Challenges in the Adoption and Diffusion of Web Services

in Financial Institutions

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ABSTRACT

In the last years many solutions have been presented as the silver bullet to enhance the IT - Information Technology - of the financial institutions. This thesis is an investigation of the possible applications of web services to generate value in the financial industry, trying to segregate the business reality from the hype surrounding them.

The work analyzes the potential benefits and the challenges involved in the adoption and diffusion of web services in the financial industry, utilizing academic research and examples of current use of web services, to try to derive the basis to their adoption in the next years.

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1. Introduction

During the last years some analysts have tried to sell an envisioned almost perfect IT - Information Technology world though the use of web services. A company might be able to assemble a whole business by piecing together web services created and maintained by other companies, and listed in public online directories. For example, “a company looking for a way to check the credit histories of its customers could have its order-processing software automatically scan the Web to find companies that offer a credit-checking web service, figure out which company offers the best deal, negotiate it and then hook up to that company's web service on the fly-even if the two companies never did business together before”. [1]

This is one of the envisioned possibilities of web services use, but “if one believes the many articles currently appearing in the popular technology press, it would seem that web services are the greatest innovation ever. Not only can web services be used in numerous situations to realize elegant solutions to pressing business needs, but they can be adopted by both developers and customers with little fanfare. As usual, the practical reality of the situation is somewhat different from this utopian techno-centric view of the world.” [2]

The management of a company’s IT infrastructure involves an effort to maintain and support legacy systems and implement new systems to meet emerging business needs, while ensuring that the overall IT infrastructure is dynamic and flexible enough to enable rather than inhibit changes in business direction and strategy [3]. To accomplish those tasks many tools have been developed or made available by vendors, and many of them pledge to be the “silver bullet” to the IT management, as the web services.

Further descriptions are presented in the following chapters, but, web service can be considered a set of agreed-on standards, allowing it integrate and communicate, via a network (internet, extranet, intranet), with diverse applications written in different programming languages and running on different operating systems and hardware without the need of close knowledge of each other’s IT systems.

In this work potential uses and challenges to adoption and diffusion of web services will be analyzed, specifically in financial institutions, separating the hype from potential real business opportunities. The focus is on the possibility of value creation to the business, exploring some technical aspects needed to fully understand the issues that can trigger or hamper the use of web services. The focus on the value creation is to reinforce that technology is a means to an end, not the end in itself, and that strategy comes first, followed by the decisions and the technologies that help support it [4], as technologies used to enhance services, increase efficiency, and leverage existing strengths [5].

Years ago a Citibank’s executive recommended that “if a new software system comes out that promises to do everything you want, wait until all the pieces of the system are fully operational and functioning” [6]. It is possible that waiting for all the pieces to be fully operational turns out to be too long a time, but in financial services, in general, it is possible to wait for other companies to debug the technology first, since it is necessary to use advanced technology but not to be on the technology’s cutting edge. [3].

Although, there is not a magic formula to define the exact time to make the decision about the adoption of a new technology, it is fundamental to not have the profits lavished on the latest and greatest state-of-the-art technology [6], nor loose space to competitors or substitutes. An earlier adoption of a technology can ensure a longer stream of benefits, but the company can also be stuck with an inferior technology in the future [7], specially when adoption of standards are a fundamental piece in the processes, as in the web services.

In the mid 1990’s, when the internet banking burst, banks were hesitant as for its adoption, but after some time a rush to its implementation occurred due to the possibilities of changing the delivery of financial services. Now, increasingly, the internet banking is viewed almost as a commodity, and at the same time

became a main part of banks products Without intending to compare the impacts or importance of the adoption of each one, the scenario of web services adoption seems similar. Financial institutions look for applications presenting functionality, scalability, ease of implementation and integration, as those promised by web services, but, so many previous solutions made these promises understandably doubtful when it comes to the most recent one. This work will point out differences and similarities between web services and some of those previous technologies.

Although web services have the potential of being used in the integration of inter and intra systems organizations, it is important to have in mind that the challenges to the integration are not only related to the available technologies itself. Over the years many IT departments have carried out the requests made by different corporate functions and tried out pledges of diverse vendors about new solutions, resulting in the development of a myriad of information systems that do not talk to one another [8]. Also, due to the rapid rate of technological changes and pressure for results, IT is many times seen in terms of short term, silver bullet solutions. Vendors pledge that new technologies will blow away what has come before. But IT must be analyzed in terms of a long-term and disciplined strategic view, and following the goals of the company [8]. Many organizations have independent IT initiatives, each one with particular business applications, technologies, cultures, data definitions, and orientation. Projects costs soar because teams are isolated and do not reuse each other's components. Those issues will be solved by neither web services nor any other technology alone. Unifying IT platforms and making them work together demands, besides technology, the same characteristics demanded by other parts of the business, as discipline, leadership, diligent execution, motivated people [8], and the many trades off with the resources available. The development of more and more isolated systems creates redundancy, inconsistency and non-interoperability, increasing the costs of running the banks' operations.

Financial services have been undergoing rapid changes fostered by globalization of financial markets, technological advances, and structural changes. Given its information intensity, financial services greatly benefit from advances in technology, enabling gains in efficiency and cost reduction [9]. Competition forces the financial institutions to exploit alternative ways of increasing their efficiency, through economies of scale, economies of scope or joint production [10] [11], and web services have the potential to help in achieving such aims.

Financial innovations have been driven by economic changes as well as technological progress. Advances in trading technologies and regulatory changes affecting not only the banks but also the corporate and investment community, have led to rapid changes. Many techniques have been developed with advanced technologies to take advantage of the increasing availability of information. At the same time, business efforts, strategic and tactical decision-making have increasingly become information- and time-sensitive. To satisfy sophisticated demands of the customers more and more, the market is creating more and more complex solutions and instruments. In such environment, mathematics, statistics, and optimization have become crucial tools, along with advances in technologies that have made their utilization possible [12].

Financial institutions are facing the challenge of cutting cost and increasing efficiencies to keep the competitiveness. Although cost issues are still paramount, the success will not be based only in containing costs and reducing expenses, but will depend on restructuring business processes to change the cost structures of business, achieving scale and scope economies in the right business, and managing investment spending more strategically. Leveraging the technology can be used to develop new products, creation of databases to explore opportunities of cross-selling, and automation of back office operations to reduce operational costs [13]. Moreover, there is a constant change in the dynamics financial services industry, demanding flexibility and agility. This work intends analyzes the application of web services in this context.

From a business perspective there are many dimensions that must be examined when considering the move to a web services model, as issues of cost (both short term and long term), timing, flexibility, control, maintenance, support, staff and return on investment to name a few [2].

Examples of current and possible applications of web services and related challenges are used to illustrate the ideas, but they can not be taken for granted. When confronted with a new business phenomenon many times companies look for marketplace outcomes for guidance. “But, in the early stages of the rollout of any important technology, market signal can be unreliable. New technologies trigger rampant experimentation, by both companies and customers, and the experimentation is often economically unsustainable. As a result, market behavior is distorted and must be interpreted with caution” [5].

The adoption of web services is a challenge for both tool developers and enterprise users. In analyzing the announced potential applications of web services, one of the issues is separating marketing hype from business reality and determining whether web services are a fundamental advance rather than something old under a new name [2].

To achieve this objective the work is organized as follow:

- Chapter 2 presents an introduction to web services, describing their main components, functioning, and the work for establishment of their standards, including specifics standards to financial services
- Chapter 3 describes the potential benefits to be achieved with the use of web services, both from the technical and business perspectives, describing and analyzing current and possible applications of web services in financial services
- Chapter 4 analyzes the challenges for adoption of web services, specially for financial institutions, and the aspects that can hamper their diffusion
- Chapter 5 establishes comparison with current applications and solutions that were claimed to have similar characteristics and objectives as those presented by web services, analyzing similarities and differences among them
- Chapter 6 uses all the aspects discussed in the previous chapters in a framework to analyze the aspects involving the adoption and possibility of diffusion of web services in financial services

2. Introduction to Web Services

The work is intended to evaluate the potential of web services in generating value to the business, and not dive in the technical side of the technology. But to do so, it is necessary to understand some technical issues and evolution of the web services' components, structure, and standards, because the development and deployment of web services are in great part related to them.

The web services concept is still under development and it is possible to find a lot of different definitions to them. Vendors try to establish definitions that best match their capabilities, organizations responsible for the development of standards try to establish definitions that give them power over the greater number of standards, and many others entities have the definitive definition to web services. Furthermore, there is a lot of discussion to analyze whether the current implementations carried out by companies and denominated web services, are really web services or not. Analyzing diverse cases and comparing with accepted definitions of web services, it is possible to realize that most of them are implementations of standards that are supposed to compose web services, but not exactly web services. This work will not delve in such discussion, and instead will analyze the potential generation of value of web services or their components, as they have been deployed so far.

Web services-based technologies are supposed to use open, text-based standards, allowing the communication among components written in different languages for different platforms [14]. One of the web service definitions is "an application interface that conforms to specific standards in order to enable other applications to communicate with it through that interface regardless of programming language, hardware platform, or operating system" [15]. The interface complies with the following standards:

a) XML (Extensible Markup Language) based documents for input and output data
b) SOAP (Simple Object Access Protocol) standard specifying how documents are exchanged
c) WSDL (Web Services Description Language) standard to provide description of the input and output parameters to use of the service
d) UDDI (Universal Description, Discovery, and Integration) to register the web service

Some definitions include additional components and other definitions do not include any specific standard. But the definition above was chosen for including the components more frequently accepted as composing web services. But, as some of those components are still not mature enough, some examples do not make use of all those components, and would not fit exactly in the previous definition of web services.

2.1 Structure of Web Services and Main Standards

The intention is not to extend in the technical side of web services, but some explanation about its structure is needed, since some challenges to their implementation lay on standards to their structure's components. Most of standards are still under development and facing constant changes, but an overview of the main components, up to now, helps in understanding the web services possibilities and challenges. Even with their constant alterations and the possibility of substitution of some current standards, their main characteristics, functions, and needs tend to remain or evolve from current ones. Furthermore, there are specific standards to each industry that need to be accompanied, and some of those related to Financial Institutions are mentioned below.

Like most network applications, web services can be viewed as a layered stack of protocols. In this case, the current basic stack consists of the following components and main protocols:

Layer	Protocol
Network Transport Protocol	TCP - Transmission Control Protocol IP - Internet Protocol HTTP - Hypertext Transfer Protocol
Meta Language	XML - Extensible Markup Language
Messaging Layer	SOAP - Simple Object Access Protocol
Service Description Layer	WSDL - Web Service Description Language
Service Discovery Layer	UDDI - Universal Description, Discovery, and Integration

Table 2-1 – Main Web Services Components [3][16][17][18]

Although, as seen in the following figure, there are a lot of protocols that can compose web services, only the main components will be explained. Those other components are mentioned as examples, but it is not the intention of this work to detail each one of them.

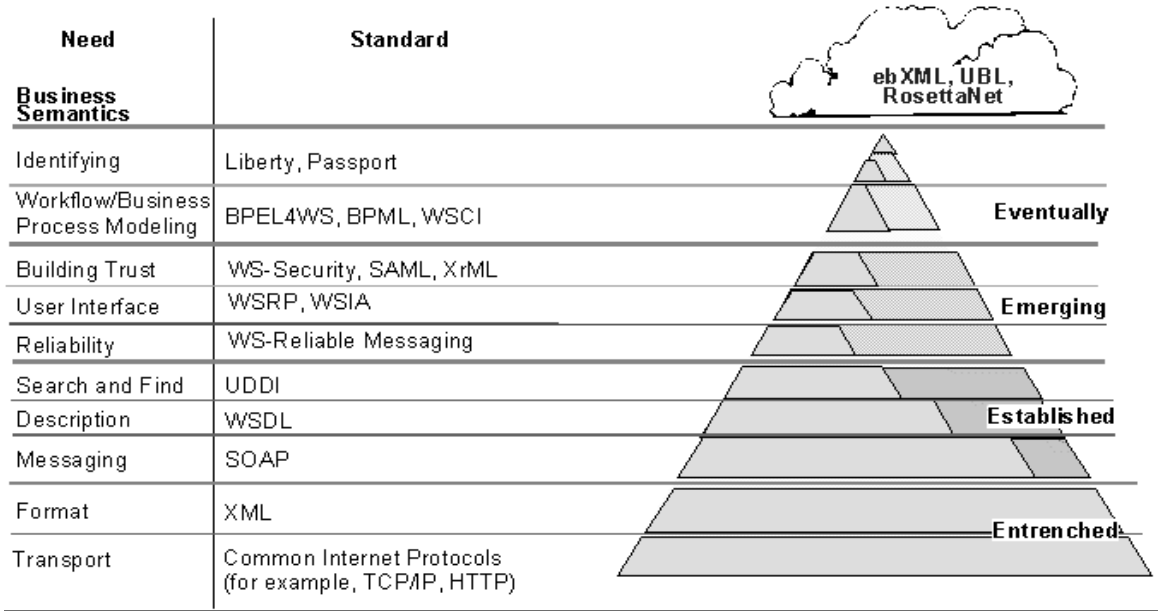

Figure 1-1 - Web Services Structure [19]

So far, each of these standards presents different levels of maturity. The network transport protocols and the XML, for example, are already used in most applications, while the others standards are still evolving, although some are also already being utilized by some organizations as the WSDL.

The use of the TCP/IP - Transmission Control Protocol / Internet Protocol and HTTP - Hypertext Transport Protocol is a positive aspect of web services, since it has taken advantage of the internet network infrastructure already in place, avoiding some deployments problems met by other middleware technologies [2]. On the other hand, the use of internet connections brings some concerns as reliability, security, and speed. [97]

2.1.1. Extensible Markup Language (XML)

The XML is the language in which web services communicate and the language in which many other standards of web services as SOAP, WSDL, and UDDI are based. [3][14] Encoding messages in a common XML format allows the message to be understood by different communicating services regardless of hardware platform or implementation language [2]. It means that information is represented as a structured document, making the interpretation and manipulation by different systems without manual intervention possible. In addition, XML provides a standard means of describing data and the data context required to interpret the data if manipulation is necessary. For example, if multiple parties agree on a XML document structure of a purchase order, it is possible to share that document across multiple systems or organizations [3].

In 2003, a survey [20] showed that 44 % of the US banks and asset managers were already using XML in some projects, but most of them lacked a defined strategy, deploying it on a case-by-case basis, mainly in internal system integration.

But, the XML is only part of the solution of interoperability, since it is necessary to implement business or industry-specific standards to describe the various products and transactions in each industry [14]. Although XML and web services simplify the system integration and interoperability through the use of technologies and standards to transport, route, discover, and connect services, they do not solve the challenges of aligning data definitions, jargon, and vocabularies within and across organizations [3]. In companies, it is very common to find many different meanings for each term in different applications, and if inside the company the consolidation of definition is not an easy task, things go worse in trying to establish the interoperability among different companies. The simplest transactions [21] can involve many subtle distinctions in terminology and meanings. To solve such problem, many industries are trying to agree on XML data definition standards required to enable cross-organization data exchange [3], since the XML would establish a common structure or syntax or grammar of the documents, but not their semantic or meaning. The XML alone enables syntactic interoperability, allowing web services and agents identify the structure of the message exchanged, but it do not provide an interpretation of the content of those messages [16].

Such standards show different status of development and agreement-on, and it is important to the companies to accompany their evolution to ease the making of decisions about its adoption or the time of adoption. As examples of organizations and correspondent financial industry data-definitions standards, it is possible to mention:

Organization	Data-definition Standard
Financial Information Exchange Organization	The Financial Information Exchange protocol (FIX) is a messaging standard developed specifically for the real-time electronic exchange of securities transactions.
Interactive Financial Exchange Forum	The IFX is a financial messaging protocol for interoperability of systems seeking to exchange financial information internally and externally, as in Cash Management, Electronic Bill Presentment and Payment and Business to Business Payments.
International Swaps and Derivatives Association	The Financial products Markup Language (FpML) is an information exchange standard for electronic dealing and processing of financial derivatives instruments, establishing protocol for sharing information on, and dealing in swaps, derivatives and structured products.
FinXML Consortium	FinXML is an XML-based framework within which vocabularies for capital markets (including interest rate, foreign exchange and commodity derivatives, bonds, money markets, loans and deposits, and exchange traded futures and options) can be defined and within which applications using these vocabularies can be developed and deployed. The FinXML is supposed to be interoperable with other standards as FIX and SWIFT - Society for the Worldwide Interbank Financial Telecommunication.
ACORD (Association for Cooperative Operations Research and Development)	XML-based standards to be used in transactions related to Property and Casualty and Life insurance sectors.

Figure 2-2 – Financial Services' Standards [3][16][17][18]

Some of those organizations have already developed standards to the finance and insurance industry as FIX and ACORD, what can ease the deployment of XML-based standards. But, as each organization seeks agreement on different standards, they can present overlaps or gaps that should be resolved, to guarantee the interoperability. And, the financial industry [96] has been confronted with a multitude of definitions which, in many cases, are competitive or even contradictory. For example, FIX, FpML, and FixXML are working on standards involving derivatives. Using the XML language to create multiple XML-based standards initiatives do not solve the problem of interoperability. It is necessary to have a standardized use of XML or guarantee the interoperability among them, since there is the possibility, for example, that a system based on different XML-based standards does not communicate with one based on other standard.

Some of such standards, as ACORD XML, are already being used, though. In the last two decades more than 2,000 providers (mutual funds, banks, insurance companies, brokerage firms, and third party administrators) entered the dispute for a share in the US$ 1.5 trillion 401 (K) market, and are incorporating ACORD XML in their projects to allow the systems integration with better service level, reduced integration costs, and higher levels of automation [22].

Another obstacle is that the meanings are not static - they change over time - and new "vocabulary" needs to be included. Thus, even after the agreement on standards, the work of organizations needs to be kept to assure the evolution of the standards.

Besides the difficulty to come to an agreement, it must be considered that after agreeing on a standard to guarantee the interoperability, companies need to incur in switching costs to migrate their already installed

base. It involves decisions on whether to adopt, complete migration or adoption only in new applications, and the availability of time to do so.

2.1.2. Simple Object Access Protocol (SOAP)

The SOAP protocol is a standard to format messages between web services, or web services and applications. It specifies the message, the header and the message body, all in XML [3]. The header is used to hold metadata associated with the request, including features, such as security and transactions, while the body is used to hold the service invocation and its parameters or the actual exchanged data [23][24]. The SOAP relies on XML to provide a mechanism to invoke a web service and retrieve the results in a consistent manner [2]. Also, one of the major advantages over the previous technologies is that, since it relies on protocols as HTTP, the messages can easily transverse firewalls, easing the communication among different companies [25].

2.1.3. Web Services Description Language (WSDL)

WSDL is a XML - based standard describing how a web service is accessed and what the needed inputs and expected outputs are. It provides the interface to the web service, such as address information to locate the service and methods to invoke its functions, so it can programmatically be used by other web services without needing human intervention. [2][3][24]. The use of WSDL documents eliminate the time consuming process of manually documenting the SOAP interface requirements, since the information is provided in a form that can be interpreted by other systems. By removing the manual process of hand coding the interfaces, it is possible to reduce the time and cost needed to develop system interfaces [3].

2.1.4. Universal Description Discovery and Integration (UDDI)

The service discovery layer, UDDI, is responsible for centralizing web services into a common registry, through which web services can be located for users and other Web Services [2]. The UDDI standards have still not met broad acceptance, mainly because there is still no need for the adoption of UDDI registries in the real world. [3]. So far, there has been no critical mass for the adoption of UDDI, and most of the web services are still inside the companies, since many security issues must be solved before going beyond the firewall. Although the implementation of UDDI registries is still not fundamental to the deployment of web services, in the future it will allow the companies and services to be found by the consumers.

The evolution of UDDI and the extensions applied to it [14] form an internet wide repository of information about web services, with information as capabilities of web service, steps to get the service, quality guaranteed, cost of the service, classification of the service according to any taxonomy and description of person or legal entity responsible for it. The capabilities are, for example, the transformation of needed inputs and preconditions, outputs, and possible side effects of the execution of the service [16]. For instance, if a download-paying service is offered, it can, as inputs, have information about the credit card number and the user; being it a valid credit card with enough limit, not expired; have as the output the document to be downloaded; and, as a side effect, the charge in the credit card.

2.2 Web Services Interaction

The figure shows how web services are envisioned, and the entities and standards involved, although it is not how they are initially being implemented.

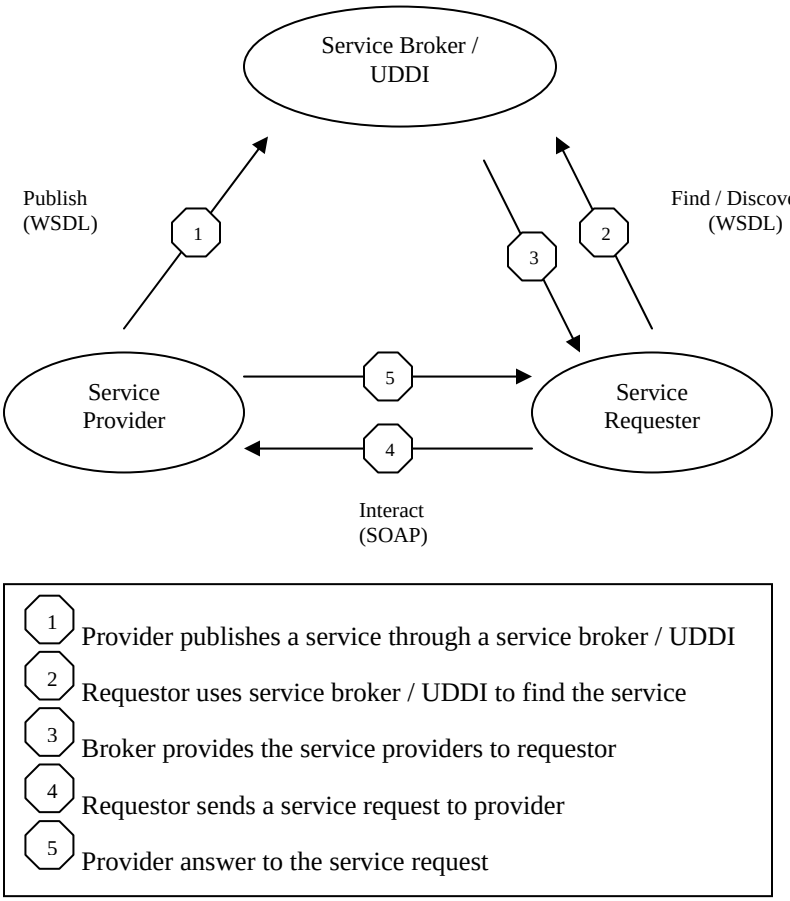

Figure 2-1 - Web Services Interaction [3][26][16][17][18]

In this vision, large repositories of services are published on the internet through service brokers, and companies subscribe and search for services to incorporate into their own applications [3][16][17][18]:

1 – the web service sends information about the service and its capabilities to be published by a service broker, in a UDDI repository, allowing the web service to be discovered and act as a provider. The service is described using WSDL.
2 – when a requester needs to contact another web service with specific capabilities, it submits a request to the service broker to search the registry (UDDI) for services that meet those specific search criteria. If the registries are not available in the service broker, the requester needs to previously know about the capabilities of the provider, and links directly to it.
3 – the service broker selects a provider or providers which declared capabilities are closer to those expected by the requester, and send to it the description of the service, location, and how to communicate to it
4 – The requester links to a selected provider to initiate the interaction, using the SOAP messaging standard
5 – The requester sends a service request, also using SOAP.

But, this is only the envisioned process. So far, the services are more frequently being published behind corporate firewalls, and the publishing and registry of services (interactions 1, 2, and 3) are optional and generally not used [3][16]. In this case, the web service involves at least two entities: a requesting web service that initiates the exchange/transaction and a provider that responds to the invocation [16]. Although such

structure reduces the flexibility of web services, it allows easier integration of systems inside the companies and the reuse of services for applications.

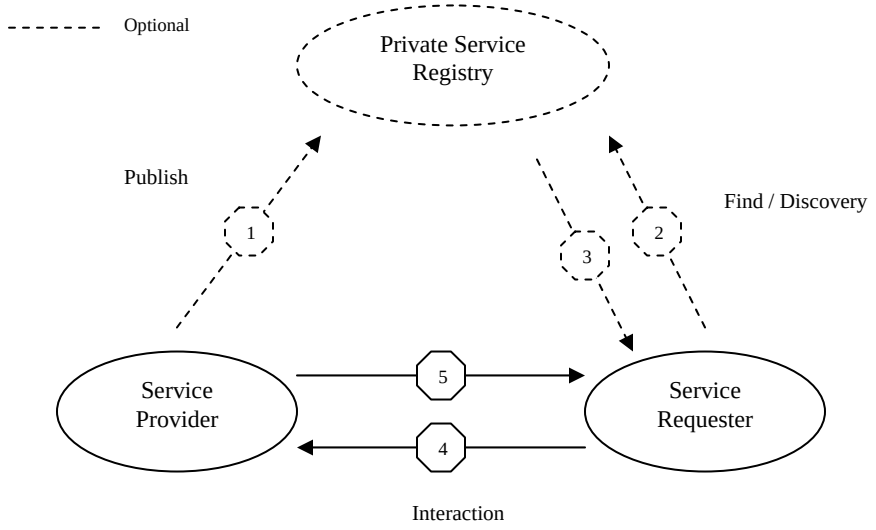

Figure 2-2 - Web Services Interaction [3][16][17][18]

Besides the technical evolution needed to achieve the envisioned process as the solution of security issues, the use of service brokers could face the same resistance met by the aggregation services, which will be discussed later. This is such because the service broker would provide the services (companies) that meet the criteria demanded by the requester (client), and the latter select one that is more suitable. Thus, depending on the information registered in the service broker, it represents an aggregation service without interface to the user.

2.3 Additional Standards

There are many other standards, or layers, in the web services stack, that have not received broad acceptance yet, but can have important functions in the web services deployment as those related to:

a) Business Process Execution - Its objective is that individual business processes can understand one another in a web service environment. It would make it possible to define a web service composed of existing services, with the resulting web service being described by its own WSDL document. The resulting

composition, or process, defines how each individual service is combined to enable the execution of an end-to-end business process [3].

b) Transactions - the web services applications will require the coordination of complex transactions between services, and transactional consistency is a fundamental requirement for building reliable service-based applications. Frameworks are being developed to ensure that participants in application or service achieve a mutually agreed-on outcome based on the success or failure of the transaction [3].

c) Management – the increase in the number of web services used in the portfolio of a company will demand tools to manage the web services' availability, to load balancing, quality of service, security, metering, and billing [3]. Nowadays there are a lot of proprietary solutions being offered by plenty of companies, and that tends to remain, since the lack of standardization in those solutions tends to not refrain the adoption of web services.

d) Security - to use services outside of private networks it is necessary to develop web services security standards in conjunction with current tools as encryption standards. And, some of the current threats in the use of internet will probably be faced in a more critical way with the use of web services. Examples are corporate firewalls failing in protecting internal networks and exposing systems, exposed information due to transmission without encryption, and spoofed transactions and services. For example, services published for no trustworthy sources can capture personal and financial information, as credit card number and passwords, to later fraudulent use [3].

2.4 Development of Standards

Nowadays there are many organizations working to agree on the standards mentioned before, allowing the interoperability of web services and their extensive deployment. The fulfillment of web services promises of simplifying integration depends on standards still in discussion by vendors and standard organizations. Those organizations, as the W3C - World Wide Web Consortium and OASIS - Organization for the Advancement of Structured Information Standards, are dominated mainly by vendors, as Microsoft, IBM, and BEA Systems, which try to push their preferred standards, although there is a minority composed by [27] big players in financial services as Fidelity Investments and J.P Morgan Chase, manufacturers as General Motors, and health-care institutions as Kaiser Permanente. But, each organization has different goals, power, and influence, and has their pillars in some group of vendors. And the major vendors submit standards to each organization depending on their interests as the possibility of getting patents. Ideally, the organizations should agree on standards, guaranteeing the interoperability, fading barriers and fears to adoption, facilitating the diffusion, and creating a momentum to the web services, and then the vendors would compete in relation to their solutions and services based on web services. In the case of web services, the establishment of standards not only reduces the uncertainties, avoiding delays in their adoption by the financial institutions, but also is essential to the deployment of web services, which are based on the interoperability of the applications.

By agreeing on standards, solutions and software companies would partially give up the use of proprietary software to lock in customers, to have the opportunity to offer a series of new products, services, and solutions. In this case it is necessary to be complementors in building the market and competitors in dividing it. Standards allow applications developed in different programming languages communicate, but many companies are waiting until definition of standards and guarantee of interoperability to deploy web services. Although standards are important to enable the interoperability among different companies, some of them are waiting to adopt them also internally. If the company adopts an immature standard, that is posteriorly substituted or substantially changed, the company will spend a lot of effort and resources to change again. Due to the huge number of standards to be defined, the difficult to reach an agreement, the need of speeding

to market, and even the different levels of need of unique standard to some protocols, agreed-on standards to the main protocols will share market with proprietary protocols with less impact in the interoperability.

Most of the companies involved in any technology industry, play a role in the battle for standards, supporting one side or trying to pick the winner technology. Unlike technology itself, the economics underlying battle for standards change little overtime. Then, it is important to understand the characteristics of such battles. Those wars are more crucial in markets with strong network effect, which cause costumers to give high value to compatibility, as is the case of web services. But it does not mean that every new technology endures a standard war, since in some cases companies pool to establish a new standard [28].

New technologies, such as web services, leverage the uncertainty on market opportunities and technology development, what can lead companies to cooperate with competitors for sharing resources and spreading risks. The motivations to cooperation with competitors are generally to access or exchange new technologies and complementary knowledge, access or stimulate new markets, and to influence or control technological standards. The alliances formed by competitors, suppliers, and customers are formed to compete with other companies or groups developing new technologies or setting new standards in the marketplace [29]. The attempt to set up standards in web services is to allow their spread through interoperability, and, at the same time, vendors and companies try to set and catch the winning standards, avoiding to engage in defeated ones. Companies, such as IBM, want to avoid the adoption of the losing standard, as in the adoption of OS/2 operational system against Windows. Even offering OS/2 by a low price, IBM was not able to surpass the Microsoft operational system.

But, by trying to set the winning standard, vendors not only present competing standards to the approval of different organizations but also launch proprietary standards in the market before the approval by such organizations. One of the risks of standards war is that it can create uncertainty around their evolution, undermining the confidence that either standard will prevail [30]. In the case of web services, the uprising of a myriad of competing standards can hamper the adoption of the technology. The concerns around the failure in establishing web services standards are not only due to the current competing standards being launched to the market, but also due to the possibility of alliances to establish standards, as the one composed by IBM and Microsoft, fall apart, triggering the launching of even more standards. Such facts could delay the adoption of web services inside the companies and hurt their deployment in the interaction among different companies. A possibility of fragmentation of the standards, instead of convergence is still possible. If the standards are agreed-on the vendors will compete on performance and price. On the other hand, if agreements are not achieved, there will be fragmentation of the market, duplicating and conflicting standards, and the clients will get confused, curbing the development of web services. In such cases, companies tend to wait for the establishment of standards before adopting a new technology.

Financial institutions are aware to adopt the winner standard or one of them. Managing customers' expectations is crucial in network markets, and vendors have promoted a proselytizing of the benefits of web services to convince customers and complementors that their standards will be the winners. Such expectations can become a self-fulfilling prophecy when network effects are strong. For this reason, vendors are engaging in aggressive marketing, early announcements of new products, standards, and solutions, and assembling allies [28].

The need and difficulty to agree on standards is not new. In the beginning of the deployment of internet banking in USA [31], it was considered that "for business and financial organizations, including banks, to develop the next generation of network-based products and services, they must agree on some primary goals and standards. It is especially important to build an infrastructure around the following characteristics: interoperability, flexibility for innovation, increasing accessibility, adequate security, and search capabilities, as well as electronic payment options..." These issues are pretty much the same as those about the implementation of web services discussed today. Furthermore, something similar to the idea of web services

has already been around: “The infrastructure must be based on a common set of services and standards that ensure interoperability. Preferably, these services and standards can be used as standard building blocks that service providers and application designers can combine, enhance, and customize” [31].

The idea of an organization to coordinate the standardization activities is also not new. The internet standard process has been coordinated by the Internet Engineering Task Force (IETF). Parties wishing to propose standards were required to have a working implementation before submitting them and place them in the public domain, being it under the control of the IETF, if they were approved [31].

The same vendors and issues involved in the establishment of web services standards are also involved in the establishment of other standards. In the United States, for example, Microsoft, Sun, Oracle, and IBM are involved in the establishment of standards to RFID - Radio Frequency Identification, and it is expected that their participation, along with Wal-Mart’s and U.S Defense Department’s decisions of demand that their suppliers adopt RFID, should help speed up the adoption of a standard to a technology created around 15 years ago [32]. It is expected that, once the standards are defined, the prices of RFID will fall. The same can occur after the definition of standards to web services, with more vendors and developers launching to the market to supply the demand of the companies’. Although RFID has been used in particular cases as marathon runners, the case shows that many technologies can take a long time to be widespread adopted in the market owing to, for example, the lack of complementary technologies, need, incentive, or standards.

Because of the difficulty, time needed to agree on standards and commercial interests, a lot of proprietary standards are emerging. In January 2004, for example, IBM launched “WS-Notification” while Microsoft launched “WS-Eventing”, both with capabilities to support just-in-time procurement. For the achievement of the expected interoperability among web services, such kinds of similar standards need to converge or be made compatible. This battle gets more complex as the same companies that are on some standards disagree on other ones. For instance, Microsoft and IBM [16], mentioned before as having different approaches to the just-in-time procurement, are working together on standards as “BPEL4WS - Business Process Execution Language for Web Services”, describing how multiple web services could be composed together to provide a more complex web service.

It is too early to be sure about the wining standards. In such a new and fast technology development, there are a lot of changes not only in the status of each standard, but also in number of standards created. Trying to define the winners is enticing, but risky - this is one of the reasons of the delay in their adoption by financial institutions.

Obviously, the adoption of standards also has disadvantages, as once firmly bound together by the benefits of compatibility or standardization, the companies will be extremely reluctant to move to a new and better standard due to the coordination problems involved. Such inertia prevents the collective switch to a possible new standard or technology [7].

3. Potential Benefits and Uses in Financial Institutions

3.1 Hype Around Web Services

It is possible to find a great variety of publications proposing so many different applications of web services, that sometimes it is difficult to distinguish marketing claims and commercial offerings from technical innovation and business reality. Some supporters of web services try to lead us to believe that they are the most important new software ever developed. On the other hand, the opponents call them old middleware in new clothes and "as transparent as the old middleware" [2].

Some stated, for example, that ERP - Enterprise Resource Planning - systems have solved some problems but also created other ones, since due to their inflexibility, they become hard to quickly adapt to changes in the marketplace and strategic restructuring, and that web services would be completely different [21]. Although the web services present potential to do so, it has not yet been proved. And, to analyze the feasibility of the application of the technology, it is necessary to verify not only its benefits, but also the challenges to be faced. Moreover, it is necessary to analyze the possibility of integration of web services with other technologies and not think it as a panacea that will substitute all the previous technologies.

The web services represent an evolution, not a revolution. The value depends on the software and applications they connect [33]. Thus, it is really necessary to separate what is hype from what are real opportunities. Statements such as "the early adopters of web services will win" and "web service is not an option, but rather a necessity", and calling web services as "Tsunami" probably are too enthusiastic and precipitated.

Technology vendors often paint great visions of technology capability, which tend to sound expensive, risky, and very long term. In addition, these great visions are framed in terms of the technology, as "dynamic composition of applications", instead of business benefits [34]. There is the idea that web services should be able to automatically locate other services that provide the solution searched and that services should be able to interoperate to compose more complex services automatically, both automating the management of supply chain [35]. But so far, there is no possibility of forecasting when and whether those capabilities will be available.

3.2 Benefits

The potential benefits described below are those conceived considering that all the standards will be agreed-on. The challenges to do so and the consequences if the agreements are not met are described in the following chapters. Furthermore, the deployment of web services can bring more challenges and decrease some of those benefits.

3.2.1. Technical Benefits

As benefits of the deployment of web services, there are: autonomy, standardization, modularity, reuse, scalability, and lower costs. Some of them are intimately connected or are a consequence of each other, but they were isolated here so as to ease the understanding of each one. However, as presented in the next chapters, some characteristics, such as the standardization, represent great potential benefits but also great challenges to the adoption and diffusion of web services.

a) Autonomy and Loose Coupling

Web services provide the communication of applications written in different languages or running on different operating systems or hardware, reducing the vendor lock-in [18], easing and reducing costs of interoperability intra or inter companies. Different applications using different technologies and processes can be linked without the need of the knowledge of each other's technologies [18], getting flexibility to the interoperability among systems and avoiding the need of conversion.

JPMorgan, for example, is using web services to connect back-end servers to the spreadsheets of their analysts' [36].

Merrill Lynch is using an XML-based language to reduce development costs to open up back office / mainframe-hosted programs to the requests of internal internet-based applications. At Merrill Lynch, as in great part of the companies, legacy-mainframe programs and data are hosted on IBM's Customer Information Control System (CICS) servers, acting as transaction-processing monitors. The company runs more than 23,000 different CICS programs, and needed to rationalize the investments made. Now, SOAP messages can be sent from the web, and the XML-based application converts it into an understandable format by the mainframe. The web service also brings the information of the mainframe, not into a public domain, but into a middle staging area where it is not vulnerable to attacks. The alternative method, which is more expensive, would be rewritten every trapped-on-the-mainframe program using web-ready code [37].

Bear, Stearns also exposed functionality residing on legacy system for checking, placing, canceling, and changing stock orders, extending the life of their existing investment.

b) Standardization

Potential use of web services agreed on standards, instead of proprietary solutions, can ease the integration of applications inter and intra companies and lower its costs.

In theory, due to the use of standard protocols, different languages and middleware technologies behind applications or data sources become transparent to programmers, easing the development of applications [38]. In addition, the human-readable language results in easier debugging and maintenance [14].

c) Modularity

The use of applications built independently but using standard interfaces will make the connection of systems and their upgrading easier, since modifications can be made in the applications without changing the interfaces or the other applications. The modularity also diminishes the risks of systems fall apart with the changes in one of the applications involved [18]. On the other hand, the modularity makes it easy for competitors to copy the services offered, especially if the company uses services of third parties.

d) Reuse

Once developed, a service can be reused in many different applications due to its modularity and standardization, reducing the cost and time-to-market of new product and services and the deployment of new integrations.

Unlike previous models, once a web service has been created, it can be reused as part of new business applications not only by the company but also by other companies that have the permission to do so. For instance, making an order entry web service encapsulated in one system available, the order entry service can be reused by many other users as the online purchasing system, call center system, [3] and branch system. Amazon.com has created a service, for example, to check different domains inventories, and its electronics page offer generation. Then, the same web service can be used to create a similar page to other segments, as apparel.

Traditional approaches require programmers to design a customized new connection for each pair of resources that might need to interact in advance. Using web services requires only a one-time investment to write a code that allows the service to be accessed by any application with an interface adhering to the same widely-available standards and protocols, such as XML. In contrast to hardwired connections, which have a less reusable code (so that each new connection represents a substantial programming effort), the initial investment in a service-oriented architecture is amortized further each time a new connection is created [39]. By doing so, possible modifications in the original system would not affect the systems used as source of entry (call center, online, branch).

Also, web services could be reused across multiple channels. For instance, completing a funds transfer via ATM or internal banking system will likely use the same web service, reducing costs of deployment and time to market [3]. Bank One uses web-services to connect to multiple back-end systems in order to get an integrated view of the customer's relationship with the bank by using XML to support multiple distribution channels as the mobile and ATM, thus cutting operational costs and increasing the scalability [14].

Obviously, the reuse of applications is not infinite, since, at some point in time, more advanced or suitable applications and solutions may be required to replace the current ones. Therefore, such decisions must be managed to optimize the reuse without harming the performance.

e) Scalability

Reuse and standardization of web services allow the use of the same service to interact with many different applications and partners, reducing the cost of adding one additional partner or application. The web service creates an interface to the application, to which any other application can link regardless of the program language or technology utilized. After creating the interface, it is possible to link many other applications without the need of changing in the applications.

3.2.2. Business Benefits

Web services offer the potential to create business value, lower cost structures, enable entries into new markets, and allow access to new customers and suppliers [3]. But, while having the potential to bring such benefits to the company, it can not be considered a panacea, and decisions must be made about the appropriateness of its adoption in each case and the benefits balanced with the challenges presented in next chapters. Other benefits can be derived from the enabled applications for web services and are presented in examples throughout the text.

a) Business Processes Agility and Efficiency

The technical characteristics mentioned before, such as autonomy and modularity, increase the flexibility to adapt or replace processes according to commercial needs. Also, the automation of processes through the system integration can bring gains of scale and increase in the efficiency of the processes.

CartaSI S.p.A, a credit card company, has implemented web services to speed up the process of around 50,000 daily-customer calls. The company has 7.5 million credit cards outstanding and services 16 Banks in Italy. The solution cost about $100,000 and captures customer information in many applications, presenting them in HTML pages. Such integration has replaced the access to many different systems to handle the customers' questions, speeding up the phone calls and avoiding new hires, infrastructure and telecom costs. Such service has started with an access to 200 employees and now services 350 [40]. The result is less 10 seconds per call, which averages three minutes each one. The integration of the systems can facilitate CRM - Customer Relationship Management - strategies and the service offered by call and contact centers. Although, it is not possible to take those numbers for granted, if the customer representatives have the information integrated without the need of searching in diverse systems, the time to handle each call can be reduced, allowing answering more calls in the same time with the same number of customer representatives, reducing the total cost per call handled. It is obvious that it must be part of a strategy to allow the customers to solve the problems by themselves through internet sites, for example. Such kind of service can become more practical with the use of web services, since more systems could be integrated to handle the customers' questions, avoiding the need of interference of a customer representative.

b) Business Relationships Agility and New Relationships

Easing the integration of the companies' systems with the suppliers, partners, and customer's systems, web services make the relationships more flexible and agile, allowing them to strengthen the existing ones and create opportunities for the establishment of new ones.

Financial institutions could, for example, offer a web service for credit card authorization on a subscription or a per-use basis to organizations operating web sites, but not willing or able to build or buy software for that purpose [15].

Deutsche Postbank intends to generate revenue processing payments for other banks, and has been coming to agreements with Deutsche Bank to do so [41]. In such a situation, the use of web services would also ease and speed up the deployment of such service.

The London Stock Exchange is also developing web services to establish automated links between broker dealers and retail service providers to exchange confirmations, as part of a messaging system to automate stock quote and execution messages [42], reducing the costs of doing business for all participants and lowering the barriers for entry in new retail service providers.

RouteOne, [43] is a joint venture formed by DaimlerChrysler Services, Ford Motor Credit Co, General Motors Acceptance Corp, and Toyota Financial Services to develop a loan management system based on web services (SOAP and WSDL) in order to enable dealers and financial sources to exchange credit application and decision information. Such system is supposed to increase the flexibility and agility of the process. The pledge is that banks and automakers are able to use their legacy systems instead of introducing a new platform. It is still under development, but has already come to agreements with companies such as Fidelity Information System. Linking the disparate systems by using the current web services standards is still a challenge, increased by the need of accompanying the evolution and change in

standards. This is a kind of aggregator that has been around for a long time, and the same concept can be applied to other products as insurance, loans, and mortgage.

c) Lock-in decrease

Due to the standardization of the components, companies are less prone to get locked-in to specific vendors than in the use of proprietary systems as ERP. Decreasing the lock in, increases the possibility of negotiating prices with a greater range of suppliers and decrease the costs of the process.

d) Costs Reducing

Reducing the dependence on proprietary systems and the need for one-to-one hardcode integration, leveraging the use of current applications, and speeding the process of integration, the costs of acquisitions, maintenance and development of solutions can be reduced.

Banco Azteca is using web services to extend web-based applications used in retail stores of a parent firm to in-store branches. Since the retail stores have migrated to a more full-service banking to reach the Mexico's working poor, some processes and risk management from the Bank have had to be integrated with retail store existing installment loan and savings account management systems [42], avoiding the need of the replacement of prior applications.

Costs can also be reduced by streamlining and increasing the effectiveness of the processes. And, the build up of web services-based reusable applications throughout the company decreases overtime the costs involved in new deployments.

Although quite simple, Motorola has transformed its credit card validation function into a web service to be reused for any other of its business sectors in business-to-business applications, and estimates to have saved between $ 100,000 and $150,000 in development costs [25].

There are other benefits commonly mentioned, but some of them need to be more industry-to-industry, or company-to-company analyzed. One of them is the upcoming of new opportunities of outsourcing the business applications and processes. Financial Institutions, for example, tend to keep their core developments inside the company due to some previous unsuccessful attempts to outsource them. In addition, the outsourcing of applications brings a high level of uncertainty as to the reliability, security, and privacy to the financial processes that companies, in general, are not prone to dare.

Another important reminder is that web services do not solve problems as weak systems architecture. For example, since portals are increasingly incorporating functionalities as content management, collaboration, and search, web services could be useful in the integration of the information composing such portals. But, while allowing the ease of integration and interoperability of portals inside the company, web service will not help with stale and meaningless portals spread throughout the intranet. The portals will continue to demand strategy and logic before its implementation. What can happen is that integrating portals through the use of web services, the difference of characteristics among them will be more apparent.

When we think of financial institutions, we think primarily of financial services offered to the customers. But, with the increasing need to improve the overall productivity, web services can also be used to improve operations such as the acquisition of materials. In such areas the outsourcing of applications can be a faster-adopted option.

3.3 Uses in Financial Institutions

US Survey [14] shows that most of the web services activities in financial institutions are in the institutional securities and investment sector (38%) and in the retail bank (20%). Examples includes Bear, Stearns and Company, in the securities trading, Dresdner Kleinwort Wasserstein, in the investment banking, JP Morgan Chase, in asset management, and ABN AMRO Bank US, in electronic payments.

The discussion of real and potential uses of web services in financial institutions is essential to a better understanding of the issues involving the analysis of their adoption. In this chapter, some points and examples as the systems integration and aggregation services are more extensively analyzed than others. The former, because it is the first use in most companies and the basis for the development of other solutions, and the latter, to demonstrate the many issues involving the deployment of a new product or service that can not be solved solely by the improvement in technologies.

3.3.1. Systems Integration

Entering in new domestic and international segments and markets and the development of new products and services, demand that financial institutions incorporate and integrate many disparate systems and many lines of business. Web services [2] have the potential to facilitate processes, as the integration of networked heterogeneous applications across the enterprise, providing business value by sharing data, communicating results, and improving overall functionality.

Most companies struggle to connect the diverse technological platforms installed over the years. Difficulties and costs are always faced when integrating systems inside the company or with partners, and, frequently does the system integration take longer than the main purpose of the task. Rather than requiring the substitution of those technological platforms and the installation of new ones, web services act as an overlay, operating on top of existing technologies by providing a potential lower cost and a more flexible way of connection. Thus, allowing companies to extend the economic value of their current platforms while attacking the integration problems [34]. Such maximization of the use of current assets can be achieved, for example, by the integration of legacy systems and the use of information contained in such systems, without incurring the costs of substituting or rewriting them. However, to maintain those legacy systems, it is necessary to keep a team with knowledge on it to guarantee its maintenance and updating. Although there is no need to change the system to integrate it with other ones, changes could be necessary due to changes in the business or in the processes. Furthermore, due to the immaturity of the use of web services, it is not yet possible to have a clear idea about either the scalability of such integration or about possible side effects of integrating such disparate systems that present, for example, divergence in performance.

For many years financial institutions have implemented similar solutions to those promised by web services, especially in systems integration. The potential difference is that now the tools to promote such integration will make use of standards as XML, SOAP, and WSDL instead of proprietary techniques as those embedded in EAI - Enterprise Application Integration, potentially speeding up the implementations and decreasing their costs, because of its use.

It is very difficult to connect corporate databases containing information about customers, suppliers or products. Studies show that a great part of the work consequently, the money spent in IT departments is related to the integration of applications. Furthermore, data errors and inconsistencies lead individuals to try to identify the source of inconsistencies, and many times more time spent trying to gather the right information rather than analyzing it [3]. By using web services, for example, if a bank marketer needs to find out how many mortgage holders have direct-deposit and their characteristics to design direct-mail campaigns, developers would not have to overhaul software controlling such databases to make them communicate.

Instead, it would add a new layer of text written in XML on top of each database, so that the database can be used by many different applications without further rewriting [44]. Obviously, this explanation is an oversimplification, especially due to the lack of proof of the concept and immaturity or the non-existence of standards, but it gives an idea of the application.

Another use could be in the integration of acquired companies. In such cases, the acquired company's systems tend to be absorbed by the parent's system, to obtain costs savings, increase the value creation of the acquisition, enhance product consistency, and allow common back office operations, minimizing risks and complexity [13]. But, since it can take some years, web services could be used to integrate the acquired and parent's systems until the former could be absorbed by the latter, guaranteeing a faster integration of the companies. But, until the security issues are not solved, doing so would require bringing the acquired company's system onto the parent's private network.

Web services standards can be incorporated in a layer of software put atop an existing application, allowing other applications with similar interface to link and communicate. Writing these layers is less expensive than customized code. In the latter case, if the underlying application is changed, the customized connection must be changed or rewritten, whereas web services allow to modify applications while avoiding changes in the interface and in the application linked [45].

Not only market and making decision needs, but also regulatory concerns as the Basel regulations and country specific requirements (as the Patriot Act in the USA) have created increasing needs for timely and accurate regulatory reporting and operational risk management. In the financial market, for example, "information is critical to the evaluation of risk. The less that is known about the current state of a market or a venture, the less the ability to project future outcomes and, hence, the more those potential outcomes will be discounted…By itself, more abundant real-time information should both reduce the uncertainties and lower the variances employed to guide portfolio decisions. At least part of the observed fall in equity premiums in our economy and others over the past five years may have resulted from a permanent technology-driven increase in information availability, which by definition reduces uncertainty and therefore risk premiums. And because knowledge once gained is irreversible, so too are the lowered risk premiums" [46].

For part of the banks [47] enhancement of IT systems and data integration will account for more than 75 percent of the investments to meet the Basel II requirements. Then, if web services meet the pledge of allowing systems to be more easily integrated in order to give accurate and timely information, they would be working to reduce risks and costs of the institutions. But, regardless of the technology used and all the possibilities of integration, it is important to keep in mind that exceptions to be handled by humans, are always around. Furthermore, in each situation faced, the temptation to undertake IT-restructuring must be balanced with the adoption of less elegant but pragmatic and cheaper approaches. To meet the requirements of the Basel II, one bank adopted a $20,000 spreadsheet-based solution to capture data easily and accurately for a segment with low risk and loan defaults, while a more elaborate project to integration to the main data warehouse would have cost around $ 5 million.

Some companies claim to have saved between 20 percent [38] and others much more than that, by using web services to integrate systems, but it is too early to take such numbers for granted. Additionally, unless the standards mentioned before are widely adopted [39], the range of feasible connections is very limited.

3.3.2. Companies Integration and Clients Integration

Part of the operations inefficiencies in companies are due to difficulties in connecting existing applications and information. Those inefficiencies are increasingly concentrated in the edges of the companies, where business activities involve communications and transactions with other organizations as trading partners and

customers [34][45]. The web services could improve the business-to-business, which has been, in part, inhibited by expensive integration efforts and inflexible enterprise business applications [3].

Web services can provide a way for smaller suppliers to exchange EDI-like transactions without having to invest in expensive EDI - Electronic Data Interchange solutions. Considering that web services reduce the costs of integration of systems, it could be possible to offer products and services to small and mid-size clients that were not previously economically viable [3].

One of the most potential advantages of the web services is the possibility of promoting changes in the applications without necessarily promoting changes in the interface between applications, saving resources and eliminating a hurdle in the companies' integration.

3.3.3. Aggregation Services

Since web services offer the possibility of easier integration of different companies' systems, it could be used to improve the aggregation services offered so far, if companies are willing to do so.

To customers, aggregating financial information from diverse sources present a series of benefits such as convenience, time-saving, use of only one log in to access diverse services, the possibility of viewing a summary of all accounts with diverse consolidations (per type of transaction, per period, per institution), and simulations using all data. Intermediaries, as aggregators, can [48] reduce the search costs, and often are the customers willing to pay for the service to avoid uncertain search activities and to find suitable partners. Some of them will be discussed below, considering the financial institution perspective and issues, such as privacy and security. For the financial institutions to offer the aggregation services, some of the benefits are increasing stickiness to online service, customer's information allowing cross selling, and providing of advisor services. But its use raises a lot of concerns about privacy (as the use by the aggregator institution of clients' information originated from many other institutions), brand recognition, and customer retention. Furthermore, in countries such as the United Kingdom, regulatory issues interfere in its use. This shows that the aggregation services in financial institutions are not fully deployed for a number of reasons, and not only for lack of adequate technology. Therefore, web services are not able to, alone, trigger its deployment.

Although viewing all financial accounts in a single report is the most known aggregation service, more value can be captured analyzing the data to provide advice or acting as an agent completing transactions [49].

The possibility of the adoption of web services to offer aggregation services in financial institutions is one more step in a long series of attempts. In 1997 [31], Scott Cook, the Chairman of Intuit, envisioned opportunities in a new marketplace, including not only financial planning and management tools like Quicken, Intuit's flagship, but also "direct sales of insurance, stocks, loan applications, credit cards, and other financial services traditionally associated with different industries and institutions". By that time, financial institutions had already been looking for solutions to defend against such inroads into their core business by software companies as Intuit and Microsoft. [31]

In 1999, financial institutions publicly protested aggregator services vendors screen-scrapping their web sites, due to security and customer retention concerns, and First Union Corporation (merged with Wachovia Corporation in 2001) sued PayTrust for allegedly violating First Union standard information about gathering account information from its site. But, in the following year, many financial institutions decided to offer the service to avoid its customers to use the service offered by other financial institutions or portals as Yahoo!, America On Line, Financial Times, and Intuit that announced initiatives regarding the offer of the service. Those portals offered financial account information together with other aggregations such as news and e-mails, which the customers were already using. Citibank was the first financial institution to announce the

service in 2000, followed by the first brokerage, Morgan Stanley. In January, 2002, over 100 American financial institutions in the advisory, banking, and brokerage markets offered the service. Among them: ABN Amro, American Express, E*Trade, Fidelity Brokerage, Bank of America, Merrill Lynch, Wells Fargo, and Wachovia. Financial Institutions dominate the sector, since customers were used and more comfortable to access confidential information and transact with them, due to privacy and security concerns. Adding the fact that online companies were suffering from a lack of trust caused by the internet bubble in 2000 [50].

One of the major methods to aggregate the data is the screen-scrapping. It is a process that simulates a consumer logging in the web site using one's information, such as username and password, to locate the information, store in a database, and present the information to the customer [50].

Obviously, this method presents a flaw. Financial institutions constantly change their online banking structure and formats as an evolution of the business or due to security and privacy concerns, or promote slight changes just to make it more difficult to third parties to aggregate their information. Thus, the aggregator must continually monitor the web sites to promote changes in their programs and in the interface offered to the client. If the aggregator does not take such steps, clients receive wrong information, what has happened, despite the improvement in the techniques. The tactic of changing interface to avoid interoperability has been used by large network companies in different industries [28], since compatibility may trigger price-based competition among them, what is a disincentive to compatibility [51]. During the boom of the internet many companies made bad decisions, eroding their attractiveness and undermining their competitive advantages. One example is those that shifted the basis of competition from quality, features, and service to price, creating difficulties to all the industry. If a complementor standardizes the industry offering, it will increase rivalry and depress profitability [5]. This is the case in the offering of aggregation services through the use of the same interface, causing potential lowering on the search cost and on the switch cost to the customer, driving the competition even more towards prices. Firms with good reputation [52][51] or large existing networks will tend to be against compatible products, even when welfare increases. On the other hand, firms with small networks or weak reputation tend to favor product compatibility.

Offering internet service via a personal financial management, aggregator, or similar, the banks lose control over the end-user interface and the relationship with customers [31]. Furthermore, the access to the internet banking to check the balance or to pay a bill is a great opportunity to offer new services, as loans, credit card, investments and others. If the clients use an aggregator, the use of each on-line banking page decreases, lowering the opportunity for the bank to improve its relationship with the customers, through the offering of new products, services, and information.

Some institutions allow aggregator access only by accessing its log-in page that is presented to the customer so that he can digit the log-in password. This way, there is no need to provide the aggregator with the password. Although, it minimizes concerns about the security, it does not eliminate concerns about privacy issues, such as the misuse of information by the aggregator, while eliminating some advantages of aggregators' such as the use of only one password.

The option to avoid problems originated from the use of screen-scrapper methods is the direct feeding, which obtains data directly from the bank or through the use of standardized protocols. The former depends on mutual agreement and the latter, on the adoption of standards such as the XML [50]. But, if institutions are not willing to be aggregated, they will not offer information in such standards, forcing the use of screen scrapping, which leads to a higher degree in the errors presented by the aggregator, what can make the customers abandon the service.

Some of the benefits of offering aggregator services, as the increase in the customization of the mix of services offered to the customer based on the relationship with all the institutions, are based on the hypothesis that the data originated from other institutions are to be used by the aggregator. But, with the increase in the

privacy concerns, it is possible that customers or legislation demand that data collected from other sources be not used by the aggregator. Another point of concern is that financial institutions make a great effort to make customers conscious of the need of not sharing their passwords with third parties, but to offer the service, the institutions must request the customer's passwords used in other institutions.

The adoption of aggregator services for financial institutions must also consider some aspects related to the culture and demography. In countries like USA where customers tend to have credit cards and other services spread through many institutions, the interest in the service is prone to be higher than in countries where the customers' services are more concentrated. By 2002 [53], in USA, the typical user of account-aggregation was a highly educated male, around 35 years old and with an annual income over U$ 50,000, and users of the Citibank aggregator service were, in average, also between 25 and 44 years of age with an income (reported) of over U$ 50,000.

There is controversy about the influence of the brand on aggregator services. Not only in the aggregators of account information, but also in the aggregators used to compare prices and characteristics of services as insurance, loans, and credit cards. Strong brands have some advantages, such as the trust in their name and service offered. On the other hand, the aggregator services can drop the entire struggle to build a strong brand, since the comparisons can be made only in one dimension, as price, disregarding characteristics over which the companies can charge premium price, as quality of service. This aspect is even more relevant in aggregators in which the customer selects some characteristics of the product and service and the purchase is made automatically, without the chance of selecting among short list options (this has so far been common in hotel and rental car aggregators). The competition can be based only on price or other characteristics, speeding up the process of commoditization of the product or service.

Many financial institutions are willing to neither offer aggregation services nor be aggregated, because of the reasons mentioned above and because the customers' demand for such services has not been high in many countries.

Avoiding the diffusion of aggregation services depends on agreement among institutions, since if important institutions decide to offer the service, it can create a bandwagon effect in the market. For example, Citibank was the first bank to introduce ATM in the USA in 1977. After that, other banks formed networks of ATMs, and Citibank refused to join them, keeping its individual network. The other banks' network, however, expanded more than Citibank's, costing some market shares to the latter that in 1991 joined the other networks [54]. Banks in other countries have succeeded with the Citibank strategy, though. Considering the evident differences, both situations can occur in the adoption of aggregation services depending on the market.

3.3.4. Analyses of Current Web Services Projects and Uses in Financial Institutions

Some financial institutions present initiatives of using web services or some of their components, but great part is still waiting for the maturity of relevant standards and some successful installations of prepackaged software to support web service before starting its own projects.

Although faster time for the production and the facility to deploy business applications for trading partners are mentioned as advantages of adopting web services over current business-to-business applications [55], security concerns and lack of security standards are mentioned as being the major barrier for the implementation of web services. Great part of the financial institutions is unlikely to go deeper in the novelty of the technology until such worries about security are surpassed.

In many cases it is difficult to rely on data about web services due to the divergences and misunderstandings of what is considered to be web service. But, survey [42] shows that most web services initiatives are inside

the firewalls and deal or will deal with simple, one-way information distribution instead of an automated exchange of “services” or data.

Most of the examples of web services use are very recent, as well as most of the companies are still in the early phase of adopting web services components as XML and SOAP. Therefore, the solutions show some concepts and components of web services, but they are not yet web services as envisioned, and the long -term outcomes still need to be evaluated.

The RBC Financial Group, Toronto, is trying some solutions. One of them is to use web services to automatically refresh information on the global directory section of its corporate intranet, without reworking the content of individual web pages. Another project was to link the retail banking system and the insurance division legacy system so that retail online banking customers could be sent to a screen to purchase travel-related insurances. In this case, the insurance system code used for processing an on-line application is encapsulated as a service, which is evoked by the on-line banking system. After the fulfillment of the form by the client, it is sent through the service to the insurance legacy system. But, one of the conclusions is that the XML documents overburden processors and so should not be used in highly transactional systems demanding speed [42].

The Resource Bancshares Mortgage Group, Inc., a wholesale lending company, acquired by NetBank, is in a project to tighten link it’s web-based B2B front end (used by correspondents and small mortgage brokers) to its legacy loan operating system and link this package to Fannie Mae’s Desktop Underwriter, intending to improve the information given to the partners [42].

In U.S., online lenders are a growing sector. Home Loan Center Inc., an online mortgage integrator, created web services linking customers with loan products offered, based on credit score and desired monthly payment, for example. Customers can fill out the loan application and get rates locks on-line. The agility is a response to the borrowers’ pressure for better services, as instant approvals, rate locks, and fast closing [56].

VirtualBank, a division of Lydian Private Bank, implemented a solution to process auto loan applications using a set of web services [57]. After receiving the application filled by the customer on the web page, an XML-format is sent to the system that coordinates the next steps. The information is sent to a third-part (Equifax) in a proprietary format to fraud detection. The information then is sent back to the company and transformed back to an XML-format. Based on the fraud detection result, the application can be sent to the credit-check step, or to a specialist, in case of suspicion. The credit-check follows the same procedure and the application in XML-format receives a credit score (based on the information of an aggregator of three credit bureaus), and it is defined as approved, rejected, or pending. In the latter case, it is sent through a web service to a specialist’s analysis. Such services allow VirtualBank to use the same interfaces to process applications received from third-part aggregators and process them in the same way. Developing them as web services, some interfaces can also be used to the mortgage analysis. The solution costs $250,000 in a six-month project (although it is difficult to know which costs are included in such figure), and reduces the number of applications, that requires a human review to 30%.

4. Challenges for Adoption

The same vendors that some time ago painted the scenario of web services as something quite simple and cheap ("integration almost for free") now include web services consultancy in their portfolios, because since web services evolved, their planning, deploying, and managing are getting more and more complex. "Managing and tracking web services across an enterprise and ensuring interoperability, security, and performance requires a new order of architectural discipline" [58]. Companies as IBM, Accenture, Deloitte Consulting, EDS, and Hewlett Packard's are offering web services solutions as part of their overall IT services portfolio.

Many surveys show the tendency of companies to adopt web services, but the figures presented should not be taken for granted, for a lot of reasons such as: responders can fear the seeming out of the bandwagon, have the desire to show knowledge, have their sensitivity altered as to the price or to the immaturity of the technology, and the surveys many times are not answered by the people responsible for making decisions in the companies. Furthermore, in most of the surveys it is not possible to know either the number of answers analyzed or the characteristics of the companies involved. But, anyway, it is possible to try to analyze pointed reasons for adopting or not web services and put them together with possible lacking reasons. For instance, one survey shows that concerns about security are higher in those institutions that have already experimented web services. While in one hand it can be simply a result of the sample adopted, it can indicate that the hype around the technology can lead some companies that have not implemented web services yet, believe in a more mature product, whereas those experiencing them can face an unexpected level of difficulty.

The most significant barriers to the adoption of web services by financial institutions can be classified as Standard Barriers, Technical Barriers, Skill Barriers [59], Partners Issues, Financial Issues, and Legal Issues. The intention is not to exhaust the issues, but discuss those bringing more concerns to the adoption of web services, specifically by financial institutions.

4.1 Standards Barriers

Standards Barriers are those related to the lack of standards or standards immaturity and lack of critical mass of business partners behind specific standards.

4.1.1. Non-maturity and lack of standards

Up to now, web services technology is not mature, with the underlying technologies as XML, SOAP, WSDL, and UDDI being relatively new [2]. Many companies are waiting for the definition and maturity of standards before adopting them. They are not willing to dare the uncertainty of adopting a standard and see another one to be created, making it obsolete [60]. Such situation would not only make it difficult the interoperability with other companies, but also, lock in the company to a vendor, since most of the vendors are to adopt the agreed-on standard. Anyway, while some companies are waiting due to technology immaturity and costs involved, others are investing with high expectations on future developments.

To achieve its goals, the web service would need to be based on standard-based approach, and overcome the previous failed generations' problems on middleware that relied on proprietary software [2]. Vendors as Microsoft and IBM have a great interest in web services, since it can lead to an increase in the selling of computers and software. They are really pushing towards agreements upon standards. After setting the standards, companies would start to compete in the offering of solutions to the clients. Moreover, companies as IBM would not want to adopt a looser standard and lose a share of market as happened in the past.

So far, although Simple SOAP-based request and reply messages over HTTP are already working, the interoperability of solutions of different vendors is still difficult, demanding a lot of customization. [61]

There are some companies implementing web services based on standards not yet agreed-on or still not mature. In the future, if different standards emerge or are agreed-on, those companies can have a hard time and more costs to interoperate with services and applications based on the future standards or to migrate to the new ones. On the other hand, those companies will have acquired expertise on web services, and have the opportunity to try to push the standard already in use. Adopting standards that are abandoned or fail to evolve will require future changes and upgrades to allow integration with customers and suppliers. Then, at this point, it is crucial to be backed for trustful vendors, in order to reduce the risk of seeing the market and standards evolved in a different path.

Companies are acting cautiously. Wells Fargo, for example, intends to accept different formats of messages sent by customers using their services, and internally converting them into XML format to be used by their web services, avoiding to push clients to a standard [62].

4.1.2. Semantic Issues

It is important to align data definitions, jargon, and vocabulary words within and across organizations [3], solving concerns about the semantic and context of the information. Such definitions are critical to the interoperability of systems and the implementation of web services. Simple divergences as to whether the "number of employees" refers to temporary or permanent ones, as well as whether the "ROI - Return on Investment" is annualized or the amount until that date demand human intervention to make systems interoperable or time-consuming data consolidation. Different systems show different specifications as to units of measure (currency for example), different time references, and different definitions of terms, demanding a time-consuming analysis, being prone to error consolidation. The human being is normally able to distinguish among the same term to different meanings, but the systems usually are not. For example, one system can have a list of addresses used to bill clients. This list can be sent to another company or system, to make deliveries to these clients. Some of the addresses, though, can be post-office boxes, but its definition "address" does not allow the other systems to know such thing, and deliveries can be made erroneously to post-office boxes instead of home addresses. Ontologies could provide equivalence relations as information that zip code in one system is equivalent to the postal code in another one. Despite the human ability to make such differentiation, such kind of error mushrooms. With machine-to-machine interactions without an established semantic, it could be even worse.

The XML language provides syntactic interoperability, which means allowing applications and web services to identify the structure of the exchanged messages. However, it does not provide interpretation of the content of those messages. [16]. Each industry, as financial services, will need to develop a specialized XML-based vocabulary, as mentioned before. Identical XML descriptions may have many different meanings, depending on when and who uses them. The lack of XML semantics proves to be an obstacle for the development of web services to act autonomously on the electronic commerce. The XML encoded information allows web services to parse each other's message and verify whether it adheres to the expected formats and eventually locate each piece of information within the message. The two web services, however, can not be able to decode the meaning of the messages exchanged in order to extract the information contained in it. It means that the two web services understand the structure of each other, but not the content of such messages [17]. Standardizing the context and semantics of XML documents is one of the most difficult integration challenges to be overcome [63]. If standards are not achieved, each two companies will need to agree on the semantic to be used, which eliminates great part of web services benefits.

The semantic issues are not an exclusivity of systems language. There is a lack of consistency about definitions among areas of the same company. For example, different areas have different definitions to

"average time of clients in queue" and "percentage of clients attended in a determined period of time" in call centers, and different definitions of transaction volumes are ubiquitous in most of the areas. In the financial area the difference in definitions allied to the needs for duplicate inputs of data in the systems, for example, demands a series of reconciliations, with consequent expenditure of time and money. Obviously, the achievement of a global data definition throughout the company is quite difficult to implement and can be cumbersome. Then, it is necessary to clearly define the limited set of standard data definition to guarantee the level of interoperability desired.

As mentioned in previous chapter, many organizations are trying to define semantics to the financial industry. However, due to the complexity of the services and lack of agreement the works are still unfinished. The definition of such semantics is one important factor to the deployment of web services, especially in the interaction among institutions and with customers.

4.2 Technical Barriers

Technical barriers are those relative to the operation of web services as to security, reliability, and performance.

4.2.1. Security

In web services, as well as in process in general, companies face the trade-off between flexibility and security and stability. The decisions about the trade-offs depend on a series of factors as criticality of the process, perception of the risk, and tendency to take risks. In an initial phase of adoption of a new technology, this tradeoff is more evident as in the case of web services.

Since SOAP is more commonly transported in HTTP, any potential threat to HTTP will be inherited by SOAP. An additional concern in dealing with text-based XML documents - unlike conventional middleware data wrapped in binary documents - is that, if intercepted in transit, it can provide information of data and the structure of the data [64], since XML-documents are structured and marked with tags. Thus, the advantage of being extremely readable applications to computers as well as to humans is also a high risk. The security concerns are still waiting for the establishment of reliable standards [65] [66].

The information security can be divided in the following logical components: confidentiality, integrity, authentication, authorization, non-repudiation, and privacy [67][68][18][69], and each of them present challenges to the implementation of web services:

a) Confidentiality is the ability to ensure that data in transit between two parties are not available to third parties. It is achieved by either a means of private connection, as dedicated lines or virtual private network, or through encryption, as the use of SSL - Security Socket Layer.

   In the World Wide Web, the SSL protocol is used to encrypt data. The data is encrypted just after the transmission from one system and decrypted immediately after being received by the other system. It means that SSL provide security only while information is in transit between systems. However, since the web services can be composed by many systems, intermediaries can exist between the initial and the end ones. Since SSL encrypt data only while in transit, the data is decrypted when it is received by the intermediary system and could be easily read especially due to its XML format. Then, it is necessary that the development of standards enable the intermediary to see, interpret, and modify some necessary data to perform its tasks, while keeping other data unreadable and encrypted, which should be seen only by the final system [18]. Even in internal applications, some sensitive transmitted data should not be readable by the intermediary systems composing internal web services. One additional issue raised is that the process

mentioned above increase the number of encryptions and decryptions in the process, what lowers the systems performance.

b) Integrity is the ability to ensure that a message was not altered after expedited and before being received [68]. SSL can ensure the integrity of information only between a pair of entities, but not if the information goes through intermediaries and is decrypted as what can be the case of web services [18]. As of confidentiality, standards must be created to guarantee that intermediaries can modify parts of a document without having access to other parts.

c) Authentication is the ability to guarantee that the entity (person or systems) is who or what it claims to be, verifying the identity of the entities with which they interact [18]. While usernames and passwords are a common form of authentication on the World Wide Web, web services have requirements that exceed those mechanisms, especially in the machine-to-machine interactions [70]. Also, since different entities have different forms of authentication, a standard should be established to allow those diverse models to exchange identities.

d) Authorization determines the privileges available to an authenticated entity [18], guaranteeing that only authorized entities have access to each resource. The authentication refers to "who you are" and the authorization, to "what you are allowed to do" [68]. With many services being used to complete a process, the number of needed authorizations is much higher than the one when a single application is performing the process. That causes not only low performance but also demands changes in the process of authorization, since after the authentication of a service by an entity, other services can interact with the entity, changing the permissions of the service previously authenticated.

e) Non-repudiation means preventing a person or a system which performed an act, while sending or receiving a message, from denying it further on, as part or as a whole [68]. For example, buyers can not deny placing orders and sellers can not deny receiving them [18].

f) Privacy is the protection of the personal data, guaranteeing that a consumer decides what information discloses, to whom, and for which purpose. Since web services offer new means of accessing data and it is still needed to solve the security issues, it is important to be aware of possible privacy flaws.

The FSTC - Financial Services Technology Consortium, along with institutions such as Bank of America, JP Morgan Chase, Wachovia and Federal Reserve Bank, have developed a proof-of-concept corporate cash management project, concluded in mid-2003 [42][70]. The project included a case scenario with service exchanges among bank-to-bank and bank-to-corporate and small business-client participants for receiving balance information reporting as well as alerts. One of the outcomes of the project is that security needed to be better developed than thought previously. Even the Bank of America, participant of the project, has no immediate plans for developing internal projects although it has been "exploring the notion of integrating enterprise resource planning systems and treasury management as a possible future web services project" [42].

As seen above, so far, there have been no standards to guarantee identity management, such as authorization and authentication to access information in web services applications as there are in web-based applications [44]. But, although such standards to web services are still not agreed-on, halting the deployment of web services beyond the firewall, some financial institutions are trying to get around the problem. Wells Fargo's Wholesale Banking is migrating online banking internal applications for corporate customers to web services that will be offered through the corporate portal. The applications will be broken up into their discrete components so that customers can tailor the online service to match their business needs. To address the security concerns, the client still has to follow the regular procedure of establishing a relationship with the bank and get users ID to use the services. Additionally, due to the lack of security standards to web services, keeping track of each transaction each user is authorized to perform would bring underperformance. Once, in

the current web-based applications, the authorization is verified in the moment the application is launched. However, in order to offer security with the current web services solutions, an increase in the points of required authentication would be necessary [62].

Other concerns related to security, are the adaptation of firewalls to filtering SOAP messages and the Denial of Service and Replay Attack, which also need to be treated in the deployment of web services. For instance, since SOAP messages are carried over HTTP transverse firewalls [24], the latter need to be configured so that malicious requests (e.g. code embedded in SOAP messages) are not tunneled through SOAP.

New standards present flaws and need some time to be debugged and achieve an acceptable level of maturity. But in case of security issues, those flaws could be especially harmful in financial services. For this reason, the security standards, as those relative to encryption, are supposed to take longer to be adopted. Financial services are not likely to be the ones that will first debug them. The current concerns with security in web-based banking are likely to lead the tests before the adoption of web services security standards take longer.

4.2.2. Performance

Another concern in dealing with XML is that, since it is a text-based document, it is heavier than binary data. In general the XML quadruplicates the size of the messages, but it can be 20 times larger than a non-XML version, due to the inclusion of tags embedding metadata. Although the documents can be compressed in order to get a size compatible to the binary representation, the size of the messaging can introduce latency in the sending, transmitting and receiving of messages. The processing speed of an XML-document is still at a factor between 10 and 20 times slower than that of an optimized binary protocol. Sending and receiving are affected because parsing and processing text-based messages are more time-consuming and expensive. Transmission is more time consuming due to the size of the messages [71][66][72].

The increase in the volume of information to be exchanged increases with the use of XML, what can overload the network in the presence of a large number of services, penalizing the scalability of the web service model [24]. Thus, XML-documents, in which web services are based on, may not yet be appropriate for applications involving high time-sensitiveness, high volume of data, and high throughput rate [67][72]. The advances in technology tend to offer solutions to those concerns. TCP/IP also was referred to as a tool that brought too much overhead in its early years, yet it has become the dominant networking protocol, due to the features and robustness brought by the overhead, and evolution in processing speed [73]. Considerations about its adoption must balance these performance issues, including the need and costs of storage, communication, and faster processors, with the advantages as the most understandable format, interoperability of applications, using different technologies, data quality, and single entry of data to support multiple applications.

It is always difficult to connect applications with one another. By using solutions such as ERP - Enterprise Resource Planning systems, companies need to adapt their ways of doing things to the software [5]. Although web services pledge more flexibility, and customization tends to be less than a hurdle, it is likely that companies also need to make adaptations, especially in the use of web services pre-packaged solutions.

4.2.3. Quality of Service and Reliability

An application could be composed by multiple web services, each one with different degrees of reliability and security. But the unreliability of any one of the web services used by the application could cause the downfall of each other. By making various applications base themselves on web services, there is a risk of having a fault in a component, making you bring down many more dependable applications than in a point-to-point integration.

It is more difficult to guarantee the quality of service of an application over the internet and define parameters to availability, performance, and reliability [14]. Furthermore, one supposed service composed by services offered by many different companies raise issues as to the definition and agreement on responsibilities, procedures, and time for diagnose and maintenance in case of failure. In case of the failure of a banking service, the customer has no interest in the composition of the service, and the brand and reputation at stake are those of the financial institution.

Companies as J.P. Morgan Chase and Fidelity Investments have concerns about the speed of online transactions and the quality of products presented to customers over the Internet [27]. The companies offer a quality, security, and reliability of service that they are not willing to give up while adopting a new technology, since the customers are not concerned about what is going on with the technology, but about what is going on with the services and products offered to them.

4.2.4. Transactions

Some of the obstacles to be overcome as of the adoption of web services are related to the transactions [44]. So far, the concept of ACID transactions has had a fundamental role in the development of current enterprise applications. A system that conforms to these so-called ACID properties guarantees the reliability of its transactions and has the following properties [74][18][75]:

a) Atomicity - the transaction must be of the all-or-nothing-at-all type. It means that it must be completed entirely; either all the components are committed or nothing happens.
b) Consistency - whether or not a transaction succeeds, the data must end up in a consistency state.
c) Isolation - events within a transaction must be hidden from other transactions running concurrently until it has been committed.
d) Durability - once a transaction has been successfully completed, it must be guaranteed that the results stand any subsequent malfunctions.

However, these properties are suited to short-term activities executing on closely-coupled applications and environments. In a loosely-coupled environment, like the web services, they are too inflexible and restricting for many applications [76]. Acid-based transactions span some seconds or few minutes at the most and block the application during this time whereas web-services transactions are much more complex and may last quite long. If the concepts of ACID transaction are to apply to web services, some systems would be locked for many hours until the end of the transaction. Additionally, ACID transactions are conceived to run in more reliable environments, in which failures are relatively infrequent [18].

Problems of transactions involving multiple parties as in hotel reservations, airlines, and car rentals simultaneously have been solved by close coupling the systems, but there is not yet a solution or standard to solve the problem using loose coupled systems as in the case of web services.

Most of the transactions in financial institutions demand that it be guaranteed that messages are delivered, and if so, only once, and in the correct order. So far, the web services standards have not met those demands [18].

4.3 Vendor and Skill Barriers

Vendor and skill barriers include the lack of vendors support and financial institutions' in-house skills mainly in the area of external web services, security and emerging standards.

Web services implementation requires not so simple specifications, tools and techniques; some of them are still to come up during the future implementations and proofs of the concept. There are skills that must be mastered by software engineers to properly develop an application relying on web services. Intending to offer

flexibility to the development of applications, web services tools and platforms available in the market do not enforce the correct development of web services, allowing developers to create solutions not as scalable and flexible as it should be [77]. Then, the development of web services needs to be accompanied by the mentality of scalability and flexibility in the systems; on the contrary, developers can create solutions as rigid as the current ones, hampering the benefits of web services.

Although silos of information in systems have been a lot discussed, there is still a need to consider that there are silos of information in departments and in people that foresee the risk of losing power in sharing information, for example. Those silos, as well as the "not-invented-here" syndrome need to be handled by management to take advantage of the web services' characteristics as reusing.

Up to now, vendors have not been able to offer solutions to meet many needs of the companies in deploying web services. For one thing, the lack of solutions to efficiently compress XML documents [72]. And, most of the emerging standards are not fully supported by vendors, making it difficult for the companies to dare the hurdles of adoption.

Moreover, many of the needed solutions to the deployment of web services are not yet offered by well-know vendors. Deciding to acquire new technologies solutions of small suppliers' present the risks of getting the supplier to go out of business or get stuck to loser-standards, since such suppliers have less power to push towards the adoption of their solutions as standards. However, companies intending to be early adopters are going to run these risks by previously fully assessing the vendors' capabilities and selecting the most prone ones to have an active participation in the definition of standards and to keep themselves in the market.

4.4 Financial Issues

Being it a new non-completely-developed technology, it is difficult to have a clear idea about the return on the application's investment. Although some companies have claimed huge savings through the implementation, there is still not enough data to draw a complete picture and the benefits of the investment can still be considered theoretical.

The implementation of web services can demand costs in terms of new software, hardware, networking infrastructure [2] and related personnel and administrative expenses. The deployment of web services demands adaptation in applications to allow inclusion of the new standards. The different performance of processing the documents based on such new standards can demand more powerful processors and storage, as in the case of processing XML-documents mentioned earlier. Although the internet was supposed to be used as the data-network infrastructure, the connection interoperability among companies can bring up new networking expenses. These amounts and the related personnel, administrative, and maintenance expenses must be taken into account so the possible return on the investment can be analyzed.

4.5 Contractual and Legal Issues

Aspects as contracts and agreements to make use of the third parties' web services must still be brought up to discussion.

There have been attempt to create solutions to automatize business contracts (parts or all) in the e-commerce, enabling software agents in the electronic marketplace to create, compose, modify, discover, evaluate, negotiate, and monitor contracts with substantial automation and modularity [78]. Those e-contracts could be used in agreements about web services, but they are still under development.

In addition, companies need to be on alert as to the possible dispute resolutions, involving contracts and jurisdictional matters in the use of web services. Other issues tend to be more related to the breadth of the use of web services [79], as in the case of use of data in aggregation services.

4.6 Partners Issues

The security is not the only challenge to be overcome in the use of web services to integrate partners. Some companies find it difficult to connect to its partners, because the latter would need to process XML and SOAP messages; however, many of them, as some car dealers, are neither able nor willing to do so due to work and costs demanded. Some issues can also be faced in connection with customers that might not be willing to invest in connectivity with the financial services, as demanded by some solutions proposed so far.

5. Comparison to Current Middleware, Business-to-Business, and Integration Applications

While analyzing the adoption of web services, one of the first questions is why web services are different from the other middleware and business-to-business applications that, during the last decades, have pledged the same benefits, but which delivery fell short of promise. Here, the intention is not to enter in technical details about each of those technologies, but give an idea of the differences and similarities among benefits and challenges of each one, what is a necessary step in the decision about whether or not to adopt web services. Web services are not a panacea, and current technologies can continue to suit the needs of many companies and business applications. Furthermore, many providers of applications, as ERP - enterprise Resource Planning and EAI - Enterprise Application Integration, can develop their solutions to embed web services model and compete in such new market. Others can adopt the XML to ease the interoperability, as EDI - Electronic Data Interchange providers. But, while those companies can take advantage of their expertise in systems integration and knowledge of the companies involved, their new applications can be stuck in some not-so-flexible models.

Trying to overcome the problems faced by current solutions, web services were conceived based on wide spread protocols as the Hypertext Transfer Protocol (HTTP) to link services more efficiently and rely on the advances in the internet infrastructure. Additionally, web services are platform and vendor independent, enabling parties to interact, independent of technologies and hosting platforms. Considering that the web services evolve as conceived, the integration efforts are minimized and tasks of publishing, registering, finding and utilizing business services become easier due to the common format. Also, the task of constructing new business applications can become easier due to the modularity of web services that act as individual business pieces. As a result, the time to market, deploy and develop new products and services is minimized. The development costs are also minimized, once some components are developed only one time and reused in diverse business applications. The same characteristics mentioned before also make the adaptation and customization of business applications easier for new requirements and specifications [80].

The characteristics of current applications mentioned below do not intend to disregard such solutions, but only show the problems that web services try to overcome. The word “try” is important here, since web service is not yet a proved concept. Furthermore, as shown below, the current solutions have characteristics that are suitable to some business applications.

5.1 Business-to-Business Interactions

The offer of products and services to companies over the internet has a great importance to financial institutions not only through direct services, such as online banking, but in the intermediation of business and transactions with companies, employees, suppliers, and partners.

Although the ubiquity and affordability of the world wide web has made the automation of B2B interactions possible, there are several issues that still need to be addressed as scale, content, exchange, autonomy, and heterogeneity. One of the needs in B2B is that inter- and intra-enterprise applications evolve independently, yet allowing them to effectively and conveniently use each other’s functionality. In addition, a great challenge to B2B e-commerce is interaction, or the interoperation and integration with internal and external enterprise applications. Such interaction offers challenges related to scalability, volatility, autonomy, heterogeneity, and legacy systems. It is necessary to deal with disparate data representations, connect front- and back-end systems, proprietary and legacy data sources, applications, processes, and workflows to the web, and trading partners’ systems [24].

The interactions in B2B applications occur in three layers [24]:

a) Communication - the communication layer provides agreement and communication protocols for exchanging messages as HTTP and SOAP. If partners use different proprietary communication protocols, gateways should be used to translate messages.

b) Business process - it is related to the agreement on the joint business processes, such as delivery mode and contracts. The business process layer aims to allow autonomous and heterogeneous partners to advertise their terms and capabilities and engage in interactions with other partners. This is a challenge, demanding the understanding of the semantics of partner's business processes.

c) Content - it is related to the need for companies to understand the content of the information exchanged. The content layer provides languages and models to describe and organize information to be understood and used. Content interactions require that systems understand the semantics of content and types of business documents. It might be necessary to have the reconciliation among disparate representations, vocabularies, and semantics.

The most widely used technology to Business-to-Business e-commerce has been the Electronic Data Interchange (EDI) [24].

5.1.1. Electronic Data Interchange (EDI)

EDI is an inter-organizational application-to-application transfer of business documents (e.g. purchase orders, invoices, shipping notices) between computers in a compact form to minimize the cost, effort, and time incurred by the paper-based transfer of documents [24]. EDI focuses mainly on interoperability in the communication and content layer.

EDI standards provide a single homogeneous solution for content interoperability, since all partners are required to comply with EDI standard. Although there are a large number of predetermined documents supported by EDI standards, companies are limited to that set of EDI documents for which standards already exist. Then, EDI is hardly flexible in its ability to expand the set of supported document types. The introduction of a new type or the change of an existing type of business transaction may be complex and time consuming, requiring modifications in software and validation in specific committees, which usually take a long time.

Since the document exchanging is over private or value added networks, there is no concern with security issues encountered in public networks. Not only that, since business partners do not need to refer to each other's systems, changes in the companies' systems have limited impacts. However, understanding all information in an EDI document is not simple. The cost of establishing a new relationship usually requires a significant overhead, and since it is based on proprietary and expensive networks, many small and medium organizations can not afford it. As a result, they are excluded from being partners with larger organizations that mandate the use of EDI [24]. At the same time, organizations that have the possibility to offer EDI as financial institutions miss the opportunity to offer products and services to smaller organizations. It has been reported that 90% of the Fortune 500 companies in the United States use EDI, while only 6% of the other 10 million companies can make that claim.

The cost of an EDI solution depends on factors such as VAN – Value Added Network services - expected volume of documents, economics of EDI translation software (convert EDI format to/from internal business applications), and implementation time. There is an effort to reduce the cost of VAN networks based on internet solutions, what reduces the costs with VAN maintenance, but increases concerns with security and

loss in the service quality (e.g. automatic error detection and correction) associated with VANs. There are efforts to establish standard document definitions to some industries, which although will reduce the customization required per relationship, does not eliminate the per-relationship work. After the agreement on implementation standards, custom integration work is needed at both partner organizations to the enterprise systems to process EDI documents, involving, in general, the purchase of the commercial EDI system, integrating it with the enterprise systems, and writing custom code to translate the EDI system document definitions to the enterprise system. [24][18]

One of the advantages of web services is the possibility of making a faster interconnection among companies, due to the standards and easy-to-integrate characteristics. Although EDI permits companies to exchange information in standardized forms avoiding the need for custom connections, such connections are still required to translate the information for and to the application. Furthermore, it could be possible [3] to overcome the high costs of VAN infrastructure and EDI software.

5.2 Integration Applications

The current format of these applications and solutions is probably changing, in order to incorporate web services capabilities, making them more flexible and less expensive to keep competitiveness.

5.2.1. Enterprise Resource Planning (ERP)

ERP has historically focused on the integration of business functions, although there is a try to push it to the edge of the companies. While it solves some problems [18] of integration in inventory management, for example, it is difficult to change, tends to be silos isolated from other systems, making it difficult to link to other applications, create lock into the vendors, and requires expensive customization.

5.2.2. Enterprise Application Integration (EAI)

The issues brought up through the application of ERP have created the opportunity to the EAI – Enterprise Application Integration - which packages are acting as software data translators that take information from ERP and convert it into formats that other applications, such as CRM - Customer can understand and vice-versa. The EAI's major problems are that, depending on the characteristics of the applications involving simple things such as different formats to names, the applications can not be connected, or can be connected under the risk of information loss, as well as high cost [18]. Furthermore, EAI also involves proprietary solutions, are complex to use and difficult to interoperate with each other.

5.3 Components Middleware

Over the past two decades, many technologies have been designed to link the components of separate systems as CORBA - Common Object Request Broker Architecture, RMI – Remote Method Invocation, and DCOM – Distributed Component Object Model [18]. Although such models are in place for some years, few mature products exist, because they are complex and require high communication costs and overheads, while providing low degrees of scalability and interoperability [80].

There are two major problems with those technologies that web services try to solve. The first is the difficulty of communication among the technologies developed by different vendors. The second is the fact that the security of the firewall restricts communication between networks, even if systems use the same protocol to communicate. Web services solve these problems through the use of standard protocols and of SOAP that is not blocked by firewalls. [15][25]

The technologies intended to link systems as CORBA and DCOM have improved, based on previous failures and in the evolution of each other, but they still have some problems that web services attempt to solve, based also on the experience of those current technologies [18]. Besides the issues mentioned earlier, those middleware are more appropriate for a small number of partners within a company, they demand the development of ad hoc solutions for defining intra and inter-companies business processes and, in general, are not compliant with each other. On the other hand, they already provide security mechanisms such as authentication, authorization, and encryption [24].

a) CORBA - first released in 1992, deal mainly with interactions in the communication layer, and not with the content and business processes layers. It couples the systems tightly, requiring each system to have deep knowledge of the internal characteristics of the systems to which they are coupled [18]. It was designed to be independent of implementation languages and operating systems, easing the interactions; however, all the participants in a certain market need to agree on a predefined interface. Hence, any change to a partner's interface may need the corresponding interface to be changed. The complexity of CORBA development increases the costs of solutions based on it. [24]

b) DCOM - Microsoft's Component Object Model (COM) was released in 1993 as a way for applications running on the same computer to communicate with one another. This was followed in 1996 by Distributed COM (DCOM) that supported communications between applications running on separate computers. They are still specific to the Microsoft environment, though [18]. It also deals mainly with the communication layer and not with the component and business processes layers. It enables tightly coupled and long-term business relationships [24].

6. Adoption and Diffusion of Web Services

Diffusion is the process by which individuals and firms adopt a new technology, or replace an older with a new one, including the processes of learning, imitation, and feedback [81]. Understanding of the diffusion process can give some hints about the web services' diffusion.

Diffusion results from a series of individual decisions to begin the use of the new technology, product or service. Those decisions balance the incremental benefits of adopting a new technology, product, or service against the costs of change, often in an uncertain environment (as the future evolution of the new technology and its benefits) and by limited information (as those about the benefits and costs). [82]

Two characteristics commonly appointed in the diffusion of innovations are the slowness of the process and the wide variation in the acceptance rate. For example, most of the times applications software shows a lag between diffusion and innovation, since the feedback originated from the experience and demands of users are an important aspect of its development [81][82]. The web services concept is new and still presents many disadvantages in relation to the current solutions, such as the security issues. Then, it must cast doubts about the predictions that, in 2005, the web services will be widely spread. Companies must be aware of the time required for the web services' pledges to be delivered [83].

6.1 S-Curves

In general, putting the numbers of users of an innovation versus time in a graph, the typical result is an S-shaped curve, since the adoption starts slowly, accelerates as it spreads throughout the potential adopting population, and then slows down as the relevant population gets saturated or achieve an equilibrium level, [30][81][93], due, for example, to the preference for adopting a new technology, product, or service.

Figure 6-1 shows the adoption patterns of innovations in USA, although, obviously, the curves are not smooth. An interesting point is that the perception of the time of diffusions and adoption tends to be different, since people frame the time based on the time he or she has learned about the new product or service. For example [82], the internet technology was developed in the early 1970's but did not really take off until late 1980's.

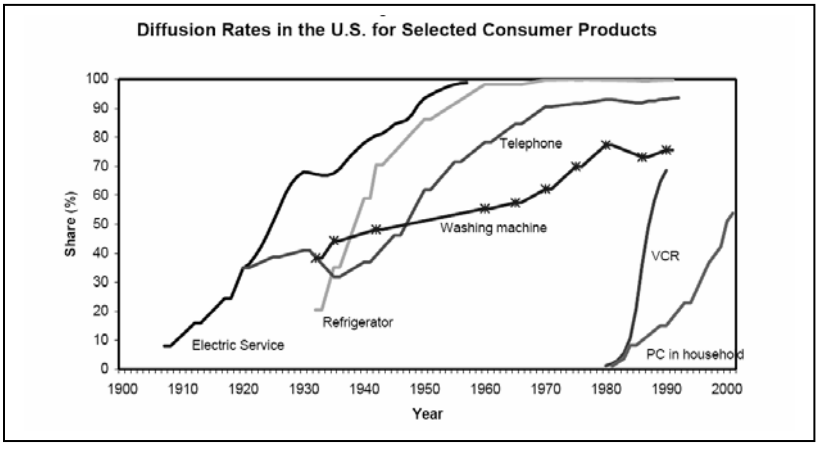

Figure 6-1 – Diffusion Rates in US [82]

Figure 6-2 presents the expected evolution of the US financial industry's expenditure in web services until 2007 that also resembles an S-shaped curve.

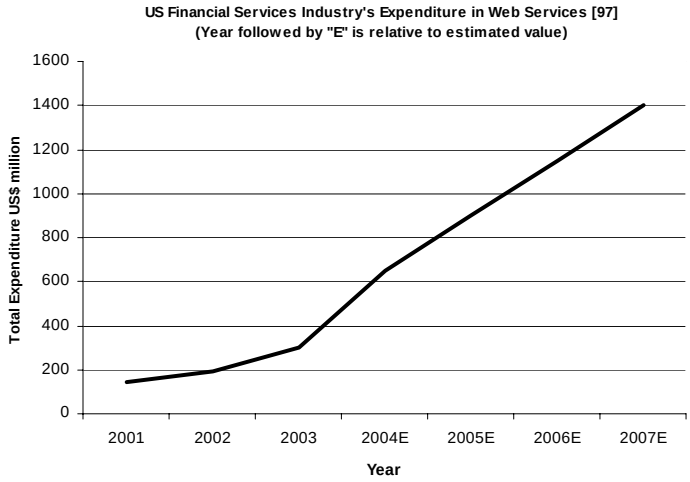

Figure 6-2 – Forecast of Web Services Adoption [14]

There are two different explanations for the dispersion of the adoption that leads to an S-shaped curve, but analyzing the combination of both seems to be a more adequate approach than treat them as mutually exclusive. The S-shaped curve is reinforced when they are combined. The first assumes that different users expect to receive different benefits from the innovation, and this expectation follows a normal distribution. Also, since the cost of new product tends to be constant or declining over time and the adoption by each potential user occurs when the benefits of each of them is greater than the cost, the S-shaped curve is generated. The second assumes that the users do not have the same information about the technology at the same time, and as the information, or more information is becoming available, the rate of adoption increases until the market gets saturated and the rate of adoption decreases. [81][82].

At first, the resulting S-shaped curve presents an exponential growth and gradually slows until the system reaches equilibrium [86][93]. Thinking about web services, the growth is initially slow due to uncertainties and different benefits perceived. As the number of users grows, more information is available and the solutions are improved, reducing the uncertainty and increasing the benefits of their adoption, increasing the growth rate. As more and more companies adopt web services the number of potential new adopters decreases slowing the rate of growth. Finally, as the potential new adopters achieve a low volume and / or new technology is made available, the number of new adopters achieves the equilibrium.

Figure 6-3 shows the relation between the S-curve representing the cumulative number of users of a technology and the normal distribution of the rate of adoption. Initially, the rate of adoption increases, causing the exponential growth of new users. As the rate of adoption achieves the maximum level and starts decreasing, the number of new users decreases, and the total number of users tends to come to an equilibrium.

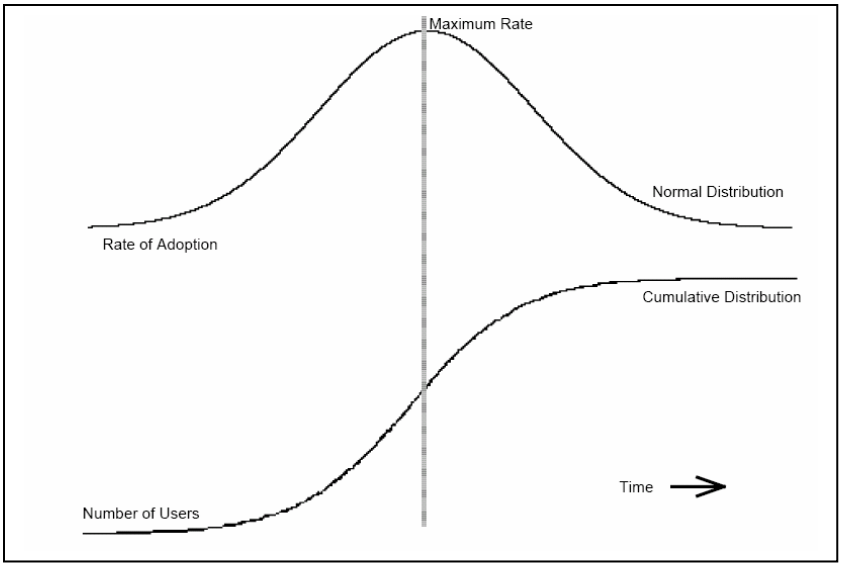

Figure 6-3 – Rate of Adoption and S-Curves [84]

In such growth pattern, one standard or technology that achieves a critical mass can reinforce its growth, diminishing the possibilities of the growth of other standards or technologies. In the case of web services, it is possible that different standards start to be adopted, and at some point in time, one or some of them achieve a critical mass, reinforcing their growth and restraining or making the adoption of other standards less interesting. For example, CORBA was overtaken by web services before it got too far up S-curve. Due to those patterns and the characteristics of diffusion that are mentioned in the next section, many times the market does not tip [9][92][93] to the superior standard or technology, but to one that aggregates more conditions to achieve the critical mass, as strengthen of supporters and compatibility.

6.2 Diffusion

The factors affecting the diffusion of an innovation can be classified as those affecting the benefits received, the costs of adoption, those related to the industry and social environment, and those due to the uncertainty and information problems [81]:

6.2.1. Benefits Received through the New Technology

The most important determinant of the benefit originated from the adoption of a new technology is the amount of improvement of the new technology over the previous ones, as the analysis of the benefit-cost ratio. The existence of current technologies that are fairly close to the new one can slow the adoption rate. Furthermore, the relative advantage of the new technology is frequently small when it is introduced; as the diffusion progresses, the learning about the technology takes place, bringing improvements and adaptation to diverse environments, making it more attractive to more potential users.

Today the use of web services is very limited, since the standards are not yet totally developed. Therefore, their use does not bring enough benefits to motivate the adoption by a great number of companies. The same benefits can be achieved in a satisfactory way by the current technologies. If the standards are agreed-on, web services have the possibility to bring the benefits mentioned before and its adoption can be triggered.

But, by and large, new technologies present disadvantages or a small advantage over the current ones to great part of the market. Over time, however, it tends to be enhanced and be more attractive to a greater number of segments and uses. Furthermore, the improvements in the complementary assets can also affect the rate of adoption. As to web services, for example, the development of faster and more powerful processors can increase the performance of applications using XML-based documents that so far have shown a much lower performance than their competitors'.

Often, when a technology is under threat of being substituted, their providers tend to enhance or change its characteristics to keep competitiveness in the new environment. In general, it tends to slow the diffusion of new technologies. However, in the case of web services, it can even accelerate the process, since providers of ERP and EAI solutions try to embed web services characteristics in their products to keep market share.

Although the evolution of past innovations is not guarantee of success for web services, one should not judge the future of web services only based in its current level of benefits. In many cases, the value of new technologies to the consumer depends partly on its adoption by other users, either because it is used to communicate with others (e.g. fax, internet, instant message, e-mail), or because the provision of complementors, as software and services, improve with the number of customers. The adoption of a particular standard for many companies increases the probability that the standard will survive and that complementors to the standard will continue to be produced and evolve. Furthermore, a standard can increase the size of potential market, which can cause the lowering in the production costs and increase in the variety and availability of complimentary products and services. Then, one important determinant benefit of the adoption is the current and expected rate of adoption [81].

The effect of a customer to value a product more when it is compatible with other customer's products is called network externalities [52][82]. Then, the number of adopters of an innovation influences the number of remaining firms that will subsequently adopt it [86]. Technologies subjected to strong network effects tend to exhibit long lead times followed by rapid growth. This pattern happens because, as the installed base of users grows, more users find adoption worthwhile [82].

Owing to such characteristics, the standard battles have increased and companies have adopted strategic behaviors to influence the standards that they adopt or support. But, the heterogeneity in the "tastes" of consumers companies and in the information gathered for them can result in more than one standard surviving [85]. In the case of web services, an increase in the number of standards to one layer can hamper its diffusion.

There are many theories about innovation adoption stating that as the number of adopters of an innovation increases, the adoption cost decreases and the return increases, making the number of adopters even higher. Additionally, the higher the number of adopters, the more information is generated, and for profitable innovations, it reduces the premium or improve the assessment of the innovation for the non-adopters, also increasing the number of adopters.

Furthermore, in some cases it is important to consider the bandwagon effect and the pressure on organizations to adopt the innovation arising form the threat of lost competitive advantage. The higher the uncertainty level, the higher the competitive and institutional bandwagon pressures tend to be [86]. Such bandwagons can lead to the adoption of standards that are not the best ones. Furthermore, as to web services, we can notice that the vendors try to create the bandwagon and sell the applications as a panacea. In this case, so far, the bandwagon has had limited effect due to few very noticeable highly successful cases published, the immaturity of most of the standards, and even the effect of the internet bubble that lead to concerns about some new ideas. After the promises of dot-com, many companies are skeptical, or overcautious about promises of IT solutions' to solve their problems. In the case of web services, this skepticism is increased due to all the hype surrounding the new technology and the push for some vendors to sell it as a panacea. "Sky-high expectations and reams of

hype are too often the death knell for emerging technologies" [38]. But, at the same time, the same vendors are making investments to develop the standards and the technologies to make the real and full implementation of web services possible, since they are interested in creating this new market to sell applications and solutions.

In the decisions about the adoption of web services, most of those concepts are applied. Intending to guarantee interoperability not only inside the company, but also with partners and customers, the increase in the number of web services' users tend to attract a larger number of users, once the benefits of adoption also rises. However, since the standards are not agreed-on, vendors are not yet offering a compelling array of solutions. Also, the number of users neither seems to be enough to accelerate the rate of adoption massively, nor are the vendors offering enough support or compelling solutions, as showed in previous chapters. One of the greatest benefits of web services is to offer the possibility of integration with partners and customers; but, since this possibility is still quite difficult due to lack of standards and few numbers of companies and customers able to integrate through web services the rate of adoption is still low.

One example of the influence of those factors affecting the decision on adopting a new technology in the financial services was in the introduction of EBPP - Electronic Bill Presentment and Payment - technology in the USA [87]. The network effects could lead some billers to adopt the first technologies available, even with the possibility of new and better technologies to be developed. At the same time, considering the high costs of early adoption, billers were willing to wait. The anticipation of a new and better technology caused the billers to wait, depending on the benefits of the early adoption and costs of possible upgrade in the future. To generate the network externalities benefits, there was a chicken-and-eggs problem, since consumers were waiting for lots of companies to offer the service and other customers to sign up, companies were waiting for more customers using the service before offering it. The question to the billers was not whether or not to offer the service, but when and which technology to use. Although the first mover movement can bring long-term advantages, the uncertainty about the new technology can bring advantages to the second mover. [87] This is especially true when the new technology is not a disruptive technology, and the companies have time to learn with past failures and burden of first movers. This seems to be exactly the case of web services in the financial industry.

6.2.2. Costs of Adopting the New Technology

In order to use the new technology, costs of acquisition, complementary investments, and learning are included. The need of complimentary investments slows the diffusion because it increases the costs, also because it takes time slowing down the rate at which the benefits of the technology are seen. [81]

The standardization, modularity, and the possibility of reusing the services tend to decrease the costs of the applications development, while launching new products and services, what could increase the rate of adoption. Notwithstanding, there are many issues involving costs and uncertainties about the technology that tends to slow down the process of adoption.

Some companies have stated the need of acquiring particular skills to implement the web services architecture. Frequently, the adoption of a new technology [81] is followed by other changes to the individual's or organization way of doing things. The adoption of web services must be accompanied by the evolution of the systems mentality, since it is necessary to have a more modular approach to the development, as the reuse of services. While such thing can delay the adoption, the technology is being deployed and the learning curve effect acts accelerating the speed of adoption. Moreover, only observing the applications in the long run, it is possible to figure out possible unknown or hidden costs in their use and maintenance. Additional costs can also be added due to the aspects of the XML documents mentioned before.

Web services are still quite immature and a decision of investing or not must be made in an especially uncertain environment. Adopting a loser standard can make the support of the vendors to that standard decrease and force the company to replace the standards to guarantee the interoperability, demanding additional investments. Furthermore, it is not clear if the web service will evolve in the structure presented so far, what increases the uncertainty surrounding the making of the decision.

6.2.3. Information and Uncertainty

The adoption of a technology involves information about its suitability to the potential adopter's situation. The information about the technology can be influenced by the actions of the suppliers (as the vendor's push in the case of web services) and availability of information about experience with it in the decision maker's environment. [81]

The adoption of web services increases the information about their benefits, problems, and costs involved. Vendors and consultants publish a lot of information about positive deployments of web services trying to reduce the uncertainty and show the positive aspects presented, what tends to increase the adoption rate. On the other hand, the many publications and project-pilots, as the one realized by the FSTC - Financial Services Technology Consortium, raising concerns about security aspects slows down the rate of adoption. The adoption [81] is also influenced by the information about experiences in the decision maker's immediate environment such as industry associations, standard committees, peers, partners, and suppliers.

The trialability, or the facility of a potential adopter to experiment the innovation before high investment, and the observability, or the ease to evaluate the results after the trial [88] influence the uncertainty about web services. Due to the modularity of web services, it is not difficult to test their use in a proof of concept project which does not involve a critical process of the company. Although some of the results of such tests are observable in the short run like the performance of the systems, some characteristics such as the scalability demand some time to be observed, and many companies delay the adoption until further tests are made by other companies.

Uncertainty about benefits, costs, and length of life slows the adoption rate. Then, the decision about the adoption can be seem as a real-option. Potential adopters have an option on a new technology, and if the adopter thinks the uncertain payoff reaches a certain value (the strike price), he exercises the option by adopting the new technology. So, the adoption tends to more often take place in industries with lower uncertainty and lower sunk costs [81]. Adopting a new technology is similar to any other investment under uncertainty and can, then, be analyzed in the real options framework. As in the case of an investment, the decision of adopting a new technology is characterized by uncertainty over future profit streams, irreversibility creating at least some sunk costs, and opportunity to delay. In a real options framework, the potential adopter is viewed as having a call option to adopt the new technology that can be exercised at any time [82]

The attitude towards risks of each company has a great influence on uncertain situations as the one faced in the current stage of web services. As seen before, some companies risk facing the flaws so far encountered to take advantage of the pledged benefits.

6.2.4. Market Size, Industry Environment, and Market Structure

Concentrated providers of new technology tend to have higher prices, slowing its adoption, but they can also determine standards more easily, increasing the benefit of adoption. If oligopolistic firms are competing to offer different standards, the process of adoption tends to speed up. [81]. With one or more firms competing, the price tends to go down with the objective to build market share, what increases the rate of adoption. On

the other hand, it is more difficult to set a standard, which tends to slow down the adoption. In the case of web services, the coming up of a great number of standards tends to decrease the benefits of its adoption, especially in the case of the main layers.

7. Conclusion

Web Services need to be thought of as an enabling tool and not as the panacea to solve all the organization's system problem as announced during the hype period. Due to the huge number of issues involved in their evolution, the decision to whether adopt web services or not depends on the characteristics of each financial institution or even on each project that is under analysis. However, even if it is not a technology able to disrupt the financial services overnight, the institutions must pay attention to the evolution of standards and uses to have information to make the decision when needed. The evolution should be accompanied not only in the financial sector, but also in other industries, since the evolution of the standards as a whole and the possible adoption by companies (current and potential customers) can give information to more adequately make the decision about the adoption by financial institution.

So far, most of the current applications that have been carried out and called web services have only been the use of some components, as XML and SOAP and not the web services as envisioned, due to the various challenges as lack of standardization. Even if web services do not fulfill all the promises, it is probable that many companies continue using some of its components, as XML and SOAP, but, in this case, the benefits achieved will be far behind those envisioned nowadays.

The web services so far have presented many flaws, uncertainties, and performance disadvantages, which can not be used as a factor to bury them. Utilizing a new technology [89] often appears to be less effective than keeping the current one, once it is necessary to bring it up to speed. Many times the users of current technology consider it more productive than the new ones and ignore the potential benefits of these new ones. As shown in the S-curve and diffusion models, in the beginning, the new technology often presents a series of disadvantages and only after a long time, it decreases the costs, increasing the productivity and bringing profits. When such thing happens, it can be quick and take the adepts of the old technologies by surprise.

In addition to that, a series of studies shows that many technologies underperforms for a certain time compared to what users are demanding, and are used only in niche markets, until they are of fully competitive performance [91]. Companies should pay attention to those points to not be fooled by the current underperformance.

At the same time, however, many technologies fail to cross the division between the early adopters, or visionaries, and the early majority of adopters of the technology, which in general represents the bulk of the market volume. While the formers are willing to deal with bugs and glitches, the latter ones want to acquire an improvement on productivity for existing operations, and if the vendors of the technology fail to provide that, it gets difficult to achieve the mainstream market. [94]

If web services achieve some of the envisioned aims, they can help companies develop new products and services or achieve new segments of the market that were not technically of economically feasibility before. However, their power to solve the IT problems of the company should be kept in perspective. While their uses have important outcomes on the integration of systems, partners, and customers and on the development of new products and services, other factors as personnel skills, process technologies, and need of investments in new technologies remain unchanged. A service or product offered by the company will not be more or less valuable only by being offered through web services. The need of value proposition to the services and products offered will not change.

The development and diffusion of web services are still slow. Even companies adopting them have still not matched the extensive forecasts as of few years ago, and many projects are in the planning or development phases. For example, financial institutions are starting to explore the possible opportunities of web services,

but there are a lot of challenges to be faced until its full use, mainly outside the firewalls. Financial institutions are not to give up security and reliability only to embrace a new technology.

Furthermore, it can not be taken for granted that web services standards will continue to be free of charge. There is a lot of controversy around the standards and proprietary standards can emerge, demanding payment of fees and licensing. Some restrictions can also be applied to the use of the standards, since some vendors have some rights even over those standards released for free. Even if an initial agreement is come to, there is the possibility that vendors develop proprietary solutions based on such standards. What must be taken for granted is that at least some of web services layers will have multiple proprietary standards and the companies will have to choose among them, based on their suitability. The problem is that, if the proprietary solutions are applied to specifications as security and reliability, the promises of interoperability through web services will be seriously threatened.

The adoption of web services demands some skills not only linked to the technology itself. Reusing components, for example, can save software and development costs, but many times egos hamper the use of a component developed by others due to the “not invented here” syndrome. Also absence of systems documentation can make it difficult to understand an application and reuse it, compelling to a new development from scratch. Companies should motivate the reuse of components and create structures that allow their rational search and reuse. Moreover, the increasing number of layers in the stack is turning them into a more complex technology to implement and maintain. If companies do not adopt one disciplined and rigorous approach for the development of web services, they will end up with a series of non-interoperable services.

Solution providers, such as Enterprise Resource Planning, which have a great influence on the financial services, will probably adapt their offers to web services capabilities, taking advantage of their expertise in such processes.

Even with agreed-on standards, there is no reason to rush towards the substitution or change of current solutions to add web services capabilities, since it is necessary to incur some switching costs to migrate their already-installed base.

In the beginning, companies are adopting some components of web services that are in a more mature stage, as XML and SOAP, and are going to add new components as they are being developed, achieving the maturity considered to be adequate by each company. There is no need to wait until all the standards and protocols are ready to start implementations, since as showed in cases like Carta SpA, using some of their elements has the potential to bring benefits.

The perpetual tension between cost and value is the essence of nearly all business decisions, and the subjective nature of value is not an excuse for not trying to estimate their magnitudes. [95] In the adoption of new technologies it is generally necessary to make a trade off between certain inherent levels of risk and potential business benefits. So far, web services have been very limited in terms of security and reliability, to name a few. Then, implementations might start in areas where those limitations are less of an issue, until those limitations are addressed [34].

Many components of web services are not available up to now, and companies can be tempted to fill the gaps with other technologies, creating hybrids that can limit its options when web services alternatives become available. Then, the use of proprietary solutions or others to fill the gaps in web services must be implemented as modules with clear-cut interfaces, easing their replacement when web services become available. [45] Some companies, for example, are creating proprietary XML languages to develop their web services. As for Merrill Lynch, who developed the X4ML (XML for Merrill Lynch) to enable the mainframe legacy program to be internally published as web service [37]. In the future there will be the possibility of adopting other

standards and the company might have to make adjustments in its language. Thus, the benefits and consequences of such hybrids adoptions must be fully analyzed.

In industries experiencing rapid technology changes, such as the current stage of web services technologies, it is unlikely that a single company have the full range of expertise needed to bring advanced products to market in a time- and cost-effective way [90]. Then, it is important for financial institutions to keep partnerships with major providers of technology and solutions to keep pace with the changes in the market and standards.

It is possible that the final result of the standards and protocols be something very different from what is expected as web service nowadays, due to either the evolution of technologies or maybe the non- total agreement on standards and protocols. It is possible to find forecasts of full web services implementation in one year, but analyzing the patterns of the diffusion of new technologies and the stage of the current standards and applications, it is hard to believe that it will occur.

Despite the possible-to-be-achieved benefits, there is no evidence of imminent disruption or revolution for the financial services industry caused by the use of web services. Although it has the potential to be a disruptive technology to same applications such as EDI, it is not yet defined how such technologies will develop in such a way that it could embrace web services and improve its capabilities.

Web Services are not a "silver bullet" as some articles have called it, and it is not certain whether web services will catch up all the hype around it. The needs discussed in this paper are real, as well as the kind of solutions. What is not clear is whether web services are the application to achieve those solutions.

Financial institutions can start adopting web services internally to test the concept and increase knowledge about its functionality, challenges, and ways to generate value. The diverse standards and technologies that will enable its full use are still under development and the inside learning can give room to those standards and technologies to be more developed or mature enough before the use beyond the firewalls or in more complex solutions. The first projects could be related to the integration of systems in CRM or Contact Centers solutions, which are inside the firewalls and demand the integration of many systems. Another option could be waiting for the full development of the technology before adopting it. Even though this option avoids the possibility of adopting looser standards and technologies, it leaves less time to the companies evolve in the learning curve in the future. Also, as seen in previous examples, even the use of the technology in today's level of maturity is able to bring value to the companies.

With the development of the technologies, a step beyond the firewall could be in the intercommunication with customers and in the participation in the transactions among companies. Nowadays, part of the services offered by financial institutions, such as bill payments, pay roll, and collection services, demands the use of proprietary solutions and a high degree of human intervention, as to inputting data and sending documents. With the development of the web services' standards, those services could be more easily offered through direct links between the companies' systems and financial institutions' systems. The companies' systems could invoke the web services of financial institutions to carry out functions such as payments, without demanding manually intervention to enter or send data. At the same time, the financial institution could provide the customer companies with real-time information about payments and collection. To achieve that, challenges as standardization and security issues need to be addressed. Despite the obvious benefits, such scenarios present a major departure from the current one and would bring new issues to be addressed by financial institutions. Nowadays, for example, customers enter data manually in a proprietary interface provided by the financial institution. In the scenario of web services, the customers would need to be using web services standards or would need to make the changes in their systems to do so. The adoption by customers depends on factors such as the trade off between the agility and reliability of the automatized transference of data and the possible costs and efforts involved to be able to do so. To solve these problems, financial institutions, such as the Wells Fargo, are willing to accept different formats of messages sent by

companies and convert them internally. But, that solution not only increases the costs of the financial institutions, but also makes them responsible for the reliability of such "translation" and certainly decreases the level of automatization of the process, what decreases the attractiveness of such solution. Having in mind that customers possibly will be using web services in the relationship with other companies, such problems could be more easily addressed. Thus, the adoption of web services solutions requires well-performed analysis beyond the decision about the technology to be used.

After that, but some years from now, the web services could be used as a platform to offer new services over the internet by financial institutions. The financial institutions could try to stimulate a network of solution-providers developing systems able to invoke their web services, as Amazon is doing now. The competition in such complementary solutions to its web services would stimulate the demand for the financial institutions' core products and services, and they would have a series of companies "selling" its services. In such scenario, some points must be addressed. Other financial solutions would follow the movement and also start stimulating solution providers to do the same with their products. But, more solution providers tend to be more stimulated as to developing applications compatible to financial institutions with greater number of customers, following the same patterns of S-shaped curves and network externalities mentioned before. Although web services could make it easier for the customer to change the financial institution providing services, it would also make it easier for the companies to start using the services provided by financial institutions, which means that the competition would happen around a greater number of potential customers.

Web services could be use to integrate the systems of the participants in the several financial industry's value chains. For instance, the use of web services and specific industry standards (e.g. ACORD) to link insurance systems of financial institutions, brokers, and reinsurers provide agility in the analysis of proposals and management and up-to-date claims, policies, risks, and underwriting. However, in many cases, signed paper contracts can still be required due to regulatory issues or security concerns, as in the case of mortgage.

In the insurance industry, as well as in services where intermediates or brokers are more prone to participate in the value chain as mortgage, car loans, and consumer loans, financial institutions tend to increasingly face attempts of aggregation. The aggregation by brokers offering products and services from different institutions can be through the internet or not. Although the internet sales of some services have not yet achieved volumes previously anticipated, the aggregation is increasingly being offered, as in the US insurance industry. So far, the use of aggregator is avoided by many financial institutions for a series of reasons, but their use tends to increase over time. While facing aggregation services, it is important that each financial institution have well-defined responsibilities to accompany the use of its aggregated information by third parties. Although such supervision represents an additional cost, it can present enormous value in the management of the brands, avoiding or timely-acting in case of misuse or abuse. At the same time, financial institutions offering internet quotes (e.g. insurance and loans) through aggregators or not, can make use of web services offered by other companies to gather information as fraud detection, credit scoring, bill payment history, and outstanding debts. Although, such information is already available nowadays, the use of web services can not only ease the automatization of the process and update information, but also provide more flexibility to the process.

As the use of alternative channels increases (e.g. department stores and others working as correspondent banks or distribution points of loans' offering), so does the need of vertical integration of systems used in the operations in order to reduce risks, streamline the process, and guarantee timely operation and information through the value chain. In such cases, especially if the intermediate has many options to offer the customer, such as car dealers and department stores, the agility in providing the answer is instrumental to guarantee the deal. Obviously, the relationship between the financial institution and the intermediaries is as important as in the current scenario, since solely timely analysis might not be able to overcome a possible dealer's unwillingness toward one financial institution's offering.

Additionally, in many cases the use of web services to automatize solutions can be limited to not only large enterprises, but also to those willing to pay for the convenience, and to those willing to invest in the connectivity with their systems. Those concerns were met by Bank Tokyo-Mitsubishi during a pilot of web services to provide export letter of credit information to enterprises [98]. Obviously, the web services do not overcome the need of assessing the customers' readiness and willingness to use the solution.

New ways of payment, devices, and channels, as those mobile and wireless-based, are prone to enable more access to services not only to the customers, but also to the sales force of the financial institutions', and their intermediaries. With such expansion, financial institutions can take increasingly scale and scope economies through the integration of the platforms in which their services are based on. Using one core XML [99] document, for example, it is possible to display the information in different devices or formats as cell phones, personal computers, automatic teller machines, and PDA - personal digital assistant - making adjustments only in the format and presentation. It is also important, for example, when different cell phone' standards are available, as in Japan. Then, a financial institution using such core XML document is able to modify only one source to update the information to all standards. The use of such tools can reduce the time of new applications and products for the market and reduce the development and maintenance costs.

Those are only some examples of future uses, and it is possible that debate about web services and the hype and excitement around them fade away as they become part of the day today, but it is also probable that they will never catch up with all the envisioned solutions. But, failures in addressing the major challenges mentioned before as the security and semantic issues can confine web services to low risk and non-critical projects to integrate some systems internally to the companies, delaying or hampering the process of diffusion.

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