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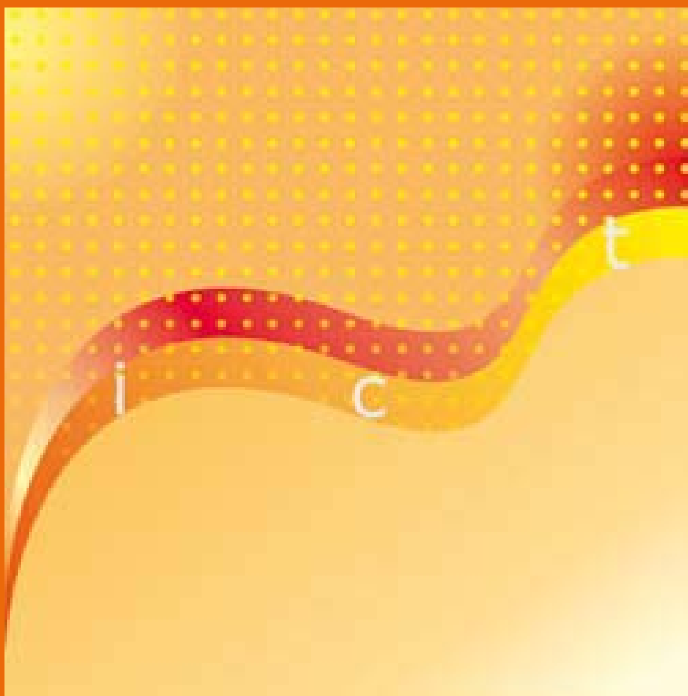
The Development Perspective



United Nations

Chapter 6

SERVICE-ORIENTED ARCHITECTURE AND WEB SERVICES TECHNOLOGIES: TRENDS AND IMPLICATIONS FOR E-BUSINESS IN DEVELOPING COUNTRIES

A. Introduction

ICTs, by making commercial transactions easier and cheaper to conduct over distances and by opening up new possibilities for business relationships, are among the driving forces of the wave of economic globalization that has taken place over the last decade. The central role of ICTs in this process has been reinforced by the development of production and distribution models that emphasize cooperation and fast information exchange among the various links in the value chain. For enterprises, particularly those in developing countries that may find themselves at earlier stages of internationalization, this means that their capacity to enter foreign markets is more and more dependent on their ability to use ICTs to integrate themselves into supply chains at regional and global levels. Efficient supply chain management is now central to the business model of the leading players in many industries, and ICTs play a fundamental role in it. Outsourcing, particularly in the services sector, is another important manifestation of globalization that could not have taken place without ICTs.

In both supply chain and outsourcing management, the power of ICTs to facilitate collaboration at every step of the processes through which value is created and exchanged has been fundamental. This chapter will describe in broad terms how such processes could be affected by the rapid development and deployment of Services-Oriented Architecture (SOA) and related Web services (WS) technologies. The issue of WS and the impact that these technologies could have on the development of e-business in developing countries was already touched on in the *E-commerce and Development Report 2003* as an emerging trend of significance for the future of e-business. Events since then seem to have confirmed this judgement, and the present chapter will make a more extensive examination of the issue of SOA and WS.

In simple terms (a more technically precise definition will be provided later on) WS can be described as technologies that enable automated interaction between computers. This interaction takes place over the Internet and involves transactions between computers that handle different business processes. Thus, a machine is able to feed into another one the information the latter needs, or conversely, it can formulate requests for information it needs for its own processes. This is made possible thanks to software that has been designed to use other software, the communication with which is based on Internet standards and protocols. A very simple example could be a catalogue in an SME's website that automatically updates prices in several currencies by checking periodically the latest exchange rates from a financial news service. Of course, the same logic could be applied to a much complex scenario involving any combination of business processes.

Systems operating in this way depend on the functionalities that other systems make available to them. Ideally, the level of dependence should be kept as low as possible in order to maximize the chances that different systems can interact with each other. Achieving such low levels of dependence is called "loose coupling", which is the goal pursued by SOA technologies. SOA is a software architectural style that aims at achieving loose coupling among interacting software agents.[1] In somewhat less abstract terms, SOA could be defined as a distributed software model "in which small, loosely coupled pieces of application functionality are published, consumed, and combined with other applications over a network."[2]

SOA and WS have the potential to become powerful instruments to enable enterprises to collaborate in shared business processes and provide the foundation of future supply chain strategies. Thus, technology proponents expect that WS will experience sustained, fast growth around the world.[3]

The main strength of SOA is considered to be the fact that, being based on industry-wide standards, these technologies allow for an easier integration than proprietary technologies and thus make cooperation among business partners or with third parties easier. At the same time, SOA implementation also seems to open possibilities for efficiency gains in intra-enterprise transactions. As better collaboration, both inside the enterprise and with business partners, and enhanced responsiveness to the external environment (customers, suppliers) and to internal conditions continue to gain importance as determinants of competitiveness, SOA and WS have a considerable transformative potential. More than a mere enhancement of an enterprise's ICTs capabilities, SOA implementations are said to involve true business-wide change, the result of which is a range of whole business processes being performed as automated services and integrated with those of the other entities in a company's "ecosystem": partners, suppliers, customers.

On the other hand, these claims are not fundamentally different from those made in the past about earlier technologies and sceptical voices can be clearly heard. They warn that much of the excitement about WS services may just be the latest example of IT vendor hype, and that businesses, particularly SMEs and developing country enterprises, should carefully examine the value proposition they are being offered by a particular WS implementation.[4] This chapter aims at providing interested decision makers in developing countries with some elements for undertaking that examination by providing an overview of these technologies, emphasizing whenever possible their implications from a developing country perspective.

SOA and WS will be considered in conjunction, as they are often so discussed – sometimes as though they were interchangeable terms. The reason for this is that although SOA and WS are two distinct concepts (SOA being a much older one than WS), WS explain much of the renewed attention being paid to SOA. WS represent a new development that makes SOA deployments easier and more productive. This chapter will approach the matter from two points of view. First, it will consider the significance of SOA and WS for the evolution of e-business technologies in general; then it will look at the role that they may play in changing international supply chains and what this can mean for developing country enterprises participating or aspiring to participate in them. Some issues concerning the role of open standards and the processes through which they are established will be presented. This will be followed by a succinct description of some experiences of the effects of SOA and WS on business performance.

The examination of the issues covered in this chapter leads to the conclusion that SOA and WS are likely to play a major role in the development of e-business. In terms of business strategies, SOA and WS will push in the direction of deeper levels of inter-business collaboration. This represents an opportunity for developing country enterprises as their participation in global supply chains could be facilitated and they could benefit from more opportunities for outsourcing. Therefore, developing country enterprises will increasingly need to familiarize themselves with SOA and WS technologies and should start their own investigation into the merits of investing in them. In this connection, the opportunities provided by free and open source platforms should be fully exploited. Another aspect that needs attention is the increased participation of users of SOA and WS technologies, particularly those from developing countries, in the standard-setting processes related SOA and WS.

From the point of view of policymakers in developing countries, the adoption of SOA and WS can be facilitated by taking the same steps as are often recommended for facilitation of the adoption of e-business practices in general. Two major issues in this regard are the reinforcement of relevant skills in the workforce and in the business community and the establishment of an environment of trust and security for e-business.

B. The business and technology forces behind the growth of Web services

By the end of 2002, according to IDC Research, only about 5 per cent of enterprises in the United States had completed a web services project, although 80 per cent of them were expected to do so in the next five years.[5] Two and a half years later IDC forecast that WS expenditure worldwide would grow from $2.3 billion in 2004 to $14.9 billion by 2009.[6] Other forecasts provide different estimates of the absolute size of the market for WS, but agree on the fact that this is an area of fast growth. For example, a study by the Radicati Group said that by the end of 2004 the market for WS would have reached $950 million and that it should grow to $6.2 billion by 2008.[7] According to that study, 52 per cent of the expenditure on WS in 2004 would take place in the United States, 39 per cent in Europe, 6 per cent in Asia-Pacific and 3 per cent in the rest of the world. More recently, a Gartner report estimated that the market for IT services related to WS would amount to $261 billion by 2008. The report added that this would represent a pervasive technology shift.[8]

From the technology point of view, WS implementations have now reached a level of maturity at which their cost-cutting potential has started to translate into bottom line figures, sufficient standards are now in place and security and management solutions are available. The next stage of SOA and WS can be expected to start developing in the short term, as enterprises move from point-to-point applications to broad application of SOA and WS inside the enterprise and in their interactions with business partners. In fact, SOA and WS can already be described as two of the most significant developments in the field of e-business in recent years.

What makes SOA particularly attractive is its potential to add efficiency and flexibility to an enterprise's information technology assets. This potential, however, may not be fully realized without extensive re-examination of the way in which information technology is used by an enterprise, and the required investments can be considerable. The question to be answered, then, is how likely is it that the promise of SOA will be fulfilled. In addition, from the point of view of enterprises in the developing countries, there is also a need to consider how developing and implementing SOA and WS can help them remove the competitive disadvantage they face as a result of the lack of e-business capabilities. For a number of emerging economies, however, SOA and WS could conceivably be a positive factor in reinforcing their presence in international supply chains with the implications that this could have in terms of trade, investment and technology.

If the answer to these questions had to be formulated purely in terms of reductions in ICTs budgets, for most enterprises the case for moving towards SOA technologies today would perhaps not be a straightforward one, particularly in developing countries. However, another important consideration is that although SOA and WS are often presented as another IT "revolution", the reality is that they are perfectly suited to incremental adoption. This consideration is particularly relevant for smaller enterprises and for those from developing countries because, although these technologies are for the time being more commonly adopted by large, internationally-minded enterprises, the scalability of SOA and WS technologies makes them particularly suitable for adoption according to critical business priorities and available budgets. As often, the pertinence of a change to SOA and WS hinges not on mere IT considerations but on their significance for overall business strategies.

From that point of view, there are strong forces for change in the way businesses organize themselves and interact with others (for example, supply and demand chain integration, and various forms of outsourcing) that support the idea that SOA and WS technologies should have a central role in the short- and medium-term evolution of e-business. From the technology standpoint, SOA and WS are manifestations of a renewed emphasis on distributed and network-based approaches to computing in which the network itself is the source of computing power. The following sections will therefore look at the technological and the business strategy underpinnings of SOA and WS.

1. Technology background

The following paragraphs are intended to give the reader a broad understanding of the specificities of the approach to IT that SOA and WS technologies represent. These technologies are part of a more general paradigm known as distributed computing. The fundamental concept supporting distributed computing is the idea that the use of computing resources (processing power or storage capacity) can be optimized by pooling them in a network, rather than concentrating them at any given place. Computing resources can then be used where and when needed.

An important element of distributed computing systems is a category of software usually known as "middleware". Middleware is often defined as the elements that join different software components in a system, or that interface the software and the network (the slash in the client/server model). Middleware can be used to interconnect applications. In this case, its task normally consists in mediating between applications in order to manage data and/or to orchestrate business process flows. The applications in question frequently use different operating systems, data formats, networking protocols and so forth. The task of middleware is to reconcile all these elements.

Earlier examples of distributed computing include middleware platforms such as CORBA and DCOM, which also consider software resources as services available on a network.[9] What makes SOA different from these[10] is that it is both based on open standards and loosely coupled. In a tightly coupled architecture, both ends of a distributed computing link had to agree on the details of the API.[11] Loose coupling separates the participants in distributed computing interactions so that modifying the interface of one participant in the exchange does not break the other's. Secondly, earlier architectures were proprietary. SOA's reliance upon universally accepted standards such as XML and SOAP (Simple Object Access Protocol) provides broad interoperability among different vendors' solutions — the importance of the use of open standards will be elaborated on later in this section. The combination of these two core principles means that an enterprise can implement WS without having any knowledge of the consumers of those services, and vice versa.

In technical terms, a definition of SOA could be the following: "an application architecture in which all functions, or services, are defined using a description language and have invokable interfaces that are called to perform business processes. Interactions are independent of each other and of the interconnect protocols of the communicating devices (i.e., the infrastructure components that determine the communication system do not affect the interfaces)".[12] As explained in the introduction, SOA should be differentiated from the concept of Web services.[13]

There are many definitions of Web services. From the viewpoint of the functions they perform, they can be defined as "open standard (XML, SOAP, etc.) based Web applications that interact with other web applications for the purpose of exchanging data".[14] They have also been defined as "self-contained, modular, distributed, dynamic applications that can be described, published, located, or invoked over the network to create products, processes, and supply chains…"[15] On the basis of the protocols and standards that underpin Web services, they have been defined as "a standardized way of integrating applications that uses XML, SOAP, WSDL (Web Services Description Language), and UDDI (Universal Description Discovery and Integration) open standards over the Internet protocol. XML is used to tag the data (i.e. to specify how a document or part of it should be formatted), SOAP is used to transfer the data, WSDL is used for describing the services available and UDDI is used for listing what services are available".[16] An important characteristic of WS is reusability, which means that once a Web service is in place other Web services (or other applications) can find it and use it as a building block.

In order to automate business interactions between two different companies (or systems within the same organizations), the business processes in question have to be specified. This role is performed by the Business Process Execution Language (BPEL), which is an XML-based language. BPEL is based on Microsoft's XLANG and IBM's WSFL. Using BPEL different services can be put together into a given business process. The collaboration between several different Web services to define a new Web Service is called orchestration

Chart 6.1
WS protocol stack

Publication-Discovery-Workflow UDDI, ebXML registries, BPEL
Service description WSDL
Messaging SOAP/XML
Transport HTTP, HTTPS, SMTP, FTP...

Chart 6.1 shows how various WS-related standards and specifications are applied at the different layers of a WS implementation (see the list of acronyms for an explanation of the other acronyms in chart 6.1).

Chart 6.2
A Web services architecture

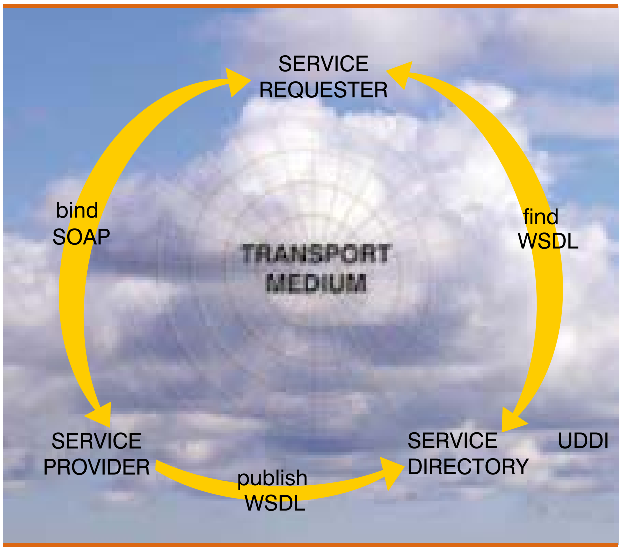


Chart 6.2 shows the individual components of a service-oriented architecture.

A Web services architecture must allow three sets of functions:

1. The dynamic discovery of registered services: looking for services that meet a particular need, provide certain information (for example, the price of a product, its physical characteristics, its time of production), and so forth.

2. The organization of services, so that one can easily understand what a service offers.

3. The description of services, including the formats and protocols that are needed in order to invoke the WS.

The service directory is where the information about the services that are available is stored. In order to publish the services they have on offer, service providers must make the necessary entries in the service directory. Service requesters use the service directory to find services that match their criteria (for example, a particular price level). This means that the service directory must include not only the classifications that are needed in order to perform a search, but also other information relevant for the business process where the service may be used (price or physical features of a product, etc.). When a service requester finds a service that matches its requirements, it binds to the service provider, using binding information maintained in the service directory. The binding information tells the service requester the protocol that it must use and the structure of the request messages and the resulting responses.

The format of messages that are exchanged between the service requestor, the service provider and the service directory is specified by SOAP; UDDI defines the structure and the contents of the service directory; and WSDL provides the capability to describe a WS service, without the need to have it formally standardized.

SOAP is a protocol for exchange of information in a decentralized, distributed environment using typed message exchange and remote invocation. It defines a mechanism for the communication with Web services over the Internet. It is an XML-based protocol that consists of three parts: (1) an envelope that defines a framework for describing what is in a message and how to process it; (2) a set of encoding rules for expressing instances of application-defined datatypes; and (3) a convention for representing remote procedure calls and responses. SOAP can potentially be built on top of any transport layer, for example an HTTP-based infrastructure.

UDDI is the definition of a set of services supporting the description and discovery of (1) businesses, organizations and other Web services providers; (2) the Web services they make available; and (3) the technical interfaces which may be used to access those services. UDDI provides information about the registration of service types and about the actual business data such as the name of the company offering the service, the type of service, taxonomies that classify the offered service, and references to those standard service types or to Web Services Description Language (WSDL) specifications.

WSDL is an XML format for describing network services based on a standard messaging layer such as SOAP. A WSDL document defines services as collections of network endpoints, or ports. A WSDL description of a Web service provides all the information needed to actually invoke it. A service is described by giving the port type to use, the kind of operations that the port type supports and the structure of the input and outcome messages.

2. A simple model of WS implementation

How does all this translate into actual business operations? Let us assume that company A has decided to outsource some services in order to cut costs. After a UDDI directory has been chosen and consulted, several potential business partners that offer such services are identified and after which one most closely matches a set of criteria has been assessed, one is selected as the provider for the required services.

In abstract terms the service provider appears as a business partner that implements a collection of port types covering the required services. For its part, company A has to provide a port type with operations that work as "stubs"[17] and that are capable of communicating with the ports that provide the service on its partner's side. In fact, company A may decide to provide multiple port types that collectively cover these stubs — that is, company A becomes itself a service provider. For the service to be delivered, both participants have to make their respective operations communicate with each other. This is done through "plug links". A plug link identifies pairs of operations that communicate with each other, and describes which operation initiates this communication. A communication consists, for example, in the process of sending a request and receiving a response message.

When the corresponding service partners are plug-linked they can start working together. The plug-links that have been defined can be used to exchange messages. Then, it is necessary to establish an agreed order ("flow model") so that both sides of the transaction expect the same sequence of events.

Company A may later wish to change the business partner to which the services in question are outsourced, because, for example, its requirements have become more complex. In that case, the new requirements can be put into a query called locator, which is run against a service directory. The locator returns a list of qualifying service providers. From this list Company A chooses a new business partner that better serves its needs.

Company A may also decide to provide value-added functions to outdo its competitors. For this purpose it creates a global model, that is a new Web service that aggregates the services of multiple service providers. This new global Web service can be published in a UDDI directory, which will enable service requesters to search and find the new service.

3. Web services and business strategies

Over the last two decades, fast technological change, the opening of a growing number of markets to international competition, deregulation and privatization, among other factors, have resulted in fundamental strategic and operational changes in business worldwide. Customers' expectations about the quality of products and services tend to converge globally at higher levels, strong competitive pressures push for faster innovation, and efficiency and increasingly globally minded shareholders demand world-class returns on investment.

In this environment, the capacity of enterprises to respond quickly and flexibly to changing market conditions becomes more important than ever. A consequence has been the implementation of intra- and inter-organizational changes that often involve the emergence of various kinds of strategic alliances and other forms of business collaboration.[18] More and more enterprises seek productivity gains by entering into networked organizational arrangements that have been described as "value networks".[19]

In sectors such as manufacturing or distribution, the effects of global supply chains on competition are so intense that it has been argued that in some cases competition is no longer taking place among companies but among rival supply chains.[20] Competitive pressures provide incentives for participants in supply chains to cooperate more and more closely. A company's customers and suppliers tend to become more and more involved in processes that range from product specification to inventory management. This requires more integration of their respective information systems.

These processes are dependent on the deployment of management tools that rely on information technologies, both internally (Enterprise Resource Planning, order processing, floor shop management) and externally (from simple e-mail to communicate with customers and suppliers to Electronic Data Interchange (EDI), web-based marketplaces).

The supply chain provides a good example of how ICT-enabled interorganizational systems (IOS) can generate competitive advantage. This has been well documented, for example, as an ingredient of the competitive success of small and medium-sized computer equipment producers in Taiwan Province of China.[21] From the developing country perspective, this is particularly interesting as participation in global supply chains provides opportunities for export-led growth and progress up the technology and value ladder. The supply chain can be considered as a web of processes and facilities by means of which the material inputs required for its productive processes flow into an enterprise are transformed into intermediate or final goods and are then distributed to its customers. This increasingly requires deeper levels of cooperation with outside entities.

In modern, more tightly integrated supply chains the links between suppliers and manufacturers extend downwards to include distributors and retailers. The digitally-enabled supply chain solution typically allows the leading operator (say, the operator of an international chain of fashion stores with suppliers in both developed and developing countries) to access information about supply and demand flows for the various ranges of products so that it can maintain the best possible balance between them. This requires digital access to demand information from the retail points (sales and stocks) as well as from its manufacturing facilities and subcontractors, down in the supply chain.

The use of WS technologies in the supply chains should help businesses to engage in extensive data exchange with their business partners, regardless of their location, at a lower cost than with earlier technologies (for example, EDI). Data exchanges through WS technologies should also offer advantages compared with "traditional" just-in-time purchasing and vendor-managed inventory systems, which are normally implemented only with suppliers based in the close vicinity. In companies that apply best practice in this area, information moves back and forth along these chains in real time, adjusting the delivery so that it closely matches the needs of the customer, in location as well as in timing. These integrated chains will deliver all their potential efficiency gains only if synchronized, real-time interaction exists between the networks of all the actors that participate in them. WS technologies fit perfectly into this picture.

More and better information enables companies to better match demand and supply and thus improve efficiency. For example, inventory levels can be brought lower (an important counterbalance to the push for higher inventory levels that may be needed as companies increasingly turn to global sourcing, which involves longer lead times and higher risks of disruption caused by transport). The so-called bullwhip effect, which consists in the magnification of the fluctuations of demand caused by imperfect information as orders flow along the supply chain, could be eliminated or greatly reduced. The aggregate effect of the implementation of ICT-based solutions along the supply chain should be higher effectiveness and competitiveness in terms of product specification, prices and services. At the macro level WS could provide an example of how, by contributing to the reduction of information asymmetries, ICTs could play a role in the smoothing of the business cycle.

Technologies such as order management systems, enterprise resource planning (ERP) and supply chain management (SCM) applications are the main ICT underpinning modern supply chains. A further step in the digitalization of supply chain management it the use of IOS that connect them through Internet-based e-business systems. However, in developing countries only a few enterprises, even in industries that are closely integrated into global supply chains, have these capabilities. If one goes a step down in the chain, even fewer of their suppliers have them, and so digital integration of the supply chain is only partial at best, limited mostly to global operators and their larger developing country suppliers. The ability of these large and medium-sized developing country participants in global supply chains to trust their lower-tier suppliers to the required degree depends much less on technology and more on organizational factors such as industry clustering, executive networks, business practices and interpersonal relationships.[22]

While downward flows carry information about product designs and orders, it is also possible to have information moving up the supply chain. For instance, smaller suppliers in the lower echelons tend to specialize in the particular input they produce. They can provide their larger customers with information about their product, in some case even results from high-value-added activities such as product research and development. Larger suppliers can also cooperate with global brand owners in product design and specification. These multidirectional flows of information along the supply chain create opportunities for efficiency enhancement through extensive automation along the chain, from global operator to the lower-level suppliers. For example, quality monitoring can be substantially improved thanks to IT. At the same time, automation can be seen by the global brand owners as opportunities to deal directly with lower-tier suppliers and thus squeeze out the larger suppliers. Such strategies could damage the traditional business networks that were critical to several developing country export strategies.[23]

The coexistence of multiple supply chain management systems based on EDI or Extensible Markup Language (XML) means that there is a useful integration role that could be played by WS. In the longer term, their use should extend to other business processes by enabling seamless, automatic interoperability between the software applications used in running every part of a business (procurement, production, sales and marketing, after-sales service, finance, human resources) with each other and with those of their customers and suppliers. Beyond that, WS will be an essential part of an economy in which "communication" between Internet-enabled objects (for example, a sensor in a machine that detects that a piece will need to be replaced soon and places an order with the supplier) will be increasingly important. Although the main impact of Web services will be on the operations of enterprises, there are also many possibilities for consumer-oriented applications. For instance, in the tourism sector — a key source of employment and foreign reserves for many developing countries — WS technologies could be used to create virtual travel agents that would combine access to reservation systems of airlines or railways, car rentals, hotels, travel-related content providers and so forth.

Outsourcing is another trend that makes the emergence of SOA and WS relevant for e-business development, and more so for developing countries, for which ICT-enabled outsourcing makes it possible to compete in a number of services that used to be closed to international competition.[24] Outsourcing is generally defined as the process by which enterprises, in order to focus on the activities and processes that constitute the core of their business, transfer non-core parts of their activities to outside partners. As these functions are transferred to specialists, more value can be generated in their performance. While outsourcing is most commonly conceived in this manner, other kinds of outsourcing are emerging too. For example, some enterprises are co-sourcing, that is pooling their non-core operations when no large-scale specialist exists. This can also be done internally, for example when affiliates of a transnational corporation concentrate their operations for a particular product or service in a single centre. In-sourcing consists in adopting best practice in a certain process and adding to efficiency gains by taking business from other companies (not direct competitors), with consequent benefits from economies of scale. In all these modalities the need to smoothly exchange information between computers running different operating systems and applications in distant locations and serving business processes that are the responsibility of different partners grows exponentially.

The adoption of WS technologies will be increasingly necessary in order to maintain competitiveness in several sectors and industries of importance to developing countries. For example, the ICT-producing sector, in which developing countries have a large and growing share of world trade, are rapidly adopting WS technologies. It can be expected that this trend will be replicated in a wide range of manufacturing activities of considerable importance in the developing world, including in areas such as textile and apparel. As for services, as mentioned above, more effective inter-enterprise collaboration through WS technologies could be of particular relevance to sectors such as business process outsourcing and tourism. Efficiency gains in transport and logistics operations through WS implementation could also represent a welcome contribution to the alleviation of the burden that these items represent for the operations of enterprises in many developing countries, in many of which inefficient transport and logistics make it impossible for enterprises to take advantage of the low cost of production. Finally, developing countries should consider the vast potential that WS and SOA technologies offer for the implementation of e-government services, both in those that are addressed in the business sector (for example, Customs) and in others that are fundamental for general development objectives (health services). In addition to the list of industries above, which emphasizes sectors of greater importance for developing countries, other areas commonly cited as particularly likely to benefit from SOA and WS are the financial services, especially retail banking and insurance and distribution services.

Box 6.1 showcases a few examples of initiatives taken by Governments of developing countries that use service-oriented technologies in a wide range of areas. In some of them these technologies are used to facilitate G2B interaction, thus providing both an example and an incentive for private sector adoption of SOA.

Box 6.1

Developing-country public-sector adoption of SOA and WS

- In *Argentina*, the national tax agency has launched a project to facilitate the access of other agencies and enterprises to the information in its unified taxpayer database. The project was based on the World Wide Web Consortium (W3C) standards and other standards addressing different protocol layers and special security requirements. Inter-agency collaboration and improved internal management enabled the tax agency to provide real-time access and validation of information to users for different transactions in a secure environment.
- In *Chile*, an efficient mechanism is needed to exchange information among government agencies in order to implement recent legislation empowering citizens to access the information that the Government collects from them. For this, a Web-based information exchange platform is being developed using open XML for data exchange, SOAP and WS. The final objective is to have all public sector agencies participating in the platform.
- About 600,000 companies are expected to benefit from a project of the Government of *India* to provide them with online services such as company registration, payment of statutory fees and filing of tax returns. Following consultations with major technology players, an SOA was chosen for the project. The business needs of users are used to define the architecture's design. Transactions will be routed through a standards-based gateway to ensure interoperability. The implementation partner is compensated on the basis of a service-level agreement which defines quality of service requirements in terms of efficiency, user friendliness and user satisfaction.

Source: Berkman Center for Internet and Society at Harvard Law School (2005).

C. The crucial role of standards

As explained before, the technology undercurrent that is moving WS forward is the mounting popularity of distributed computing, which is closely linked to the emergence of the Internet as the main ICT platform. The reason for this is that the Internet's standards and protocols are designed to let computers using different operating systems work together well. In a similar fashion, what WS do is to apply the standards embodied in, for example, XML, to enable a computer to identify the resources it needs for a given task (for instance, a piece of software or a set of data), locate and access them through the network, formulate a request and deal with what is sent in response. This way the network operates as if it were a single powerful computer that, like a desktop PC, needs a sort of "operating system" to manage the flow of requests for resources. This role is played by platforms (or "application development environments") that provide developers with the instruments they need to write their Web service applications.

For WS to deliver their potential, services from one application vendor must be able to interoperate with those of another vendor, which may have been built on a different platform. In business terms this means that there must be a guarantee that the Web service that takes care of a company's inventory management can do business with the Web service that the supplier uses to handle orders. The standard-setting process is therefore critical for the development of WS. A service-oriented approach depends on open standards. Open standards ensure that the criteria and decisions are truly service-oriented and are not biased towards one platform or another. Without open standards the possibilities that SOA give enterprises to combine, replace and mix the components of their IT systems without the need to create specific code to interconnect would not materialize.

However, from the beginning of the emergence of WS technologies, standard setting has been a major issue of contention and there has been intense debate about and around the bodies in which it takes place. Critics have argued that in general WS specifications have been

Box 6.2

What makes a standard "open"?

"...a standard [is considered] to be open when it complies with all these elements:

- cannot be controlled by any single person or entity with any vested interests;
- evolved and managed in a transparent process open to all interested parties;
- platform independent, vendor neutral and usable for multiple implementations;
- openly published (including availability of specifications and supporting material);
- available royalty free or at minimal cost, with other restrictions (such as field of use and defensive suspension) offered on reasonable and non-discriminatory terms; and
- approved through due process by rough consensus among participants."

"Ten requirements that enable open standards:

1. Open Meeting — all may participate in the standards development process.
2. Consensus — all interests are discussed and agreement found, no domination.
3. Due Process — balloting and an appeals process may be used to find resolution.
4. Open IPR — how holders of IPR related to the standard make available their IPR.
5. One World — same standard for the same capability, world-wide.
6. Open Change — all changes are presented and agreed in a forum supporting the five requirements above.
7. Open Documents — committee drafts and completed standards documents are easily available for implementation and use.
8. Open Interface — supports proprietary advantage (implementation); each interface is not hidden or controlled (implementation); each interface of the implementation supports migration (use).
9. Open Access — objective conformance mechanisms for implementation testing and user evaluation.
10. On-going Support — standards are supported until user interest ceases rather than when implementer interest declines."

Source: Berkman Center for Internet & Society at Harvard Law School (2005) and Krechmer (2005).

biased in favour of large technology vendors, and that they do not properly reflect the interests of smaller players, particularly those from developing countries.[25] The criticism has been made that organizations such as OASIS, W3C and WS-I should not be considered proper standard-setting institutions and that their outputs are not real standards, but specifications that enjoy some level of consensus.[26] For these critics, those organizations lack full stakeholder involvement and openness, and their outputs are not freely available and implementable. For example, the claim that some of the world's largest IT companies deliberately undermined the development of the UN-supported ebXML is presented as an example of the way in which standard setting is skewed towards the interest of the largest corporations. From this viewpoint, although standard setting may be a formally open process, participation is costly and so the smaller player is "priced out of the standards game" and private considerations prevail over the public interest.

Criticisms such as those summarized above became particularly strong in February 2005, when OASIS announced a revised intellectual property rights policy that included three modes for standards work: Reasonable and Non Discriminatory Access (RAND); royalty-free on RAND terms; and royalty-free on limited terms.[27] For FOSS advocates the move would imply that the organization's standards could not be considered open. The response from OASIS was that none of the fully formalized OASIS standards required a royalty to be paid and that less than a dozen of the approximately hundred specifications under discussion at that point would have royalties. As for the W3C, after similar criticism of a proposal to allow companies to charge royalties for patented technologies they had contributed to its standards, it maintains a royalty-free policy.[28]

There are many alternative views, some stricter than others, about what defines an "open standard", two of which are summarized in box 6.2. It should be noted that for the authors of the first set of criteria for open standards, the output of the work of these entities would fall into the category of "open standards".

Regardless of the conceptual issues involved in the definition of a "standard", the role of formal, government-accredited standard-setting bodies in the field of ICT has diminished in importance over the last two decades at the national and global levels. The main reason for this is competition from private consortia (including entities requiring membership fees) and informal bodies, as a consequence of the

Box 6.3

Who's who in WS standard setting

The Organization for the Advancement of Structured Information Standards (OASIS, www.oasis-open.org) was founded in 1993 under the name SGML Open as a consortium of vendors and users devoted to developing guidelines for interoperability among products that support the Standard Generalized Markup Language (SGML). OASIS changed its name in 1998 to reflect an expanded scope of technical work, including the Extensible Markup Language (XML) and other related standards. It describes itself as "a not-for-profit, international consortium that drives the development, convergence, and adoption of e-business standards", and claims about 5,000 "participants" representing over 600 organizations and individual members in 100 countries. It has developed standards such as UDDI v.2, Web Services Security (WSS) and others (see annex I).

The World Wide Web Consortium (www.w3c.org) was created in 1994 and has published more than 90 standards, which it calls "W3C Recommendations", including Web services standards such as WSDL, UDDI and SOAP, and XML-based specifications. W3C is an international consortium whose operations are hosted mainly by the Massachusetts Institute of Technology, the European Research Consortium in Informatics and Mathematics, and the Keio University of Japan. IT has a presence in 16 other locations, including three in developing countries (India, Republic of Korea and Morocco). Its nearly 400 members include businesses, government agencies, NGOs and academic and research institutions.

The Web Services Interoperability Organization (WS-I, www.ws-i.org) was created in February 2003 by a group of some of the leading global IT companies and is supported by major players in the WS field. Its purpose is to promote interoperability among Web services. The WS-I does not consider itself a standard-setting body in the sense that this term is normally understood, that is as a forum in which experts discuss successive versions of a proposed standard until consensus is reached and a standard is published. Instead, the WS-I produces technical guidelines to ensure that Web services products from different providers can work together. The WS-I offers a sort of Web services seal of approval, providing certification that Web services adhere to standards put out by other standards organizations, such as the World Wide Web Consortium (W3C), the Organization for the Advancement of Structured Information Standards (OASIS) and the Internet Engineering Task Force (IETF).

Box 6.4

A comparison between ebXML and Web services

Although Web services and ebXML rely on the same technologies (SOAP/XML), they follow different approaches, are suited to somewhat different purposes and are not yet interoperable.

In a Web services architecture, services are published on the Internet so that anyone who is interested can use them. A Web service is described, advertised and provided by the same organization. The requester finds the service and eventually binds to it. In the case of an ebXML implementation, business partners exchange predefined documents in an pre-agreed business process. This is a contract approach that can be bilateral or even multilateral. The trading partners must negotiate their profiles, agree on a contract and then conduct the business transaction.

Web services are designed in a bottom-up process: the specifications for the core requirements are implemented first (SOAP for messaging, UDDI for discovery, etc.) and then brought together to create the service. In ebXML the process is top-down: first the requirements of an e-business process are assessed and then the specifications to meet them are defined. While the bottom-up approach results in greater flexibility (thus allowing WS technologies to be useful for many non-business purposes), the top-down approach of ebXML may be more adequate for supporting specialized business transactions.

From the point of view of the protocols and specifications, ebXML has achieved maturity faster than WS. On the other hand, WS enjoy larger vendor support as they have a larger market and, as a consequence, all major players support the technology.

growing importance of private service providers and technology developers. The extent to which this trend has resulted in a suboptimal consideration of the public interest in ICT standard setting is open to discussion. It is also argued that the dominance of private interests in standardization also reduces the openness of standards by increasing IPR costs.[29]

In addition to the question of the marginal role that is left to the smaller stakeholders, the relationship among the larger players within the various WS-related bodies, and for some time also among the bodies themselves, was not always easy. For instance, Sun Microsystems was initially excluded from the board of the WS-I. The situation has evolved and a division of labour has been established between the major organizations, which are listed in box 6.3.

OASIS and the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) have jointly developed a set of standards based on XML, the Electronic Business Extensible Markup Language (ebXML) that enables enterprises to conduct business over the Internet. Its objective is to provide an open, XML-based infrastructure that enables the global use of electronic business information in an interoperable, secure and consistent manner by all trading partners. The original project envisioned five layers of data specification, including XML standards for business processes, collaboration protocol agreements, core data components, messaging, and registries and repositories.[30] ebXML provides a standard means to use the Internet to exchange business messages, conduct trading relationships, communicate data in common terms, and define and register business processes.[31]

In order to use ebXML, a "business process specification" (which describes how a business works) and a "business document" (which describes the information to be exchanged in the transaction) are needed. The business documents are exchanged using the ebXML Messaging Service, which is based on SOAP. The system is completed with ebXML registries, which are used to find information on potential partners that offer the required services.

1. Main standards, openness and IT interoperability

Typically, an IOS is made up of a content platform, a delivery platform and a trading partner base.[32] In order to conduct business with their partners through their system, the members of an IOS need to have their private corporate data put into a format that the IOS can understand. This is the role of the content platform. The delivery platform is then used to physically move the data from the computers of an IOS member to those of another one. The data reach the counterparts in the trading partner base to which they were addressed. The degree of openness of an IOS will be determined by that of each of its constituent elements, ranging from the proprietary system, partially open (EDI) and open-based system (Internet-based).

In a proprietary IOS, data standards (content) and participation and access (trading partner base) tended to be under the control of one of the members (typically a large supplier or purchaser dealing with many smaller customers or suppliers). As a result, the systems tended to be highly customized and usable only for transactions with the dominant player: investing in the systems generated a lock-in effect for the smaller partners.

In the case of EDI, although some of the earlier data standards were proprietary, the most widely used ones were developed by open organizations (in particular, EDIFACT standards are approved and published by the United Nations). Thus, the content platform of EDI allows communications with a larger base of trading partners and is less prone to lock-in effects. However, in the typical case in which data transmission takes place over private value-added communications networks (VAN) the system cannot be said to be fully open.

XML provides an open platform for Internet-based inter-organizational systems. SOAP and WSDL may also be considered to be open standards content platforms. The Internet, as a globally accessible public network based on open standards and protocols, provides an open delivery platform. Enterprises that join in an Internet-based IOS with other partners enjoy the benefits of openness at the levels of both content and delivery and can theoretically extend their IOS to virtually any other firm in the world that has a computer with access to the Internet.

Zhu et al. (2005) includes a number of references to the existing literature about the differences between XML and EDI standards. It has been pointed out that cross-industry coordination is easier with XML-based standards, as these are often less complex, rigid and partner-specific.[33] XML standards are self-describing and significantly more user-friendly. Learning and applying XML standard requires less technical expertise than EDI. For all these reasons negotiating a business cooperation deal to be implemented through EDI-based technologies is considerably more costly and requires a longer-term perspective than doing so on the basis of XML standards.

The delivery platforms and communications protocols add another factor of differentiation. EDI normally used VANs with their own proprietary communications protocols. Interconnection with other VANs may imply the payment of additional charges or may even be plainly impossible. The Internet, on the contrary, is based on protocols designed to ensure the global interoperability of the millions of networks of which it is made up. The consequences in terms of costs are significant, making XML-based systems much more affordable and suitable for small and medium-sized enterprises. Finally, there are important differences in the trading partner bases of EDI and XML-based standards. Internet-based IOS are open to a much broader partner base and thus have the potential to generate more significant network effects. In particular, thanks to the standards for the Universal Description Discovery and Integration Registry (UDDI) companies can search for unknown trading partners, while EDI implementations could happen only within an existing business relationship.

As products based on SOA and WS begin to enter the corporate mainstream, the more visible commitment of key technology providers should give enterprises the confidence to prepare for implementation of upcoming WS standards, as many real-world products based on these standards are now being developed. Annex I lists some of the most commonly cited WS-related specifications and standards.

For example, in 2005 IBM, Microsoft and a group of other technology providers, including Actional, BEA Systems, Computer Associates, Oracle, RSA Security and Verisign, announced that that they planned to place three key Web services security specifications under the control of the Organisation for the Advancement of Structured Information Standards (OASIS). The three specifications, all based on the core WS-Security, are:

- **WS-Trust** (which defines extensions for requesting security tokens and brokering trust relationships);
- **WS-SecureConversation** (which defines mechanisms for securing multiple messages);
- **WS-SecurityPolicy** (which defines security policy assertions for **WS-Security, WS-Trust** and **WS-SecureConversation**).

This move places fundamental WS specifications under the control of OASIS and reflects the growing maturity of WS security. Many of the basic elements of secure WS are now in place. The publication of these specifications as OASIS standards should help to advance interoperability, although further work, perhaps in the form of enhancements to the Web Services Interoperability (WS-I), may be required in order to help enterprises make their deployments as compatible as possible. Also, the basic security policy language is likely to require extensions, which will be implemented in both proprietary and future standard versions.

Open standards play an increasingly important role in the generation of the economic value that enterprises can derive from their participation in these business networks. The combination of open standards with application-level intelligence and "dumb" network is consistent with the Internet's underlying end-to-end principle. As chapter 7 of this Report shows, maintaining the integrity of the Internet's constituent layers is crucial for its potential to be fulfilled, including with regard to its business transformation aspects. Thus, while EDI had been available since the 1970s, it was the widespread adoption of Internet technologies (based on open standards such as the TCP/IP and XML) that accelerated the development of ICT-enabled inter-organizational systems (IOS).[34]

Enterprises that adopt open standards not only minimize their risk of being trapped in obsolete standards but also empower themselves to capture more of the economic benefits generated by the Internet. The importance of openness for SOA and WS technologies naturally leads to the consideration of how a closely related trend, namely the growing importance of free and open source software, may facilitate the adoption of SOA and WS technologies, especially in developing countries.

2. Free and open source software, SOA and WS

Free and open source software (FOSS) is an approach to software development whereby communities of developers create software through a public process and the resulting product is made available free of charge.[35] FOSS represents a major paradigm shift in the software industry, which is rapidly being adopted by many major middleware producers. For those companies, taking the FOSS approach ensures that their products will be of the highest quality, at least equivalent to that of commercial proprietary products. They build their business models around the sale of support and other services.

Like all other FOSS products, SOA and WS implemented on a FOSS platform make it possible for users to utilize the software without restrictions and without paying licence fees, as well as giving them the possibility to modify it and develop applications of it as they see it fit, and the possibility to distribute it to other users. Building WS on an open source platform also reduces concerns about vendor lock-in issues. Of course, these features of FOSS-based WS are particularly interesting for developing countries.

The value of implementing SOA and WS increases exponentially with the number of services that are available on the SOA. Implementing a commercial, proprietary SOA normally involves the payment of fees that are proportional to the computing resources that are running the SOA infrastructure (number of computers and/or processing power). This means that going for a truly comprehensive SOA implementation that connects all the enterprise's services and applications can become rather expensive. If a FOSS platform is chosen, this restriction is lifted and the enterprise (or the public sector agency) can add as many services and applications to the SOA infrastructure as makes business sense.

A second interesting feature of FOSS is that vendor lock-in issues are alleviated. FOSS developers' communities have a strong culture of supporting the evolution of standards, which is particularly relevant in the case of SOA technologies. And they do not go out of business or change licensing models, thus leaving previous buyers stuck with technologies that are fast becoming obsolescent.

Another point of convergence between FOSS and SOA and WS is that standards are crucial for their successful implementation. FOSS production methods encourage the developing community to move towards standards. As shown by the listing in annex I, SOA and WS rely on the existence of an increasing number of standards. This makes it possible, and actually provides an incentive for the FOSS community, to develop solutions for SOA and WS. For developing countries FOSS platforms for SOA and WS also have the advantage that they may be able to benefit at no cost from solutions and updates that have been integrated into existing implementations and made available to the developing community.

The popularity of FOSS products such as Linus, Apache, MySQL and others indicates that the FOSS approach has been particularly productive in the systems and applications infrastructure layer. FOSS platforms using LAMP are among the more widespread platforms for the implementation of WS. LAMP stands for "Linux, Apache, MySQL and PHP", although the acronym is increasingly used to refer to WS built with any combination of FOSS products, such as Linux, FreeBSD/OpenBSD, Apache, Python, Perl, PHP, PostgreSQL and MySQL.

Table 6.1

Some open source projects relevant to SOA and WS

Project	Description	More information
ActiveMQ	Java Message Service (JMS) provider	Activemq.codehaus.org
Axix	Web services connector for Java	ws.apache.org/axis
Celtix	Enterprise Service Bus (ESB)	Celtix.objectweb.org
JEMS	Suite of open source tools for SOA implementations	Www.jboss.org
JORAM	JMS implementation	Joram.objectweb.org
jUDDI	Java implementation of the UDDI specification for Web services	ws.apache.org/juddi
Mule	ESB messaging framework	mule.codehaus.org
open-esb	SUN-sponsored ESB	Open-esb.dev.java.net
openadaptor	Java/XML-based services connector	Www.openadaptor.org
OSMQ	Java message router, broker and middleware framework	www.bostonsg.com/osmq/index.html
RM4GS	Implementation of WS-RM, which provides reliable messaging for Web services	businessgrid.ipa.go.jp/rm4gs/index-en.html
Sandesha	Implementation of WS-RM, providing reliable messaging for Web services	ws.apache.org/sandesha/
ServiceMix	An ESB and SOA toolkit	servicemix.org/site/home.html
Synapse	Web services connector	wiki.apache.org/incubator/SynapseProposal
UDDI4J	Discovery service client	uddi4j.sourceforge.net/

As of mid-June 2006, typing the words "web services" in the search engine of http://sourceforge.net (a site that hosts open source development projects) turns up 421 Web services projects. Increasingly, commercial vendors are themselves participating in open source projects, a trend that is likely to continue. As mentioned before, middleware vendors such as IBM, Sonic Software, IONA Technologies, SUN Microsystems and others have begun passing code to which they held proprietary rights on to open source projects. Table 6.1 lists just a few open source projects that are relevant to SOA.

FOSS platforms provide a significant opportunity for enterprises in developing countries to experiment with and gradually adopt SOA and WS technologies in an effective, secure and affordable manner. FOSS solutions offer tangible benefits that have been proven at the infrasructure layer and should receive full consideration by anyone interested in SOA and WS.

D. Effects on e-business of SOA and WS deployments

According to a recent IDC Research report,[36] a clear focus for many of today's SOA implementation is the extension of information and business processes to new users (e.g. employees, partners, suppliers, customers and agencies). Other typical solutions include optimizing procurement, inventory and B2B information exchange processes, as well as sharing sales and financial information for use in planning, billing and credit processing. Many industry-specific use cases have been identified. For example, solutions within the health-care sector range from claims processing to bedside patient care.[37]

In general, companies tend to change to SOA as part of a medium- to long-term shift towards network-based IT solutions. However, there are also short-term benefits to be reaped. For instance, integration and compatibility across various retail channels can result in increased sales revenues, as they make it possible to more easily integrate demand-side information into the design and production processes.

Merger processes offer another example of how WS (as an initial step) and more sophisticated SOA implementations (at a later stage) can bring about substantial efficiency gains, in this case through the easier consolidation of databases and systems.

In retail financial services, the use of WS can result in significant cost reductions. For example, a leading North American bank added new functionality to existing Web-based customer application processes, achieving a consolidated view of customer account and

Box 6.5

An imaginary example of how to implement SOA

From its African home in Cornucopia, Bricks and Mortar Plc. (B&M) has grown into a global construction materials supplier with presence in six countries of West and South Asia and Latin America. Having accumulated a few years' experience with XML, B&M has launched a long-term SOA strategy in an effort to redesign its IT strategy to adapt it to the needs of its growing international activities. The goal is to create a single, cross-regional infrastructure to replace their rather fragmented base, and at the same time, to add IT capacity by sharing a larger part of the available resources. Another key objective was to enhance the efficiency of its supply chain management.

As is often the case with companies starting to experiment with the SOA model, it has taken about two years for B&M to have more than a few implementations running. However, the effort over these two years has served to sharply concentrate the company's IT policies on WS. B&M has established a policy to review its proposed WS implementations to make sure that they comply with the company's conditions and standards before they are published through the enterprise's registry. B&M continues to use traditional integration and middleware software while gradually deploying more and more WS solutions for areas such as development, security, management and business process orchestration.

In terms of concrete gains from the move towards SOA, B&M's IT management team are particularly pleased with the creation of a supply chain "control panel" that brings together information taken from applications from several vendors into a single view. They estimate that thanks to their decision to use SOA this project could be implemented with monetary savings in the region of 30 per cent and within much tighter deadlines. Equally important was the fact that this success story helped convince B&M's senior management to accelerate SOA and WS adoption in the company.

Source: UNCTAD elaboration of case studies published by SOA tool vendors.

credit information. This allowed the bank to retire half of its process locations and save several million dollars in costs. Another bank now allows online customer access to banking services previously available only to call centre agents. A US federal agency created a shared service centre to better manage inventories and handle logistical processes across its agency, customers and commercial trading partners. By implementing a seamless data architecture, it can more efficiently handle requisition approvals and updates, inventory searches and allocations, shipments and financial transactions.[38]

It is interesting to note that there is a wide diversity of reported reasons for adopting WS and SOA. Some organizations have targeted automating specific business functions and processes that were previously manual activities due to complexities in integrating fractured applications and systems. Others have opted to introduce SOA in non-mission-critical business functions in order to reduce the initial risk and ensure future investments. Box 6.5 presents the case of an imaginary enterprise, putting together information available about the experience of various enterprises in implementing SOA and WS in a developing country context.

Box 6.6 summarizes the motivations and expectations of an enterprise that plans to implement a SOA.

1. The transition to SOA

It is to be expected that not every aspect of an enterprise's systems will be immediately open to WS implementations. Normally, enterprises will not wish or need to completely reshape all their IT systems for that purpose. However, many companies, mostly in developed countries but also others based in developing countries, have started to implement WS to such an extent that they do need to put in place adequate SOAs.

This is not being made easier by the abundance of standards and the danger that there could be a divergence in this regard among major vendors. The response to these concerns tends to be that precisely because SOA allows the loose coupling of systems, each individual technology choice becomes intrinsically less risky. Enterprises that have taken a centralized approach to policy-making for SOA adoption are reported to have been more successful.[39] The teams of SOA experts that are thus created become a useful resource to identify best practice in the application of SOA and WS to key business processes. They also help build the enterprise's knowledge base about SOA, its impact on both IT systems and in overall business operations and how to identify the better candidate processes/services for the deployment of those technologies.

Box 6.6

The case of Asian Paints

Asian Paints is an Indian manufacturer of consumer and industrial paints with operations in 23 countries. It has experience in using IT to automate important business processes, including manufacturing, distribution and inventory management, and sees IT and particularly SOA as a means of differentiating itself from its competitors.

In 2000, Asian Paints decided to undertake a migration of critical systems from in-house-developed custom applications to vendor-provided solutions. An important reason for this move was the need to integrate internal systems with its supply chain business partners. The company currently uses XML to exchange information with its partners. The use of SOA technologies should in the future allow supply chain partners to obtain product and inventory information themselves rather than require Asian Paints to provide this information to them. WS and SOA standards are expected to broaden the range of interactions with supply chain partners and to lower their cost.

SOA-based applications will target better and more integrated supply-chain and production planning processes. Asian Paints also plans to add business process management, automated controls for compliance and specialized applications to support its painting services business with the new SOA architecture.

In order to maximize the value that could be generated by its SOA-based strategy, the company will need to convince its business partners to also take an SOA approach to their IT systems. Most of them do not currently use SOA/WS standards.

Source: IDC (2005).

Enterprises considering automating business processes through WS will not face any scarcity of commercial technology providers, either in developed or in developing countries. However, they should be aware that this is a field where experience about central issues such as performance, security and interoperability is still being accumulated at a fast pace. Therefore, before engaging in the process of change that WS and SOA involve it is important for enterprises to achieve a sufficient understanding of the standards and basic underpinnings of these technologies. They should also undertake their own investigation into the priorities for WS and SOA implementations and the necessary business process redesign.

2. Theory and practice

There is little doubt about the real positive impact that WS and SOA can make on competitiveness by facilitating integration of applications and collaboration with business partners. For example, leading players in the B2C arena such as eBay and Amazon seem to have been able to make significant gains by implementing WS. Other companies claim that they have observed productivity gains, although this may be more in terms of additional capabilities than can be transformed into future benefits than of actual profits. In the United States, a survey of 437 companies made by the Yankee Group in 2004 found that 48 per cent of respondents had already implemented WS and another 39 per cent expected to do so in 2005. Seventy-one per cent said that they planned to increase spending on WS in 2005. The advantages most commonly quoted were improved ability to cooperate with business partners (77 per cent), reduced complexity in distributed applications (66 per cent), higher revenues (66 per cent) and lower application development costs (58 per cent). Security ranked at the top of the list of WS-related worries (72 per cent).[40]

Yet the experience of WS implementation so far shows that difficulties are bound to remain, for technical reasons but also, and more difficult to address, business reasons. The earlier WS adopters have tended to be large corporations. These are usually able to push their business partners to participate and eventually fix to a large extent the conditions under which their suppliers/customers engage in WS. For instance, a small company that intends to use eBay's WS to sell its products has no possibility of negotiating the WS that will apply to their transactions. All it can do is to adhere to the standards published by eBay. But even in these cases, applications used by different companies, even those used in the same business process, rarely include the same data or handle it in exactly the same way. Even minor data format disagreements (for example, the format in which decimals or dates are notated in an order) may involve extensive work before real systems integration can happen. There is no specific solution that WS can contribute to this problem.

As companies start to discuss solutions to these issues, the business problems of system integrations become apparent: decisions have to be made about the level of control each partner retains over its own information (some of which may be highly sensitive, i.e. customer data) and how much it provides to its partners. Details of financial and other business practices need to be agreed on, which may be challenging when the partners are based in countries with different business traditions and regulatory frameworks. For instance, at what time of the day is a transaction considered to have taken place the next business day? Or at what point in the history of the relationship with a customer are certain credit conditions granted? Resolving these issues can be time-consuming and expensive, even within different units of the same company.

In theory, WS should be equally applicable to transactions taking place inside a company or with external companies. In practice, it is more frequent to see them implemented for internal transactions. For inter-organizational links it is much more frequent to see WS used between enterprises that have a long record of cooperation and are technologically sophisticated. In terms of size, there are more examples of implementations among large corporations, although the case of WS relationships between large companies and their smaller suppliers is also frequent. But even in developed countries, smaller enterprises tend to cooperate using non-structured technologies such as e-mail and Web rather than structured ones such as EDI, XML and WS.[41]

In terms of the nature of the business processes to which WS are being applied so far, they tend to be the ones most simple and easiest to automate, such as the transmission of orders and the description of the items in a catalogue. In an evolutionary process WS are expected to extend their support to other more complex processes. However, for enterprises, particularly those with less experience in complex IT implementations, it is advisable to take an incremental approach to their adoption of WS.

There are a number of considerations that an enterprise should bear in mind when assessing the possibility of investing in a WS implementation. The first one is the kind of relationship it has with the business partners that are most likely to use the proposed WS. This includes not only the nature of the business relationship itself but also its time horizon. Then there is the issue of how data are going to be shared and who and how is going to handle a given segment of a business process, and how it is going to be handled. There are decisions to be made about the way in which the WS is going to be implemented: what processes are to be automated and if/how WS are to be extended to other business processes. Finally, there is the question of how the enterprise is going to handle the WS implementation so that at the end it has developed an additional competitive advantage and added to its knowledge base.

The preceding paragraphs made several references to the importance of work on security-related standards for WS.[42] WS may put outsiders in contact with systems that are at the core of the activity of an enterprise. This is a manifestation of a general trend towards greater openness of enterprises, in relation to both their customers and their suppliers. Normally, enterprises benefit from this greater openness, because they can be more responsive to their customers and receive better service from their partners. But it should not be forgotten that any interface with the outside world represents a risk of intrusion, ranging from the merely indiscreet to the seriously malicious. While the industry is taking significant steps to address security concerns, at this stage of the technology's maturity, and of the user's understanding of it, fully addressing security issues (including the implications for project scalability) should remain a central consideration of any major Web service implementation.

E. Conclusions and recommendations

The preceding sections of this chapter have shown how, for reasons that have to do with trends in the evolution of ICTs but also, and perhaps even more, with changes in business strategy, services-oriented architectures and Web services will have a major role in shaping e-business in the next few years. SOA will probably represent the next major wave of enterprise IT architectures, replacing in many instances the client/server model in its dominant role. Web services standards will play a central role in the materialization of this change, as they are what renders operative the networking, transport, security and other layers of SOA implementations.

In a wide range of industries, many of which (such as electronics, textiles, other manufactures and tourism) are of great importance for developing countries, competitiveness will be greatly influenced by the ability to integrate information systems inside the enterprise and with those of business partners. SOA and WS will be fundamental for this and enterprises need to be aware of these technologies, understand their underpinnings and put them into practice.

As wider deployment of SOA and WS technologies facilitates the achievement of deeper levels of collaboration among enterprises and across geographical boundaries, opportunities may arise for those from developing countries. These may come from easier participation in supply chains and from widened possibilities for outsourcing. Both increasingly require deeper levels of integration and interaction between the IT systems of enterprises. As companies share information better with their customers and suppliers, and IT enables them to cooperate at deeper levels, they can enhance product design and specification, customize production, improve quality, reduce stocks and become more responsive to changes in market conditions. In this context, SOA and WS may become a sort of global production infrastructure supporting a common organizational logic. The challenge for developing countries is to ensure that they become part of this global business infrastructure.

Decision makers in enterprises and in the public sector should be aware that interoperability is as much a business strategy issue as it is a technology one. Technology makes interoperability possible, but only if interoperability is incorporated into the business plans of the enterprises or public sector agencies concerned. Frequently, the main barriers to interoperability are not technical, and include issues such as the following:

Regulatory (or market-driven) limits on the nature of information that can be shared with business partners or, in the case of the public sector, on the kind of cooperation arrangements between different agencies;

Institutional and/or cultural boundaries that separate organizations in terms of information sharing or that generate resistance to perceived losses of control over information;

Lack of awareness about the services that are available and the ones that may contribute to a particular business need;

- Lack of managerial capacity;
- Fear of loss of intellectual property; and
- Concerns about security problems.

Therefore, besides technology, planning and implementation monitoring should address aspects such as the desired levels of information sharing, the changes that may be necessary in business processes and the upgrading of human skills, including at the managerial and strategy-setting levels.

In particular, Governments and enterprises should be aware that in a market environment increasingly marked by cooperation within, and competition among, networks, the capacity to generate and sustain trust among business partners and customers becomes a fundamental ingredient of success. Regulatory entities have a crucial role to play in this regard and Governments of developing countries should make sure that their enterprises are able to operate within a legal and regulatory framework that creates trust and facilitates ICT-enabled information sharing and collaboration.

Another consideration that should be incorporated into public policies in order to facilitate the adoption of services-oriented architectures and Web services relates to the role that public-sector agencies can play as early adopters and role models for the private sector. In addition to enhancing the effectiveness of public services, SOA and WS implementations in public-sector agencies can raise awareness about these technologies among the less internationally exposed enterprises and provide incentives for their adoption. In so doing, both public- and private-sector decision makers should give full consideration to FOSS platforms for SOA and WS. Governments should also consider establishing their own frameworks for IT interoperability.

Finally, this chapter has shown how without open standards, SOA and WS technologies lose much of their business transformation potential. However, many aspects of standard-setting in this, as in several other areas of ICTs, are currently outside the public sphere and dominated by a small number of private players — mostly technology vendors. Whether the interests of users and consumers, particularly those from developing countries, are adequately taken into account in these standard-setting processes is open to discussion. Government involvement is not necessarily a precondition for the development of open standards. But Governments, including those of developing countries, should pay adequate attention to those processes, and both as intensive IT users and in their function of protecting the public interest should provide input and feedback into the SOA and WS standard-setting processes, promote awareness about them among their private sector and facilitate the presence of private sector players from developing countries in the bodies that develop SOA and WS standards.

Annex I

Some Web services specifications and standards

WS-TF (Web Service Transaction Framework)

WS-Coordination	Protocol that coordinates activities in distributed environments. Enables existing systems to hide proprietary protocols and operate in an heterogeneous environment.
W S-Atomic Transaction	Coordinating protocol for handling well-known and accepted two-phase commit protocols.
WS-Business Activity	Defines protocols allowed to coordinate a business activity.

Metadata

WS-Policy	Defines a base set of constructs that can be used and extended by other Web services specifications to describe a broad range of service requirements, preferences or capabilities.
UDDI	Universal Description, Discovery and Integration, used to locate Web services by enabling robust queries against rich metadata.
WSDL	Web Services Description Language standard, an XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information.
WS-Discovery	Defines a multicast discovery protocol to locate services.
WS-Addressing	

Reliable Messaging

WSRM	WS Reliable Messaging defines a mechanism to guarantee the delivery of messages to applications and Web services.
WS reliability 1.1 (WSRX) (OASIS Standard)	Idem (OASIS standard).

Security

WSS v1.0	Web Services Security describes mechanisms for message authentication including exchange of identification through profiles such as user name, X.509 certificates and Kerberos (OASIS Standard).
WS-SX	WS Secure exchange includes WS SecureConversation, WS-Trust and WS- SecurityPolicy (see below).
WS SecureConversation	Provides for the establishment and sharing of security contexts as well as a mechanism for deriving keys from security contexts.
WS-Trust	Defines mechanisms for establishing a trust relationship between Web services. Extends tokens that can be exchanged between trust domains.
WS-SecurityPolicy	Defines policy assertions that apply to Web services security (SOAP Message security, WS-Trust, WS-SecureConversation).

Management

WSDM	Defines the means to provide management of services in a distributed environment. It comprises MOWS and MUWS (OASIS standard).
MOWS	Management of Webs Services, describes a mechanism for managing Webs services, including functional, resource and service management (OASIS standard).
MUWS	Management Using Web Services, describes the mechanism required to manage resources using Web services (OASIS standard).

Source: http://www.networkcomputing.com/showArticle.jhtml?articleID=180205695

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Notes

1. According to the IEEE Standard 1471-2000, architecture is defined as the fundamental organization of a system, embodied in its components, their relationship to each other and the principles governing its design and evolution.
2. Stencil Group (2002).
3. For example, see IDC Research (2005a).
4. In 2003 Gartner predicted that about $1 billion would have been wasted on misguided Web services projects by 2007. See http://www.cio.com/archive/100103/standards.html.
5. IDC Research (2003).
6. IDC Research (2005a).
7. Radicati Group (2004).
8. Gartner (2005).
9. CORBA stands for Common Object Request Broker Architecture. It is a standard that defines how applications written in various languages and running on different platforms can interoperate. DCOM stands for Distributed Component Object Model. This is a Microsoft proprietary technology that lets software components distributed among several interconnected computers communicate.
10. It should be noted that sometimes CORBA is considered a case of SOA implementation. See, for example, http://www-128.ibm.com/developerworks/webservices/newto/.
11. API, Application Programming Interface — an interface that lets one programme use facilities provided by another.
12. http://isp.webopedia.com/TERM/S/Service_Oriented_Architecture.html.
13. http://searchwebservices.techtarget.com/originalContent/0,289142,sid26_gci1044083,00.html for a long catalogue of possible definitions of SOA.
14. http://www.lucent.com/search/glossary/w-definitions.html.
15. http://publib.boulder.ibm.com/infocenter/wbihelp/v6rxmx/index.jsp?topic=/com.ibm.wbix_adapters.doc/doc/webservices/webservi10.htm.
16. http://isp.webopedia.com/TERM/W/Web_services.html.
17. A stub is a small program routine that substitutes for a longer, possibly remote, program. For example, a stub might be a program module that transfers procedure calls (RPCs) and responses between a client and a server. In Web services, a stub is an implementation of a Java interface generated from a WSDL document. http://publib.boulder.ibm.com/infocenter/adiehelp/index.jsp?topic=/com.ibm.wsinted.glossary.doc/topics/glossary.html.
18. See, for example, Cravens, Piercy and Shipp (1996).
19. See Greenspan (2002). Stabell and Fjeldstad (1998) define value networks as organizations that create value for customers by linking them together or mediating exchanges between them. See http://lef.csc.com/foundation/library/value/RP01.asp. for a presentation of their concepts. See also http://www.vernaallee.com/value_networks/A_ValueNetworkApproach_white_paper.pdf for an alternative definition of value networks.

20. *The Economist,* The physical Internet: A survey of logistics, 17 June 2006, p. 3.

21. See Ernst (2000).

22. Yang (2006).

23. Ibid.

24. See chapter 5 of UNCTAD (2003) for an extensive study of ICTs, their role in the expansion of business process outsourcing and the issues that this raises for developing countries.

25. For a vocal argumentation along these lines, see "You call that a standard?", an interview with Professor Robert Glushko of the University of California at Berkeley, available at http://news.com.com/You+call+that+a+standard%3F/2008-1013_3-5200672.html?tag=guts_bi_7345. This interview generated an interesting online discussion and a considerable amount of criticism among XML developers, some of which is available at http://www.xml.com/lpt/a/2004/05/12/deviant.html.

26. Ibid.

27. See OASIS intellectual property policy at http://www.oasis-open.org/who/intellectualproperty.php.

28. http://www.w3.org/Consortium/Patent-Policy-20040205/.

29. See Krechmer (2003).

30. See http://www.ebxml.org/geninfo.

31. The Center for E-Commerce Infrastructure Development of Hong Kong (China) and the Department of Computer Science & Information Systems at the University of Hong Kong (China) sponsor the freebXML project, which was launched to promote development and adoption of ebXML-based open-source. See http//:www.freebxml.org.

32. Johnston and Vitale (1988), quoted in Zhu (2005).

33. The reason for the complexity and relative rigidity of EDI messages is that these standards were developed in a context of bandwidth scarcity in which efficiency in the transmission of information was at a premium.

34. EDI standards define the format of messages and the communication protocol. Historically, EDI tended to be implemented over private networks.

35. See UNCTAD (2003) for a comprehensive overview of the FOSS phenomenon and the benefits that developing countries could derive from a positive and proactive approach to FOSS.

36. IDC (2005b).

37. IDC (2005b).

38. All examples in this paragraph are quoted from IDC (2005).

39. IDC (2005b).

40. CIO Magazine (2004).

41. See "Confronting the reality of Web services," an interview with Professor A.P. McAfee, Harvard Business School Working Knowledge, 16 May 2005. Available at hbswk.hbs.edu/item.jhtml?id=4800&t=technology.

42. See UNCTAD 2005 for a presentation of some key aspects of security in relation to the development of e-business.