end who would be happy to accept another option with fewer privileges and features in order to obtain service at a lower price? Again, different countries have different answers to this question. But as Table 2 showed, the cost of delivering information continues to decrease, and in the countries shown on the table there are few people who believe it is expensive to access the Web. As for obtaining information, most people believe they can obtain information from the Web at no charge. Therefore, the Semantic Web can be ruled out as a Low-end Disruption.

Although the Semantic Web does not appear to satisfy the litmus tests for either a new market or a low-end disruption, it will continue to bring sustainable innovations to the Web. As the volume of available information becomes larger and larger on the current Web, its size will pose a stumbling block for users, making it more difficult to find relevant information easily. In other words, the current Web may not perform as well in terms of providing valuable intelligence easily. This means the current Web is still below the measurement “Performance that customers can utilize or absorb” as shown by the dotted line in Figure 9 above. Since the Semantic Web enables users to find relevant information from a massive volume of information easily and correctly, I conclude that the Semantic Web is a sustainable innovation for the current Web.
3.3 Web Services and the Semantic Web

In this section, I will explain how the Semantic Web is positioned as a Web Service in terms of business impact.

Considering the current penetration of Web Services, this technology might fail to cross over the Chasm between “Early Adopters” and “Early Majority” in the Technology Adoption Life Cycle defined by Moore (1991) (see Figure 13).

![Diagram of Technology Adoption Life Cycle]

**Figure 13 Technology Adoption Life Cycle**


The results of a survey that shows the availability of Web Services among Japanese companies is shown in Figure 14. It indicates that the percentage of “Already Adopted” increased from 2001 to 2002, but in 2003 and 2004 user momentum to apply Web Services to real business cases diminished and has been stagnant for the past few years (Koshiba, 2004).
What is the reason for stagnant adoption? Is there no longer a need for low-cost system integration inside companies or between companies that could be served by Web Services? Or are there difficulties in the process for realizing such needs when using Web Services?

Koshiya (2002) found that companies have a strong need for system integration. Figure 15 reinforces that finding, showing that approximately 60% of respondents indicated a need for system integration. Consolidated enterprise management and the globalization of management require companies to integrate a variety of separate systems that are already in place in each business unit. The same is true for system integration between companies. Like Dell, other companies are seeking ways to integrate their systems in order to collaborate effectively with other complementors in their value network to utilize their new services. As an external factor, since cost pressures as a result of economic depression compel many companies to streamlined their operations, they regard
outsourcing as a feasible implementation and try to unify their own system with an outsourcee’s system.

![Figure 15: Necessity for System Integration (N=266)](source: http://www.atmarkit.co.jp/fbiz/survey/01/biz0203.html)

If the need for system integration is high, there may be a problem in realizing the need. One reason is that the system, which is highly optimized to perform specific operations in each business process, inhibits the distribution of data inside an entire company or between companies.

In a manufacturing industry such as automobiles, modularization results in advanced automation and reuse of components. Compared with the manufacturing industry, the process of system development is not efficient due to low modularity and unclear design of component. It is common, in such a case, for a system developer to implement standardization of components and then perform the same kind of job repeatedly.

When a connection is established between various systems as a result of using Web services, the data that comes from one system will not be processed in other systems because of a lack of
standardization—a fundamental requirement for successful system integration. The Semantic Web can play an important role in the process of standardization by unifying the meaning of data. This notion was represented earlier in Figure 7. I believe that combining the Semantic Web with Web Services will provide solutions for data standardization that can overcome the current barrier against Web Services penetration. Therefore I conclude that the Semantic Web also achieve sustainable innovation for current Web Services.
Chapter 4  Applying the Semantic Web to Business

4.1 E-Business Models and the Semantic Web

In this chapter, I will introduce e-business models and examine the impacts of the Semantic Web on these business models. Then I examine examples of actual business applications. Each example implements a different phase of a Semantic Web business application. I explain the applications and analyze their implementation phases.

I believe the Semantic Web can be applied to business in three phases (see Figure 16)

- **Phase 1.** Information control and dynamic information structuring by utilizing Metadata (RDF)
- **Phase 2.** Searching information semantically and information interaction among various entities by utilizing Meta data (RDF) and Ontologies (and Web Services)
- **Phase 3.** Autonomous information management by utilizing Meta Data (RDF), Ontologies, and Intelligent Agent (and Web Services)

![Figure 16 Three business application phases of the Semantic Web](image)

Source: Berners-Lee, 2002, revised by author
4.1.1 Atomic E-Business Models

Weill & Vitale (2001) are the authors of a business model called the atomic e-business models. These models consist of eight business models as shown in Table 3.

Table 3 Atomic E-Business Models

<table>
<thead>
<tr>
<th>Atomic E-Business Models</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Provider</td>
<td>Provides content (information, digital products, and services) via intermediaries.</td>
<td>Weathernews Inc. Morgenstar Reuters</td>
</tr>
<tr>
<td>Direct to Customer</td>
<td>Provides goods or services directly to the customer, often bypassing traditional channel members.</td>
<td>Dell, Amazon</td>
</tr>
<tr>
<td>Full-Service Provider</td>
<td>Provides a full range of services in one domain (e.g., financial, health, industrial chemicals) directly and via allies, attempting to own the primary consumer relationship.</td>
<td>GE Supply Merrill Lynch</td>
</tr>
<tr>
<td>Intermediary</td>
<td>Brings together buyers and sellers by concentrating information.</td>
<td>eBay Yahoo! Mannheim</td>
</tr>
<tr>
<td>Shared Infrastructure</td>
<td>Brings together multiple competitors to cooperate by sharing common IT infrastructure.</td>
<td>ABACUS Asian Airline Computer Reservation System</td>
</tr>
<tr>
<td>Value Net Integrator</td>
<td>Coordinates activities across the value net by gathering, synthesizing, and distributing information</td>
<td>CISCO Systems Seven Eleven Japan</td>
</tr>
<tr>
<td>Virtual Community</td>
<td>Creates and facilitates an online community of people with a common interest, enabling interaction and service provision.</td>
<td>The Motley Fool The WELL</td>
</tr>
<tr>
<td>Whole-of-Enterprise/Government</td>
<td>Provides a firmwide single point of contact, consolidating all services provided by a large multiunit organization.</td>
<td>Ford Motor Company e-government</td>
</tr>
</tbody>
</table>


For example, the business model for Lonely Planet (publisher of the well-known travel guidebooks) is shown in Figure 17.
Lonely Planet has established a free communication infrastructure for travelers as a virtual community model. In this figure, Lonely Planet provides a bulletin board service, called Throne Tree, for Traveler A and Traveler B so they can exchange information about their travels. In addition, Lonely Planet sells a product called CitiSync and a travel guidebook to Traveler B, which makes this model a Direct to Customer model.

On the other hand, Lonely Planet uses a Content Provider model for Traveler C and Traveler D. Lonely Planet provides travel information to Travelocity and Yahoo!, and Traveler C can obtain that value-added information from Travelocity and Yahoo!. Lonely Planet uses Borders and Amazon.com as a retailer of its travel guidebooks. In this case, Traveler D goes to Borders Bookstore.
in his own neighborhood and buys the Lonely Planet travel guidebook. Alternatively, he can orders it via Amazon.com. Lonely Planet also sells maps and photos to airlines, which insert them into their flight magazines.

4.1.2 Impact of the Semantic Web on each Atomic E-Business Model

Using the atomic e-business models mentioned in the previous section, I examined how the current company, which conducts business on the Web, might be affected by the Semantic Web.

First, I define the value proposition for customers for each atomic e-business model, as shown in Table 4 and use them as a performance measure of each business model. Following the table, I briefly discuss each model.

<table>
<thead>
<tr>
<th>Model</th>
<th>Customers’ Value proposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Provider</td>
<td>better quality of content and better price-to-quality ratio</td>
</tr>
<tr>
<td></td>
<td>strong brand name</td>
</tr>
<tr>
<td>Direct-to-Customer</td>
<td>greater choice</td>
</tr>
<tr>
<td></td>
<td>increased convenience, which customer can order what he/she want on the Web</td>
</tr>
<tr>
<td></td>
<td>lower costs</td>
</tr>
<tr>
<td>Full-Service Provider</td>
<td>lower transaction costs for search, specification, ordering, and increased convenience, which customer can get what he/she wants by conveying simple overall objectives</td>
</tr>
<tr>
<td>Intermediary</td>
<td>lower search and transaction costs, better than do by himself</td>
</tr>
<tr>
<td></td>
<td>increased convenience, which customer can get wide range of value-added services instead of simple transaction process</td>
</tr>
<tr>
<td>Shared Infrastructure</td>
<td>lower costs by economies of scale</td>
</tr>
<tr>
<td>Value Net Integrator</td>
<td>powerful position in the value net</td>
</tr>
<tr>
<td></td>
<td>strong brand name</td>
</tr>
<tr>
<td>Virtual-Community</td>
<td>greater opportunity to interact electronically with like-minded</td>
</tr>
<tr>
<td>Whole of Enterprise</td>
<td>increased convenience, which customer can easily find suitable products and services from different business units</td>
</tr>
</tbody>
</table>

Source: Author, 2004

Content Provider

The performance measurements for this model are quality, volume, price of content, and their balance. The price-to-quality ratio seems to be most important. The quality of content comes from the
skill of the creators and their information sources. Thus, how to manage the content-producing process efficiently is the lifeblood of the Content Provider.

From this point of view, the Semantic Web can provide a solution for efficient content management, such as versioning the content, ranking it according to importance, and so forth. In addition, using RDF metadata, it can handle not only documents but also pictures and movies equally well. This means that the Semantic Web would likely improve the business process of a Content Provider.

**Direct-to-Customer**

The performance measurements for this model are variety of choice, convenience, and low cost. As mentioned above, the Semantic Web will further improve the variety of choice and convenience. For example, Amazon.com can provide a new search service, which allows users to utilize conversational language, such as: “The software book published recently, the author is Michael Cusumano.” Amazon.com currently offers advanced searches for users who wish to conduct multiple-condition searches. However, the number of conditions is limited and an easier interface would be welcome, especially among those users who have less computer literacy. Therefore the current performance of this model would be reinforced by the Semantic Web.

**Full Service Provider and Intermediary**

The improvements made possible by the Semantic Web are more effective for Full Service Providers or an Intermediary model because they already have a wider network in place and are adept at obtaining information from the network. For example, at present Google offers more convenience and greater choice than does Amazon.com. They could combine their existing technologies with the Semantic Web and offer the cheapest search service by going around the Web and gathering their own information. Such a service would enable users to find the cheapest price of a book anytime, in a single location. Google also could provide the service not only for books but also for whatever is sold.
on the Web. Thus Google could be the premier discount seller on the Web and could guarantee “Every time a low price.” Furthermore, Google could help users find not only the cheapest product but also tell them how quickly they could obtain it. Eventually Google could become an automated shopping agent for customers to make comparisons and decide from among multiple options that satisfy a customer’s request based on rules defined by the users.

In this scenario, for Amazon.com and eBay, Google could cut into their direct relationship with customers and build their own strong relationships with customers instead.

**Value Net Integrator**

The value of this integrator lies in knowing how to coordinate suppliers of products or services to respond customer needs. This is the same as a Full Service Provider or Intermediary, but a Value Net Integrator owns the relationship with customers. Therefore, the integrator can expect more improvements by implementing the Semantic Web, similar to the improvements mentioned for Full Service Provider and Intermediary.

**Whole of Enterprise**

In contrast to the Value Net Integrator, Whole of Enterprise focuses on the internal coordination of business operations. As mentioned in Section 3.33.3, current Web Services combined with the Semantic Web would lower the barriers internal and external to the company. The differences between a Value Net Integrator and Whole of Enterprise would get smaller and smaller.

**Virtual Community, Shared Infrastructure**

Based on their value proposition, Value Community and Shared Infrastructure would not be affected by the Semantic Web.
4.2 Examples of Business Impacts

4.2.1 Kauppalehti Online using Profium SIR (Content Management)

Overview

Kauppalehti has been and remains the most-read Finnish daily business and financial newspaper for over 100 years. Its circulation is currently over 80,000 copies, with more than 300,000 Finnish business readers.

Kauppalehti Online is the biggest business online-medium in Finland, with over 75,000 regular weekly visitors. Kauppalehti Online is part of Alma Media, Finland's second largest media group, which consists of 30 newspapers, two TV channels, two radio channels, and 30 different Web services. The financial information provided by Kauppalehti Online is published in four different media: print paper and supplements, the Web, mobile networks (GSM, WAP, PDA etc.), and television.

In 1999, Kauppalehti faced explosive growth in the volume of incoming information, and a consequently a need to more efficiently manipulate it. Kauppalehti also worried about how to maximize revenues brought in by each client. They decided to utilize a new content management solution (Profium, 2003).

Solution

Portals are a prime target for Semantic Web technologies because of their need to structure information by meaning and deliver it to customers based on their personal preferences. The company behind the Kauppalehti portal, Alma Media, chose Profium’s Smart Information Router (SIR) product, with its in-built RDF capabilities, as the basis for its content management system.

Kauppalehti was able to improve its content management significantly with the help of Profium SIR. Financial information—simultaneously produced by an editorial team of eight people, by various press agencies (Reuters, Bloomberg, Direkt, Dow Jones, BNS, STT), by the Helsinki
Stock Exchange, and by correspondents—is collected and assembled in real-time to keep the website updated (200 articles per day). This mass of information is also used for printed versions of the newspaper and for continuously changing text bands (mostly stock information) on one of Alma Media’s TV channels.

Through Kauppalehti’s chargeable newsfeed services, corporate clients can receive specific up-to-date information that they can further distribute to their Intranet and Internet sites, as well as to their clients’ mobile devices. For example, Finnish telecom operator Sonera publishes, for special client groups, online news that originates from Kauppalehti’s financial information services.

Today, almost two-thirds of the revenues from the Kauppalehti Online financial news portal come from the sale of information content (Profium, 2003).

**Profium SIR: Content Management Platform**

Profium SIR (Smart Information Router) is a Content Management platform that allows users to search, manage, and distribute content, sought throughout millions of different documents, in text or multimedia format. SIR manipulates masses of different information types by classifying each information element with certain attributes, so-called RDF metadata. SIR stores this earmarked information to the company’s relational database, which allows the company to later easily find any content, regardless of the type. See Figure 18 for an illustration of how SIR works.
Figure 18 How Profium SIR works

Source: Profium website, 2004

Analysis of this Business Application

In this case, Kauppalehti takes the role of both content provider and direct customer. As content provider, Kauppalehti successfully improved the efficiency of its content production. As a direct customer, Kauppalehti provides multiple platforms for information retrieved from one source.

This is a Phase 1 type of implementation of the Semantic Web. As mentioned in Section 4.1.2, this business application is a good example of effective content management using the Content Provider model and the Semantic Web.
4.2.2 TIME2RESEARCH using OntoBroker (Information Portal)

Overview

TIME2RESEARCH is a service of Ontoprise GmbH, a 1999 spinoff from the Institute of Applied Informatics and Formal Description Methods (AIFB), University of Karlsruhe, Germany. It supports financial institutes and venture capitalists in making technical evaluations of investment targets within the TIME industries (TIME is an acronym for telecommunications, information technology, multimedia, and e-business.) The company provides different services that are adapted to the different stages of an investment decision. They also offer customized services and consulting. Their business area includes areas such as e-business, ERP, CRM, SCM, document and system management. One of Germany’s largest venture capital organizations, the most successful stock trader, and the lead manager of the Neue Markt in Frankfurt (among others) rely on their services.

Major Customers and Service Examples

A major customer of TIME2RESEARCH is TFG Venture Capital, a company listed on the SDAX, with offices throughout Germany. TFG has played a leading role in shaping the German venture capital landscape for six years. The company went public in early 1999, and since then its shares have developed at rates well above the average. TFG benefits from an investment portfolio that is well-balanced in terms of the sectors covered and the stages of corporate development, and from the earnings that this portfolio generates. Its IPO track record includes high performer like OAR, Vectron, ComROAD, and Eckert & Ziegler (T2R website, 2004).

TIME2RESEARCH supports TFG with the following services:

◊ **Investments**: decision support for venture capital financing, from business plan analysis to technical due diligence

◊ **Milestone-Investments**: verification of milestones defined in financing contracts
Another major customer is Concord Effekten, an independent investment bank focusing on small and mid-cap companies in growth industries. In its Frankfurt and Munich offices, about 170 employees engage in three business areas: financial markets, corporate finance, and asset management (T2R website, 2004).

TIME2RESEARCH supports Concord Corporate Finance Division in the areas:

◊ **Private Equity & Venture Capital:** technical due diligence of investment targets prior to providing capital

◊ **Mergers & Acquisitions:** identification of strategic options for merger & acquisition-activities, research for appropriate targets

◊ **Going Public:** the issue of IPO documents and brochures

**Information Services Provided**

TIME2RESEARCH analyzes information and documents, in particular business plans, to give its customers a meaningful impression of the target. It looks for unique selling points (USPs), strength and weaknesses of products and utilized technologies, future market growth rate, and competitor movements, as well as identifying strategies for tackling the market (T2R website, 2004).

USPs define the value of companies and must be identified by venture capitalists prior to investing. The search for USPs and an estimation of the company value requires the analysis of large amounts of information and these are central points of due diligence. In such situations, venture capitalists need information about pre-selection of business plans, identification of potential investments, and verification of companies prior to investment. Later on they need services following the investment, such as milestone checks, IPO support, and M&A consulting.

The decision-making process for analysts can be structured into five separate steps (see Figure 19), all of them applied in different stages of an investment decision.
Figure 19 Five Steps of Decision Making

Source: T2R website, 2004

Each of the five steps can be understood as a separate process, made up of different single steps. The “Information Research” step can be further split into search via the Internet, extraction of information from knowledge bases, reading external documents (business plans, IPO documents, quarterly reports, etc.), and on-site investigations with interviews. Depending on the stage of an investment decision, these single steps will be assembled differently in an overall information research process.

Following the search for information, there is an analysis process. In general, research and analysis determine each other and build an iterative process—e.g., analysis of information, for example, may raise additional questions that require further research. But independent from this chronology, the analysis can also be split up into several single steps, like linking the information or conclusions of hypotheses.

The results of the analysis process are then summed up in a suitable form. Some underlying knowledge is added semi-automatically to the report template to explain certain topics like technology or market growth. New knowledge and insights derived from the analysis are integrated into the template to form a complete and coherent report that will be presented as an answer to the customer.

TIME2RESEARCH Portal Site

The TIME2RESEARCH portal is an application developed by Ontoprise for the above-described services. The portal enables efficient and accurate delivery of relevant information for technical evaluation processes. By analyzing the information, new knowledge will be produced that
afterwards can be organized into a knowledge warehouse. To (semi-) automatically access and process information from that knowledge base and thus support all stages and steps of the decision-making process, one needs intelligent semantic technologies applied in the TIME2RESEARCH-portal.

The design of the portal is a three-tiered structure. That means the user layer, application layer, and data layer are separated from each other. The user and data layer rely on purely standard technologies. The major technological difference from an ordinary information portal lies in the application layer. There, the OntoBroker technology generates the added value. For the presentation of information, the user needs Microsoft Internet Explorer 5.5. The output format is produced in HTML and JavaScript, and the XML format is under construction. Communication with the application layer over the Internet is handled via a secure connection.

Figure 20 Schematic Structure of the TIME2RESEARCH-Portals

After a successful log-in, the user’s ID serves as a way to personalize the content, which means building pages according to the user’s preferences. OntoBroker and a web server process the user’s request in the application layer. OntoBroker functions as the user’s centralized viewer onto all available knowledge bases. All data is enriched with metadata by OntoBroker and stored in a separate knowledge warehouse. The main advantage is that data can be gathered from different information sources and are available for the user via OntoBroker.

A future source of information will be the Semantic Web, an initiative of the W3C to semantically enrich the World Wide Web. To do so, description languages like RDF are used to transform information from the internet in machine-readable semantic. By that the internet will elevate to the largest database of the world. As the OntoBroker already can process formats like RDF, information pieces from the Semantic Web can be extracted and stored in the knowledge warehouse as well. Because of its semantic technology the OntoBroker is able to identify the right answers in the knowledge base for the users’ request. Ontologies serve as the ‘semantic backbone’ of the system. They hierarchically order meta-information in form of concepts, which are interrelated with each other by formal relations. Thus the ontology puts meta-information in a certain relation and by that all annotated information in a well defined context, what is an essential pre-condition for machine-readable semantics.

With formalized rules and available information new knowledge can be derived by the internal inference engine. That means that the user will get the right answer even when the explicit information is not directly stated in the knowledge base or Semantic Web.

Using the TIME2RESEARCH portal, analysts can profit from the technology and the underlying knowledge. In contrast to ordinary web portals where no information is displayed unless it matches the precise wording (syntactically), this portal delivers exactly the answer and knowledge one needs for a decision in specific functional situations. The portal even generates answers that are not explicitly stated in the knowledge base as a result of the ability to derive new knowledge. This is truly a competitive advantage, with great promise for consultants and knowledge workers. The portal
user does not waste time making them read irrelevant information, but saves valuable work time and
gains another advantage for their customers in terms of shorter response times.

**Analysis of Business Application**

TIME2RESEARCH is a Full Service Provider type of model as mentioned in Section 4.1.1. It
provides users with the customized information based on analysis of a large volume of data from
various information sources. As mentioned in Section 4.1.2, the Full Service Provider model utilizes
the Semantic Web to find suitable information for customers from a wide variety of information
sources. I judge application to be in Phase2 implementation of the Semantic Web.

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**4.2.3 Swiss Life: Using the On-To-Knowledge Toolkit (Knowledge Management)**

**Overview of Swiss Life**

Swiss Life is a leading provider of life insurance and long-term savings protection. It offers
individuals and companies comprehensive advice and a broad range of products via agents, brokers,
and banks in its domestic market, Switzerland, where it is the market leader, and in selected European
markets. Multinational companies receive custom-made solutions from a network of partners in over
50 countries. Swiss Life Holding was founded in 1857 and is listed on the Swiss Stock Exchange
(SLHN). The company employs around 11,000 people worldwide (Swiss Life website, 2004).

Swiss Life conducts research into new IT trends and their impact on business, and transfers
the research results to Swiss Life projects. Swiss Life also joins field research projects or practical
projects outside the company. Its budget is roughly divided 50% for research projects and 50% for
practical projects, with the output presented at internal seminars, presentations, and academic
conferences. These progressive research projects enable the company to attract highly qualified
people continually (Reimer, 2000).
**Participation in the On-to-Knowledge Project**

Swiss Life’s IT R&D focuses on two main topics: data mining and knowledge management. During its work in the field of knowledge management, Swiss Life participated in the On-to-Knowledge project, a European research project organized by the Information Society Technology (IST) (Reimer, 2000). The On-To-Knowledge project develops methods and tools and utilizes the full power of the approach to facilitate knowledge management. The On-To-Knowledge tools are helpful to office workers who are not IT specialists, enabling them to access information repositories company-wide. Examples of target On-To-Knowledge users are help-desk personnel, sales staff, and mid-level and higher management (On-to-Knowledge website, 2004).

Swiss Life has built ‘organizational memory’ complete with an intranet-based portal that utilizes On-to-Knowledge tools (see Figure 21) Three case studies explore problems connected with this application (Fensel, et al., 2000):

1. A skills database contains a large variety of structured and unstructured documents like CVs, recruitment profiles, course and project descriptions. Today these documents do not exist or are not integrated into a single repository. Furthermore, there is no common vocabulary (i.e., ontology) that guarantees a unified usage and understanding of the documents, resulting in insufficient retrieval results.

2. Information about an insurance product is comprised of documents for sales persons, for training purposes, about performing office tasks, etc. This information is created in different places, in different formats, and is often not distributed to the right places.

3. An IAS (International Accounting Standards) document is part of the global Swiss Life Intranet known as GroupNet. The document has 1,000 web pages which makes it extremely difficult to find relevant passages, even though it is divided into chapters and sections.
Analysis of the Business Application

In this case, Swiss Life uses Semantic Web technology inside the company. For most companies, while the necessity of knowledge management is recognized, it is difficult for them to implement knowledge management as a system. Various problems must be solved, such as how to express the knowledge, how to reuse the knowledge, how to find the relevant knowledge, and how to motivate employees to provide their own know-how (Nonaka & Takeuchi, 1995).

This Swiss Life case found one solution for these problems. Using Ontology and RDF metadata, the more natural expressions of knowledge and an easier, more effective search for knowledge have been realized. I judge that this application is in Phase2 implementation of the Semantic Web.
4.2.4 Intelink: Using the Horus Toolkit DAML+OIL (Intelligence Information Management)

Overview of Intelink

Intelink, which began as a testbed operation in 1994, is both an architectural framework and an integrated intelligence dissemination and collaboration service that provides uniform methods for exchanging intelligence among intelligence providers and users. The Intelink framework conforms to the future direction of the National Information Infrastructure (NII). The Intelink service was patterned after the Internet model in which a variety of institutions have come together in the context of a global network to share information (FAS website, 2004). The Intelink intelligence network links information in the various classified databases of the US intelligence agencies (e.g. FBI, CIA, DEA, NSA, USSS, NRO) to facilitate communication and the sharing of documents and other resources.

Intelink has four components, as follows:

✓ Intelink-P (Policy Net) — the most highly classified level, operated by the CIA and only available to very high-level policy makers

✓ Intelink-SCI (Sensitive Compartmented Information) — top secret information, available to about 50,000 people

✓ Intelink-S (SecretNet) — secret level, primarily serving the military, with around 265,000 users

✓ Intelink-U (UnclassifiedNet) — open-source, unclassified information, available to members of the Open Source Information Service (OSIS) which is managed by the CIA, or others approved by them.

The Horus Project

To solve current web technology limitations, the Horus Project began as a joint effort by the Department of Defense Advanced Research Projects Agency (DARPA) and the Intelink Management
Office (IMO) and brought Semantic Web technologies to Intelink and the intelligence community. In 2002, Horus was refining a toolkit to bring Semantic Web tools to user sites on Intelink. They would support users in building enhanced, web-based knowledge portals that provide access to both structured data in databases and unstructured data extracted from web sources.

The focus of Horus is to enable and exploit Semantic-based markup of sources to promote information discovery and integration, ultimately by software agents as well as general users. Users and agents will access, manipulate, and create knowledge that is organized as Horus "knowledge objects." These (conceptual) objects represent real-world entities, such as military units, terrorist organizations, and geopolitical events. Information in knowledge objects is linked to its source (i.e., a database or web page). This enables the maintenance of information pedigrees and allows drilldown to the original sources. User sites will build portals to access these objects, resident in a Horus Knowledge Base (ISX website, 2004). The information translation on Intelink-S is shown in Figure 22. In addition to working with site developers of user portals, Horus is also coordinating with the Joint Intelligence Virtual Architecture (JIVA) Project's Knowledge Map effort, IMO efforts for tagging standards (metadata, security, and content), and related Intelligence Community efforts for document markup (using XML, etc.).
Figure 22 Horus Transition

Source: DARPA, 2004

Analysis of the Business Application

This case, like the Swiss Life case in the previous section, is an example of a knowledge management system that is enabled by the Semantic Web. However, in this case the number of users is larger than Swiss Life, so this case is more a practical example. I judge that this application is currently between Phase 2 and Phase 3 implementation of the Semantic Web because they are engaged in accomplishing information processing as a utilizing agent.
In this chapter, I discuss the current situation of the system integration business. I begin by reviewing the business from several points of views, such as business model, player, and market. Then I analyze the current business situation using Porter’s Five forces model plus one additional factor—infrastructure and complements (Hax & Majluf, 1996; Hax & Wilde, 2001; Porter, 1980). I conclude the chapter by discussing opportunities and threats for the system integration business.

5.1 Overview of the System Integration Business

The system integration business can be defined as follows:

Development and integration services customize or develop IT solutions, assets and processes and then integrate these solutions, assets and processes with established infrastructure and processes. Development and integration services implement designs conceived by consultants.

Development and integration services include three subsegments: AD services, integration services, and deployment services.

- **Applications Development** - AD services create new functionality for custom-developed or packaged applications. AD services frequently serve to integrate or link internal or external business processes. These services may include conversion applications to run on different platforms or architectures.
- **Deployment** - Deployment services support the implementation and rollout of new applications or infrastructure. Activities may include hardware or software procurement, configuration, tuning, staging, installation, and interoperability testing.
- **Integration** - Integration services are detailed design, implementation and management services that link applications (custom or prepackaged) to each other or with the existing or planned IT infrastructure. Specific activities might include project planning, project management, detailed design or implementation of application programming interfaces. (Gartner, 2003)

Table 5 depicts the full definition of IT services as explained by Gartner.
<table>
<thead>
<tr>
<th>Product Support</th>
<th>Hardware maintenance and</th>
<th>Client computing hardware services</th>
<th>Personal computer services</th>
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<td>Document management</td>
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<td>hardware services</td>
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<td>support services</td>
<td>Infrastructure equipment services</td>
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<td>Software maintenance and support</td>
<td>Applications software</td>
<td>Back-office/ERP and supply chain</td>
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<td>Operations services</td>
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<td>Process management</td>
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In this thesis, I refer to the system integration business as a business that provides customers with development and integration services. System integration has become a key factor in the operations, strategy, and competitive advantage of major corporations in a variety of sectors, including computing, financial, automotive, telecommunications, military systems, and aerospace.

System integration is a strategic task that pervades business management not only at the technical level but also at the management and strategic levels. System integrators generally provide all of the professional services defined in Table 5—consulting, development and integration, IT management, and Process management.

5.1.1 Business Model of System Integrators

A business model of system integrators is shown in Figure 23.

![Figure 23 Business model of System Integrators](image)

Source: Author, 2004
A system integrator’s business falls into two categories. One is IT partner with customers, the other is service provider for customers. As an IT partner, system integrators not only provide the system but also work with their customers and assist them as consultants. Through this process, system integrators strive to understand their customers' business and operations, and eventually they provide effective and efficient integration solutions for customers, in some cases for a whole industry.

They can also provide a sharable service within the industry as a service provider. However, currently it is difficult to find a universal solution that can apply to an entire industry. But as a service provider, they can provide customers with various side services that may be required in the information network society, such as security, education, and so forth.

5.1.2 Market and Industry Players

The IT services market in the world is worth over half a trillion dollars. Figure 24 indicates the historical trend and future forecast of market size by regions.

![Graph of Worldwide IT Services Market Revenue by Region, 2000-2007](image)

*Figure 24 Worldwide IT Services Market Revenue by Region, 2000-2007*

Source: Gartner, 2003
The CAGR (Compound Annual Growth Rate) of the IT services market worldwide through 2007 should grow at a healthy rate of 5.7%. North America (combining the U.S. and Canada) accounts for 47% of the global market and will be slightly higher than the global CAGR. While Western Europe currently accounts for 29% of total market size, its CAGR is expected to be lower than the global rate. In this figure, Japan is the only one entry consisting of a single country. Judging from its market size and growth rate, the Japanese market should be attractive for IT service providers. The emerging markets of Asia Pacific, Eastern Europe, and Middle East/Africa are currently experiencing strong growth, with expected CAGRs of 9.50%, 7.70%, and 7.50%, respectively.

Considering the individual players, the leading firm, IBM Global Services, has at most 7% of the market, with Accenture, Hewlett-Packard, Computer Sciences Corporation, and EDS Corporation following behind. This industry is huge but highly fragmented (Computer Wire, 2003).

As shown in Table 5, IT services consist of hardware maintenance and support, software maintenance and support, consulting, development and integration, IT management, and process management. The historical trend and forecast of each segment is shown in Figure 25.
Figure 25 Worldwide IT Services Market Revenue by Segment, 2000-2007

Source: Gartner, 2003

This figure shows the steady growth of the system integration business, which is indicated by Development and Integration in the figure, and the rapid growth of the IT Management and Process Management segments.

This trend is supported by users who plan to do the following:

- IT budgets will decrease slightly, but the IT services budget will increase.
- IT service projects will focus on gaining profitability as a result of cost-efficiency.
- IT spending among small and mid-size enterprises will generally remain stable.
- More strategic IT-related business decisions will emerge.
5.2 Five(Six) Forces Analysis of the System Integration Industry

In this section, I analyze the System Integration industry by using Porter’s five forces plus one factor, complementors (see Figure 26).

**Barriers to entry** (High)
- Required trusty from customers
- Required for superior human resources, consultant, system engineers, IT architect, and system operators
- However, at some niche area in this market, new entrants can work with customers

**Complementors** (Neutral)
- Sometimes, hardware or software vendors who can not have enough human resources become complementor for system integrators to sell its products

**Bargaining power of suppliers** (Low)
- Hardware vendors and software vendors want to cooperate with system integrators to sell their own products
- In case that they have no connection with customers, they have to sell their products through system integrators

**Bargaining power of buyers** (High)
- Basically, customers' needs driven, hard to drive customers' demand comparing to general products
- Difficult to measure ROI for customers
- Long term investment for customers
- Difficult to estimate the performance beforehand

**Threat of substitutes** (High)
- Hardware vendors and software vendors can provide customers with system integration services directly, such as IBM, Microsoft
- The easy use of the system integration software may not require any system integrators’ support

**Intensity of the rivalry** (Modest)
- High switching cost for customers to change IT partners
- However, the prevailing standardization will lessen the switching costs

Figure 26 Porter’s Five Forces, plus one
Figure 26 describes the system integration industry. Overall, the industry is protected from new entrants due to existing customer relationships. Suppliers have low bargaining power since they expect system integrators to be representative of the sales forces. In some cases, suppliers play a role as complementors and introduce new customers to the system integrators. The threat of substitutes is currently increasing because suppliers move into this business, including IBM, Microsoft, and so forth. In addition, quick and easy system integration software makes it possible for customers to integrate the system themselves.

Intensity of rivalry is characterized by two aspects. One is high switching costs for customers to change IT partners, which keeps the intensity of rivalry low. The other is prevailing standardization which will encourage customers to lower switching costs.

Finally, the bargaining power of buyers is high. Even though there is strong demand for system integration, it is difficult to estimate the effect of system integration beforehand and measure ROI. Especially in economic downturns, therefore, the bargaining power of buyers becomes strong.

5.3 Opportunities and Threats Facing the System Integration Business

To clarify the current situation in the system integration business, I have defined the opportunities and threats facing the system integration business, and I explain some key factors.

**Opportunities:**

- Steady demand for system integration
- Replace mainframe with open system (Unix or Windows server)
- Adopt application service provider model
- Adopt open source software and free software
- Technological breakthrough by using Semantic Web services
**Threats:**

- Software and hardware manufacturers entering the system integration market
- Easy and rapid system development
- Security concerns – less trust of system integration

The last bullet point in the Opportunities list is a major focus of this thesis. I will discuss this topic in greater detail in the next chapter.

### 5.3.1 Replacement of Mainframe with Open system

The replacement of mainframes with an open system has been seriously discussed since the late 1990s. The mid-1990s saw a boom in client server systems, and GUI-based systems became popular when operating systems changed from Windows 3.1 to Windows 95. In the late 1990s, a three-tier system using the J2EE application server became popular, along with a Web-based system that aimed to decrease the total cost of operations. Currently, most new systems are developed based on an open environment, and it is difficult to find any actual new implementations of mainframes as a new system development. There are three reasons why mainframes have gradually been replaced over the last few years.

- a decrease in the number of skilled COBOL engineers
- a mixture of mainframe and open systems that has pushed costs upward
- greater reliability and performance of open systems

In addition to the first two reasons which are undisputed fact, the performance and reliability of open system are reaching the same levels as that of mainframes and they are becoming suitable for mission-critical system markets. Open systems have aggressively dealt with the problems around reliable technology for fault-tolerance and availability technology for optimized CPU, memory, and Input/Output device sharing as a virtual server. Although these technologies were developed for mainframes over forty years, the open system has absorbed them in ten years.
I will use the story of Sabre as an example of actual system replacement (Greenemeier, 2002). In October 2002, Sabre Holdings Corp. revealed that it has begun to migrate its well-known airfare-pricing application from IBM mainframes to Hewlett-Packard NonStop servers. The application migration was the first part of a four-year program to switch Sabre’s entire pricing, scheduling, and seating system from IBM’s proprietary transaction-processing technology to Unix systems using relational-database technology. The process still continues, but considering the size of the implementation and the publicity surrounding the system, this challenge will be huge encouragement for various other companies, not just airlines, to replace their mainframe systems with an open system.

This trend will be a good opportunity for system integrators, because it offers them not only the replacement business opportunity but also an especially appropriate time to redesign the system to conform to Service Oriented Architecture (SOA) and Application Integration. The replacement will undoubtedly result in further system integration needs for customers, and the redesign assists the future system integration process.

5.3.2 Application Service Provider

The Application Service Provider (ASP) business has been around since the late 1990s. The general definition of an ASP is a Web-based computer application that resides on a server rather than on a local computer. However, when the dot.com bubble burst, ASPs were forced to learn about the layers of enterprise procurement, and they subsequently adopted the following three disparate options (Gartner, 2003):

- Web-based application access – completely outsourced application functionality; provide proprietary software solution hosted at an Internet data center
- Remote Application Management – reside on customer premises and provide management services and monitoring of network operations center
➢ Application Hosting – a completely outsourced application infrastructure; provide best-of-breed applications that are delivered over private networks (frame relay of VPN)

These options show some overlap of functions between ASPs and system integrators. For example, Remote Application Management and Application Hosting are already provided by system integrators. System integrators provide the application management service developed as a result of in-house system management experience. System integrators already have their own data center and provide interoperable systems among multiple customers as service providers on VPN or Web. Thus I conclude that ASPs are one business model that system integrators can provide.

How is the future of the ASP business perceived? Recently, ASPs were referred as a good example of a disruptive technology facing the current “software as a product” business model from Independent Software Vendors (ISVs) (Aberdeen Group, 2003). The current ASP market has several characteristics that are consistent with Christensen’s definition of a disruptive technology:

◊ **Inferior technology and products** – Today’s online application software systems are much slower than off-the-shelf packages and security remains an issue.

◊ **Small market** – Initial markets for ASPs have been small businesses, not Fortune 500 companies.

◊ **Lack of market definition** – Large and generally profitable customers are still demanding non-on-line network and software packages and market information, while the needs of smaller businesses remain spotty

◊ **Address new need** – ASPs free up server space for small companies and reduce expenditures on constant upgrades of new software

According to Gartner Research, in 2002, 8% of small and medium businesses chose an ASP for their CRM programs. By 2006, approximately 25% of small and mid-size businesses will conclude that an ASP has a role to play in their customer relationship management initiatives (Gartner, 2004).
Although many larger corporations have begun to invest in on-line application service capabilities, the industry has seen an emergence of new entrants like Salesforce.com, which are rapidly gaining market share within the small business segment. As technology improvements such as greater bandwidth and more reliable security become available, it is likely that these new entrants will be well-positioned to move upstream toward larger and more profitable customers, taking market share away from the ISVs. Figure 27 shows how the core competencies of ISVs differ from those of ASPs.

![Diagram showing the differences between ISVs and ASPs]

**Figure 27 Differences of core competencies between ISVs and ASP**

Source: Gartner, 2003

As a result, the ASP business will become one channel that system integrators can adopt to provide IT solution to their customers. At present, this mechanism works well for small and mid-size business enterprises, and it will become feasible for any size enterprise in future.

At the same time, the differences of core competences between ISVs and ASPs are becoming a barrier for ISVs to enter this type of business.
5.3.3 Open Source and Free Software

"Open source" means software programs whose source code is widely available free of charge and is not owned by any one person or organization (Cusumano, 2004). The software is developed and maintained by the community and is basically distributed for free. There are various kinds of open-source software, such as operating systems, web servers, web application servers, database, integrated development environments, and so forth.

Some open source software, including Linux and Apache, were rapidly adapted into real business situations. Linux has higher-cost performance than UNIX but fewer security problem than Windows, and this cost performance has been used successfully to promote the adoption of Linux. For example, Morgan Stanley has 5,400 servers in the world, 700 of which were replaced by Linux servers. Credit Suisse First Boston has replaced more than 20 Sun UNIX servers with nine Linux servers and has successfully curbed initial costs and reduced annual running costs.

I defined an open source software as delivered from open source community to enterprise customers through three possible trajectories, shown in Figure 28. Currently, each trajectory is not stable, and each player must take care of the dotted lines which are not currently established or seem to be very weak.
Software vendors cannot sell open-source software as it stands but have to add value to it. There are two ways for them to do this. They can build other relevant features on it, or they can bundle it with some service(s), such as consulting, upgrade and maintenance support, and/or training. Red Hat, the major company that sells Linux to consumers and enterprises, has actually done both. However, in November 2003, they stopped selling the RedHat Linux product line and began to sell RedHat Enterprise Linux by annual subscription. This change is a big step for them as they work to build a strong relationship with enterprise customers.

On the other hand, open source software will impact the system integrators’ business. Since it will be available without charge, system integrators who take advantage of open source software can provide some solutions at lower prices, mainly for small and mid-size businesses, which means an
increase of market size. The adoption of open source will gradually expand to include operating systems and middleware application servers and databases.

However, applying open source software to an integrated system may lead to some unforeseen errors, termination of patch supply, and incompatibility caused by upgrades. If they experience such troubles, system integrators must acquire a deeper knowledge of open source software and added know-how about using such software with system integration. I believe system integrators will accumulate the skills and know-how needed to apply open source software to integrated systems, so they will be in a position to support small and mid-size enterprise customers who are seeking low-cost system integration. It will also arouse further demand from customers who had refrained from adopting open source software, which includes large-size enterprise customers.

The application development approach of open source software is different from existing approaches, such as traditional waterfall styles or the iterative styles adopted by Microsoft (Cusumano & Selby, 1995). Such approaches will also impact the system development methodology used by system integrators, especially if they are considering the use of any open source software.

5.3.4 Easy and Rapid System Development

From automation of code generation to high-end quality and process management tools, there are various tools and methodologies to improve the quality and productivity of software development. For example, IDE with GUI allows system engineers to produce software program without typing code. In addition, by using various UML modeling tools, system engineers can generate programming templates to replicate a customer’s business process. The programming code generated by tools becomes homogeneous, and the uniformity of the code assures its reliability and reusability. Improvement of software productivity reduces the need for human resources in system development, and in extreme cases business consultants or IT users may be able to develop a system themselves.
Under the circumstances, system integrators who own system development workforces in-house will suffer huge cost pressures during system development.

Originally system integrators had to leverage their knowledge into their business model. However, in the real world, most system integrators tend to be labor-intensive, and they have increased the number of employees in order to expand sales. To counteract the growing number of employees needed to increase sales, some system integrators have decided to outsource system development to engineers in China and India who will work for lower wages. I believe system integrators should consider a business roadmap in order to concentrate high value-added services. They should regard system development as a non-core business and reduce their development and integration forces with effective automation of system development or through outsourcing.
As discussed in the previous chapter, there are new opportunities for system integrators, owing to technological breakthroughs in system integration through the use of Semantic Web Services. In this chapter, I describe the goal of system integration and explain the concept of information integration. Then I examine how system integrators can apply the Ontology to information integration. Finally, I consider the impacts of other opportunities and the factors that may threaten this opportunity.

### 6.1 The Goal of System Integration

Currently most companies have the traditional IT architecture shown in the upper portion of Figure 29. This figure shows that multiple silos of an information system, developed by each business unit, exist in the corporate networks and infrastructure services. Each silo consists of data, applications, and a technology platform. Each silo is separately designed and there is no consistency among silos. Thus, when some interaction among silos is needed, knowing how to interact is complicated and may be done in an impromptu manner. In some cases, the lack of data standardization and insufficient application design may result in a need to extract data from an application. This painful effort requires much time and cost for the company.

On the other hand, the lower part of Figure 29 shows the enabling IT architecture. At the base of IT architecture, there are infrastructure services, including shared data and middleware and enterprise systems. The competitive capabilities are located on the infrastructure services. The system that ensures the company’s core competitiveness should be realized in this tier and be shared among all sub-systems. On the top, maverick or stopgap solutions are realized with short lifecycles to enable
Figure 29 Traditional IT Architecture and Enabling IT Architecture

Source: MIT Course 15.571, Spring, 2004
faster time to market. The information is entered from the top level and the necessary information is accumulated in the shared data section, following downward gravity.

As an example, MetLife, one of America’s oldest and largest insurance and financial companies, had experienced a series of acquisitions. In the various companies there were independent systems that resulted in very messy operations. However, the company began to redesign its IT architecture as shown in Figure 30.

Figure 30 MetLife’s Enterprise Architecture

Source: MIT Course 15.571, Spring 2004

They built an infrastructure that can be shared among the various business units, including an operational data store. The information from every business unit is gathered through an integration
hub and stored in the operational data store. The information is transformed into XML format and delivered to applications, each of which represents MetLife's competitive capabilities, such as marketing, illustrations, order entry, underwriting, and so forth, all based on the service-oriented architecture. These applications are available through a portal site that enables users to add their own stopgap solutions. The portal is publicized inside the company and to partner companies to ensure smooth interactions with partner companies. Currently, MetLife has implemented 85% of this big picture in three years.

The MIT Center for Information Systems Research (CISR) defines four stages of maturity for system architecture, as shown in Figure 31. CISR also conducted a survey of forty Chief Information Officers, asking them to tell which stage their company's IT architecture fit in. Ten respondents regarded their company's IT architecture as "Application Silo." Twenty-two answered "Standardized Technology," and six chose "Rationalized Data."

![Figure 31 Strategy-Architecture Relationship](image)

Source: Ross, 2003

The remaining two respondents consider their IT architecture to be "modularized." The research warns that modularity is not the right place for all companies. However, many companies are
moving toward a more mature IT architecture. I believe a system integrator should support the movement and push customers' IT systems as they reach the more mature stage.

### 6.2 Information Integration

Given that all companies have to move toward the right-hand side of Figure 31, the survey mentioned in the previous section found that difficulties often come in the transition after “Standardized Technology,” since the number of companies in that segment account for only 27% of those in “Data Rationalization.” Table 6 shows the learning needed at each stage, and the achievements needed to reach each stage.

<table>
<thead>
<tr>
<th>Table 6 Learning at Each Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IT Capability</strong></td>
</tr>
<tr>
<td><strong>Application Silo</strong></td>
</tr>
<tr>
<td>IT applications serve isolated business needs</td>
</tr>
<tr>
<td><strong>Key Management Innovation</strong></td>
</tr>
<tr>
<td>Technology-enabled change management</td>
</tr>
<tr>
<td><strong>Business Case for IT</strong></td>
</tr>
<tr>
<td>ROI of applications</td>
</tr>
<tr>
<td><strong>Funding Priorities</strong></td>
</tr>
<tr>
<td>Individual applications</td>
</tr>
<tr>
<td><strong>Who Defines Applications</strong></td>
</tr>
<tr>
<td>Local business leaders</td>
</tr>
<tr>
<td><strong>Key Governance Issues</strong></td>
</tr>
<tr>
<td>Estimate, measure, communicate value</td>
</tr>
</tbody>
</table>

Source: Ross, 2003
According to the table, the company needs standardization of data supporting a disciplined core business process as an IT capability in order to move from “Standardized Technology” to “Rationalized Data.” This fact supports the survey findings mentioned in Section 3.3.

Based on their competitive situations, companies must specialize in their core capabilities, while at the same time considering outsourcing and collaboration with other companies. To specialize in their core capabilities, they have to understand existing business processes and integrate them effectively and efficiently, known as “Business Process Integration.” If an existing business process is highly dependent on specific systems, those also have to be integrated. If not then they must be abolished in order to develop a new system from scratch, known as “Application Integration.” In doing so, they have to consider “Information integration,” which means standardizing the information inside the company, integrating it, and then utilizing it (see Figure 32).

![Diagram of Integration Roadmap](image)

**Figure 32 Integration Roadmap**

Source: Author, 2004

Currently, the importance of information integration is not sufficiently focused. Companies tend to pay more attention to Application Integration and Business Process Integration. My research found that the lack of attention to Information Integration will result in poor Application Integration
and poor Business Process Integration as mentioned in Section 3.3. Therefore, successful Application Integration is highly dependent on Information Integration.

However, Information Integration by a system integrator is almost always a very difficult task. In many cases, the data in one business unit cannot be understood by other business units since each business unit defines the data format in its own way. In such a situation that have occurred recently, many companies try to build a data warehouse that can be used all over the company for business-driven needs such as inventory control, analysis of turnover rate, reduction of lead time, and budget planning. However, the quality of information stored in the data warehouse is too poor to be used. In such a case, the data warehouse cannot be used effectively and does not bring sufficient return on investment. This indicates that companies cannot cut out a step in the Application Integration process by ignoring the Information Integration step shown in Figure 32 above.

To solve the problem of standardization, an XML-format data exchange has often been used in recent years. Data structure can be easily standardized in the XML format and original data is easily transformed to XML. However, missing information in the original data cannot be processed automatically even by using XML. I experienced this problem several times, and I believe it's a key issue which a system integrator must overcome. Unless the missing information can be filled in automatically, the information will not be truly integrated into the company, and unless information is truly integrated, the company cannot move into the “Rationalized Data” stage. Missing information in the original data usually occurs for two reasons. One is that the original data literally had no information. The second is that the original data had only partial information or was expressed in a different form. In the latter case, I believe the Semantic Web will be a promising technology for system integrators, enabling them to accomplish automatic information integration. By utilizing the Ontology, a computer can understand the meaning of data, revise its expression, complement the missing information in the original data according to predefined strict procedures, and finally create complete standardized data, as shown in Figure 33.
Technologies in the higher levels of the Semantic Web layer stack (refer back to Figure 2) such as Rule, Logic, and Proof, not only enable more dynamic Information Integration but also a more flexible Application Integration. These technologies help computers find the appropriate applications to achieve a goal and coordinate the data interaction between them automatically without predefining the process. However, since these technologies are currently in the experimental stages, I believe it will take more time to realize a fully automated Application Integration.

Reconsidering the relationship between Web Service and the Semantic Web, Figure 32 shows that Web Service is a technology for Application Integration, while the Semantic Web is a technology for Information Integration.
6.3 How to Apply Ontology

Based on my research and analysis, I developed a way to apply Ontology for system integrators, as shown in Figure 34. The key is to keep Ontology inside the system integrators.

![Ontology Application for System Integrator](image)

Figure 34 Ontology Application for System Integrator

Source: Author, 2004

When System Integrators build an Application Integration system based on standardized data, they must create a system like the one shown in Figure 33. The system will be located in the customer’s premise or the system integrator’s premise. If system integrators locate the data warehouse or Application Integration system in the customer’s premise, they can separate the data standardization service and provide it as an ASP service. I believe customers will choose the ASP for data standardization for the following reasons:
to reduce the cost of system development, especially in small and medium-size businesses

if the data standardization system is only for temporary use, the company will move the Application Silos to a more mature IT architecture.

The second reason indicates that ontology will not be used for some companies after they discard the Application Silos and build the application on infrastructure services that are based on standardized shared data, as shown in Figure 29.

However, the company may still need to use the Ontology for Information Integration with another company. When system integrators can apply the Ontology to other company’s information integration as well, they not only support the system integration inside but also facilitate the data exchange between the companies by utilizing separately developed Ontologies.

Considering the current data exchanges among multiple companies, consortiums have been formed to define standard formats and expressions for data exchanges. However, it is difficult to define standards that satisfy all players in an industry. Even if the standard is successfully established, some users cannot afford to change their own system in order to satisfy the standard. Furthermore, if the data exchange occurs among companies in different industries, it becomes even more complex and difficult to define a mutually acceptable standard.

The Ontology approach for Information Integration provides one solution to the problem, and there is no need for a consortium to define standards for a whole industry or among industries. Instead, by defining a standard for each company, accumulating and linking the meaning of each company’s standard data by using Ontology eventually enables Information Integration among the companies. For example, when Company A use a Kg unit for standardized weight and Company B uses a pound, a consortium would have to decide the standardized unit of measure—Kg or pound. If Kg is adopted as the weight unit, then Company B has to add a data conversion function to its existing systems to change its weight unit from pound to Kg. But, by using Ontology, as long as the relation “1 pound = 0.453 Kg” is registered in the Ontology, Company A and Company B can successfully exchange their own data as in its present form without need for conversion.
However, there could be a scalability problem in this approach. At first, most Information Integration assumes the existence of a single ontology for a particular company. New ontologies are either merged with existing ones to form an even bigger ontology, or they have to be connected with all the previously used ontologies. Both approaches cause problems. Such large, single ontologies are hard to maintain and extend, mappings between local ontologies are hard to find, and the effort of building mappings grows with every new ontology release.

To solve these problems, system integrators have to provide an Ontology infrastructure that has two dimensions of the Ontology layer as shown in Figure 35. These layers trade off local and global ontologies in such a way that systems can define terms individually with meanings that can be compared across systems without explicit mappings. The local layer stores the customized ontology for specific customers, and the global layer is nothing more than a collection of knowledge regarding the data standardization, which is applicable to other companies.

![Figure 35 Data exchange by Ontology](image)

Source: Author, 2004
6.4 Impacts of Other Opportunities and Threats

Considering the other opportunities mentioned in Section 5.3, I believe these will support the application of Ontology for Information Integration.

- **Steady demand for system integration** => supports customers’ demand for Information Integration.
- **Replacement of mainframe with open systems** (Unix or Windows server) => facilitates System Integration, which produces demand for Information Integration.
- **Adoption of an ASP Model** => provides cost-effective way to furnish the system to small and mid-size businesses and enable system integrators to keep Ontology inside and maintain it.
- **Adoption of open source software and free software** => offers cost-efficient way to develop a system for small and mid-size businesses.

All these opportunities indicate a steady demand for Information Integration from customers, and further market expansion by low-price information integration.

On the other hand, considering the threats facing system integrator mentioned in Section 5.3, I think the following indicate warnings for system integrators:

- **Entry of the System Integration market by a software or hardware maker**

  Before achieving the Information Integration, it is hard to develop a general System Integration solution which gives a software or hardware maker an advantage. Therefore system integrators should focus on their business consultation skills and utilize their broad and deep knowledge of their customers’ business to provide Information Integration solutions. At the same time, system integrators should prepare for commoditization of their business.

- **Easy and rapid system development**

  As mentioned earlier, system integrators focus on the Information Integration first, and then the integration results in the homogeneous data-sharing infrastructure. The infrastructure
enables system developers to build systems more easily than previously and promote easy and rapid system development.

➢ Security concerns: less trust of System Integration

As Information Integration proceeds, an automatic information exchange will become common. Therefore system integrators have to be more sensitive to security issues and provide solutions to them.
Chapter 7  Conclusions, Lessons, and Future Work

7.1 Conclusions

In this thesis, I examined the business impacts of the Semantic Web. In Chapter 2, I researched current technologies for the Semantic Web and realized that while the Ontology level and below seems to be feasible today, the layers above Ontology have not yet been sufficiently developed for companies to use them into real business situations.

In Chapter 3, I presented my research about the potential disruptiveness of the Semantic Web and confirmed that it has the potential to bring about sustainable innovation for the current Web and Web Services.

In Chapter 4, I researched business applications of the Semantic Web. The current business applications of the Semantic Web focus on areas such as Knowledge Management and Content Management.

I examined potential applications to Business Integration apart from knowledge management in Chapter 5 and Chapter 6. First, I researched the current business situation of System Integration from a system integrator’s point of view. Second, I described current customer demand for System Integration and considered how to maximize the trend. To achieve this, I believe that Information Integration plays a key role. And I concluded that the Semantic Web, especially Ontology, is a promising technology driver for Information Integration. Furthermore, based on Information Integration, Web Services will be adopted to integrate applications automatically, both inside companies and among them.

As a conclusion, I recommend that system integrators deploy the Semantic Web in their information integration projects. Even though some customers may hesitate to implement the Semantic Web due to its technological immaturity, system integrators should implement accumulate
the knowledge thorough some pilot projects within the companies and apply it to actual projects with customers. I also recommend that system integrators implement the Semantic Web step by step from the generation of RDF metadata to the development of the Ontology as some actual business cases indicate.

7.2 Key Lessons

From a system integrator’s perspective, there are two key lessons to be gained from this thesis.

**Present a clearly defined position to customers**

The position of a system integrator, as perceived by customers, should become transformed through the process of Information Integration. System integrators should be aware of the change and consider an appropriate deployment of resources.

Customers who have Application Silos try to cope with a particular system integrator since it has known their business and their system well for a long time. The complexity of Application Silos does not allow other new entrants to step between them. In such a situation, system integrators can handle the problem not only by adopting the best combination of solutions selected from multiple software and hardware vendors, but also by providing a value-added solution.

On the other hand, customers who have a more mature IT architecture than Application Silos will change the criteria they utilize to select the system integrator. They will choose a system integrator and expect that system integrator to provide a solution—either core capabilities or maverick and stopgap.

To utilize its know-how and consultation power, a system integrator should provide more specific and effective solutions to customers, otherwise customers may very well choose another system integrator or software vendor due to low switching costs achieved by standardization of
infrastructure service. In addition, the standardization and commoditization of infrastructure service will help customers choose the most cost-effective method by contracting with general solution providers.

Therefore a system integrator has to consider ways to enter the commoditized market as a service provider. As shown in Figure 35, I regard a data exchange service among companies to be a potential option for system integrators that desire to enter the service provider business, and this options is more easily achieved by utilizing the Semantic Web (see Figure 36).

Figure 36 System Integrator Play Key Role

Source: Author, 2004

**IT doesn’t matter...Does it?**

Nicholas Carr (2003) explains that IT is a basic infrastructure for a company and, just like electricity and telecommunications, the infrastructure cannot avoid becoming commoditized as time goes by, based on historical examples. He pessimistically articulates the future of IT spending as follows:
More and more, companies will fulfill their IT requirement simply by purchasing fee-based “Web services” from third parties – similar to the way they currently buy electric power or telecommunications services. ... Again, the upshot is ever greater homogenization of IT capabilities, as more companies replace customized applications with generic ones. (p. 44,45)

He also mentioned this trend in the following Figure 37. Companies’ competitive capabilities generated by IT are compared to the tip of an iceberg in an ocean. The major part of the iceberg consists of commoditized capabilities like IT. As the iceberg sinks into the ocean, competitive capabilities like IT also go down as a result of the commoditization of IT. Like snow falling, if there are not enough technological and business innovations, we cannot retain sufficient competitive capabilities, which mean that IT does not provide competitive capability to companies. He forecasted that the snow cloud is shrinking and the iceberg continues to drop further into the ocean.

Figure 37 IT Capabilities Iceberg sinking down

Source: Carr, Class Seminar Spring 2004, adapted by author.
I believe that the Semantic Web and strong demand for System Integration is becoming a “snow cloud” over the IT capability iceberg. At the same time, System Integration brings commoditization and pushes down the iceberg. However, IT still plays a significant role in creating competitive advantage for companies. Furthermore, considering the technological breakthroughs and other undefined technologies surrounding the development of the Semantic Web, I think the snow will continue to fall, and the tip of the iceberg will maintain a significant presence above the ocean.

According to Figure 38, there are many emerging technologies within a certain time horizon. I did not determine whether every technology was in the right place or whether every technology can be applied to the real world. But I did confirm that a large number of technologies have been developed, and they will continue to enable companies to build competitive advantage by making effective use of those technologies.
7.3 Future Work

I have identified three topics that could be pursued as future topics for research, following on the outcomes of my thesis.

- **Business Applications and Impacts of the Semantic Web on the Consumer Market.** As I mentioned in Section 4.1, the Semantic Web will also impact the business model in the consumer market. I forecast that companies in the consumer market will emerge using Semantic Web technology as their core strength. Especially in Direct-to-Customer businesses, such as Amazon.com and eBay, the Semantic Web will help to complement their
business. Likewise, for full-service-providers and intermediary businesses, the Semantic Web will help them to aggregate relevant resources on the Web.

- **Business Applications and Impacts of the Higher Layers of the Semantic Web.** While I focused on the layers under and up to Ontology in the Semantic Web stack (see Figure 2) as business applications, there are still untapped layers. These layers originally came from the artificial intelligence research field and their aim is to realize agent processing through the use of computers.

- **How Other Emerging Technologies Impact the System Integrator Business.** I believe the system integrator business is required to understand the technology impact long before the customers know and then be prepared to apply them aggressively from the experimental stage forward.
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