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Trust and Security in Service-oriented Environments

1.1 Introduction

The advent of the Internet and the Web provide connectivity and information richness over great distances at any time. This has created a dynamic, open and convenient environment for social and business development. It not only provides the opportunity for new entrepreneurial endeavours utilizing the Web, but also opens up new opportunities for old, static, closed, locally based businesses to adopt new business paradigms and new organizational forms. The Internet has also opened up modes of interaction and dynamic organizational configurations that were previously inconceivable within a wide array of human and business activities. However, these have also introduced challenges. One of the most pressing of these arises from the fact that in a business or social interaction on the Internet, we cannot rely on the usual physical, facial and verbal cues that we might have relied on to reach a judgement as to whether or not the other party will fulfil the service that they are promising. In addition, in the case of the purchase of physical goods over the Internet, we have no direct physical, sensory contact with the specific product and are reliant solely on the promise of the seller. We are being put in the position of 'buying a pig in a poke', rather than being able to 'squeeze the tomatoes' to determine their firmness. There could, in some cases, be difficulties ensuring that the purchaser pays for the goods. These factors and several others, when taken together, create the imperative for being able to make judgements within such an environment about the other parties' trustworthiness and capability to provide the service at a specific level of quality. Through adopting new *trust* technology in the service-oriented network environment, a platform for both consumers and businesses to learn from each other is created. Thus, real business value, increased consumer confidence, guaranteed quality of product and service could become a reality in the virtual word.

In this chapter, we study why trust is important and make clear distinctions between the concepts of trust and security. We also offer a detailed introduction to service-oriented environments, which are an integral part of a networked economy.

1.2 Why Trust?

In recent times, we have seen an increasing number of people carrying out a myriad of different activities on the Internet. These range from writing reports to looking at the news, from selling a car to joining a club, from the purchase of goods (e.g., [1]) to the purchase of services (e.g., Priceline.com for travel arrangements), from entertainment (music or games) to research and

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development (information surfing), from private resource utilization (grid computing) to remote file sharing (peer-to-peer communication), from shopping at the mall (BizRate.com) to bargaining in virtual markets (e-Bay), from e-bill to e-pay, from the virtual community to virtual collaboration, from e-governance (e-administration) to mobile commerce (stock trading), from e-education (cyber-university) to e-learning (getting an MBA online), from e-manufacturers (remote control production) to e-factory (e-products), from offshore development (business expansion) to outsourcing (such as IT), from e-warehouse (warehouse space booking) to e-logistics (goods shipping orders), and limitless other possibilities.

Transactions have moved away from less face-to-face encounters to being more on the Internet. The infrastructure for the above business and information exchange activities could be client–server, peer-to-peer (P2P), or mobile networks. Most times, users on the network (the customer or business providers) carry out interactions in one of the following forms:

- Anonymous (no name is to be identified in the communication)
- Pseudo-anonymous (nicknames are used in the communication)
- Non-anonymous (real names are used in the communication).

In such distributed, open and often anonymous environments, *fraudulent* or *incomplete practice* could occur where the seller or business provider or buyer (the agents on the network) does not behave in a manner that is mutually agreed upon or understood, especially where terms and conditions exist. This could take several forms:

(a) The *seller* or *service provider* only delivers part of the service promised or is inconsistent in delivering the goods or services, for example, sometimes delivers and sometimes does not deliver or cannot deliver or never delivers what was promised or advertised.
(b) The *customer* or user may always be negative and disruptive of the business, or gives false or faulty credit details.
(c) The provider provides a *service*; however, it is not up to an acceptable standard.
(d) The seller's *product* is not of a good quality.

Trust and *trust technology* have come into the picture for the virtual environment recently to give an online user the sensation of being able to 'squeeze the tomatoes before you buy' or for providing opinions and assessments before a decision is made. It boosts consumer confidence and helps facilitate judgements about business reputations. In other words, you feel confident to pay for a service or product because you trust the seller's reputation or the quality of products (goods) or services. This helps mitigate the risk in the business transaction. On the other hand, *sellers* or *service providers* can learn about users and customers through trust technology so that they can improve on-demand service that meets customer needs better. Trust technology such as trustworthiness systems, or rating systems, or recommender systems already exist on the Web. For example e-Bay, Amazon, BizRate and CNet already have some rudimentary versions of trust technologies. Regardless of the fact that these examples of the use of the technology only provide some basic functions, trust technologies are becoming more and more popular and providing a convenient tool to simulate social trust and recommendation experience for online users.

Trust is a crucial ingredient in any mutual relationship and where transactions are carried out in an anonymous, pseudo-anonymous or non-anonymous distributed environment to provide the agreed to Quality of Service (QoS).

With trust technology–supported web-based e-business, one is able to respond to dynamic individual and business needs, thus achieving the targeted productivity improvement, lowered operational costs, and enhanced customer service. On the consumer side, such system support will allow greater confidence, leading to greater willingness to participate in transactions on the Web.

1.3 Trust and Security

Trust and security are not the same thing in the world of e-commerce. Unfortunately, a variety of uses, particularly of the term 'trust', could lead to some confusion. In this section, we clearly distinguish between trust and determining security and when they could be synonymous and when they are not. This will help develop a shared conceptual vocabulary, which will form the basis of the discussions in this book.

Connectivity and information richness through the Web have led to the possibility of convenient environments for social and business development. We move away from notions of static, closed, local and competitive environments to new interaction models, new business paradigms, new organizational forms and new economic environments that were previously inconceivable in many activities. Such an environment is able to respond dynamically to individual and business needs in a more timely fashion. Individuals and organizations have equal opportunity to utilize the Web to increase productivity, improve operational costs and enhance customer service. However, this new, open and flexible environment introduces two broad challenges, namely, *security* and *trust*.

Security focuses on protecting users and businesses from anonymous intrusions, attacks, vulnerabilities, and so on, while *trust* helps build consumer confidence and a stable environment for customers or businesses to carry out interactions and transactions with a reduction in the risk associated with doing these in a virtual world, thus allowing one to more fully reap the possible rewards of the increased connectivity, information richness and flexibility.

1.3.1 Security

The dynamic, open and convenient Web environment not only boosts business potential and the economy but also creates concerns of security, trust, privacy and risks. If these issues are not dealt with in a timely fashion, they could hamper business in utilizing the Web. Security issues can affect communication, infrastructure, servers, client browsers, e-products, e-services, software, hardware, electronic documents, business transactions and organizational back-end databases. We need to prevent hackers, attackers, unauthorized individuals and malicious users or servers from taking advantage of honest online users, from damaging private businesses and also from attacks on non-government and government organizations.

Security threats and attacks on the Internet include, but are not limited to, the following [2]:

- *Eavesdropping* – intercepting and reading messages intended for other users
- *Masquerading* – sending/receiving messages using another user's ID
- *Message tampering* – intercepting and altering messages intended for other users
- *Replaying* – using a previously sent message to gain another user's privileges
- *Infiltration* – abusing a user's authority in order to run hostile or malicious programs
- *Denial of service* – preventing authorized users from accessing various resources
- *Virus and worms* – micro virus or attachment virus, Morris worm, cert/cc, short for the Computer Emergency Response Team Coordination Centre, studied at Software Engineering Institute at Carnegie Mellon University examine Internet security vulnerabilities.

Security Technologies that are widely available to address these include the following:

- Encryption (RSA encryption, algorithms, keys, encryption standards, etc.)
- Cryptography (hiding messages in text)
- Steganography (hiding messages in pictures or media)
- Secret information sharing (algorithms, symmetric keys)
- Digital signatures and standards

- Authentication (digital certificates, verifying identities, public keys)
- Authorization (controlling access to particular information and resources)
- Data integrity (a receiver can detect if the content of a message has been altered or a receiver can detect it)
- Intrusion detection.

Currently, the above-mentioned security technologies are sufficiently mature for e-commerce, and most of the technologies are already standardized [2].

The field of security research is still very active in the following areas (though it is not limited to them):

- Electronic payment (electronic wallets, dual signatures, etc.)
- Digital money (blind signatures, coins, double spending, etc.)
- Web security (HTTP messages, header leaks, Secure Sockets Layer (SSL) tunnelling etc.)
- Server security (data and database security, copyright protection, etc.)
- Client security (privacy violation, anonymous communications)
- Mobile agent security (agent protection, malicious agents, attacking servers, sand box, cryptographic trace)
- Mobile commerce security (Global System for Mobile (GSM) security, subscriber ID authentication, etc.)
- Smart card security (SIM card, biometrics, etc.)
- Communication security (firewalls, security negotiations, virtual private networks, network layer securities)
- Data, database and information security (triple keys, Hippocratic databases)
- Security policies (international legislation and regulation, enforcement of security)
- Security management (infrastructure, network, application and database)
- Computer forensics (electronic evidence, expert witness, etc.)
- Risks and emergency responses
- Privacy (protecting the identity of individuals and their information and allowing them to control access to their information).

Security and trust are two distinct concepts. Security provides a safe environment and secure communication along with protecting end-user and business from intrusion. Trust is the belief or faith that a person or agent has in another person or agent with respect to certain activities at a given time. In order to acquire trust in another entity over the anonymous distributed network, security-establishing mechanisms may be necessary to provide sheltered communication or information protection.

1.3.2 Trust

In the networked virtual environment, we study trust along the following dimensions (though not necessarily limited to these):

- Trust, trust value, trust relationships, initiation, association
- Trustworthiness, trustworthiness value
- Reputation, reputation value
- Trust management
- Reputation management
- Dynamic nature of trust, implicitness, asymmetry, context specific, time dependency
- Trust ontology
- Trust and reputation modelling

- Trust relationship diagrams
- Establishing trust relationships, building and maintaining trust
- Trust management protocols
- Trustworthiness measurement
- Trustworthiness prediction
- Assigning trustworthiness
- Trustworthiness scales
- Trusted business, business value, consumer confidence
- Trustworthiness systems, rating systems, recommendation systems.

Most of these concepts will be discussed in this book.

Trust, trustworthiness and reputation are innovative technologies reshaping the world of e-commerce. Many of the largest commerce websites and organizations are already adopting these technologies albeit in an early and rudimentary form. They help business providers learn from their customers and help the customers find the best deals available and understand the risks associated with a transaction with a particular supplier.

1.3.3 Trust in Security Context

The concept of 'trusted computing' known as *Palladium technology* was initiated by Microsoft around 2001 as a combined software and hardware solution and a tamper-proof computer environment for secure communication (Figure 1.1). Microsoft's 'trusted computing' known as the *secure computation service* [4] claimed that 'this significant evolution of the personal computer platform will introduce a level of security that meets rising customer requirements for data protection, integrity and distributed collaboration' [4]. The significance of *trusted computing* (Palladium technology) is its potential to improve system integrity, personal privacy and data security. Reliability and security are achieved as the applications run in the protected communication environment provided by Palladium. This promising technology is available only in a beta version on the market, and its promises still need to be proved.

The concepts of Microsoft's 'trusted computing', 'trusted network', trusted communication', 'trusted agents', 'trusted... ', and so on, are here, related to security issues, security mechanisms, security technology and security services. All topics of security study and research are directed towards providing a secure and tamper-free environment, or network or communication. In this context, 'trust' is synonymous with 'secure', which is tied to 'security'. However, this is *not* the same as trust in the business paradigm, which is the subject of this book.

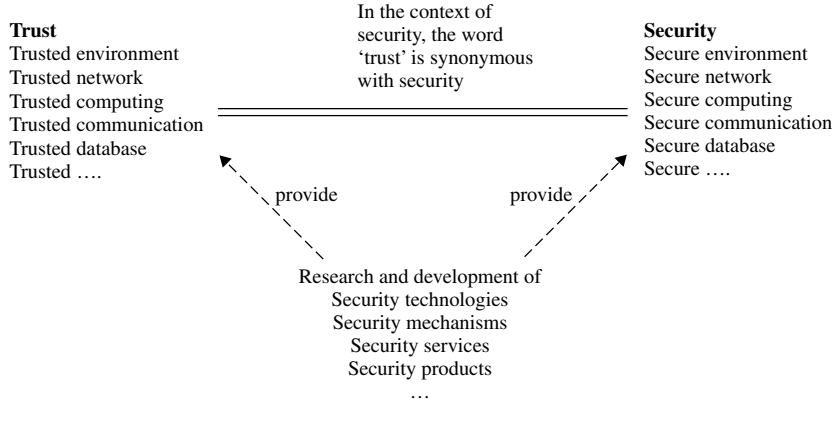

Figure 1.1 'Trust' in security context

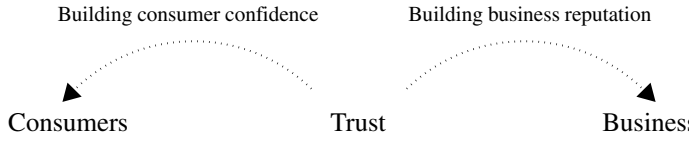

Figure 1.2 'Trust' in business context

Figure 1.3 'Trust' and 'security': complementary technologies

1.3.4 Trust in the Business Context

Trust is a belief of confidence or a feeling of certainty that one person has in another person or thing that he/she is interacting with. Everyone or every organization wants assurance, certainty and confidence about what they do and what they will receive. In the business world, trust is especially tailored for ensuring honest dealings and quality of products or services and that is usually related to mutual agreements and understandings (Figure 1.2).

When we discuss trust in a social or economic context, there is a limited relationship with security. The motivation behind trust technology is to help build business reputation, consumer confidence, fair trading and mutual relationships. This book is about trust in business and specifically focuses on trust technology, trust establishment, trust level measurement and prediction and trust relationship development.

Security can be used to support *trust*, through providing a secure trusted environment, secure network and secure communication so that trusted business transactions can take place.

However, building trust in social and economic environments also helps to reduce aspects of *security risk*.

Both trust and security are equally important in business, commerce and the world of technology. Trust and security are complementary to each other (Figure 1.3). In the field of security, the word 'trust' is synonymous with 'security'. However, in business and social contexts and their support through the Internet they mean different things and both require complex studies, research and development.

1.4 Service-oriented Environment

The advent of the Web and its intrusion into business, commerce, government and the health sector have led to Web-based e-commerce for business interactions and collaborations over great distances and at any time. In the last ten years, this new Web-based environment has enabled economic growth, industry development, technological innovation and resource sharing. This new business environment has led to the development of the *service-oriented environment* that *transcends* the previous *static, closed, competitive models* and has moved towards *flexible, open, collaborative, sharing* and *distributed environments* that are able to respond in a timely manner to consumer needs and business dynamics inherent in the networked economy.

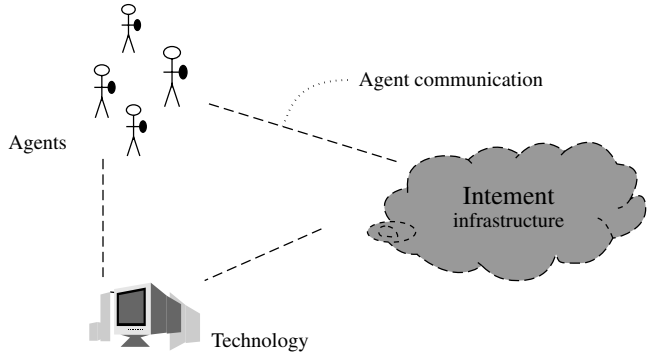

Figure 1.4 The definition of technology-based *environment*

1.4.1 Environment

Environment in social terms is defined as the external elements and conditions that influence the growth, development and survival of an individual or organization.

In technological terms, we define the *environment* as a networked virtual community in which there are agents, infrastructures and technologies which enable the interaction and operation of agents for the growth of the community, economic development and social evolution (Figure 1.4).

1.4.2 Essential Elements in the Technology-based Environment

1.4.2.1 Service

In technological terms, *services* often refer to *software applications, methods, operations* or *communications* between two computing objects, or the *interface* between two software components. These technological terms for *services* are influenced by the business community, as the aim of technology is not simply the development of new technologies but the development of real business solutions. It is important that we study technology not for its own sake but for its application to industry and business.

1.4.2.2 Agents

Agents in business terms are often referred to as intelligent representatives, acting on behalf of a company, business or individual and having the *power, authority* and *ability to make decisions*.

In technological terms, *agents* are referred to as *intelligent software agents*, or communication facilitators, or users of computer systems, and so on. The intelligence comes from a knowledge base, a rule base or ontology that we program or design or build into the software or hardware agents. Therefore, they can behave autonomously and perform business or services automatically without human intervention.

1.4.2.3 Agent Interaction

As in the physical world, where humans or enterprises need to interact to carry out business or services, in the technological environment *agents* need to communicate in order to carry out business activities. As a result of agent interaction, a business transaction or deal is accomplished.

1.4.2.4 Infrastructures

Infrastructure in a business sense is *a base* or *foundation* to provide basic facilities so that the primary business can be operated, and technology is a tool to support or facilitate the business.

The *infrastructure* in a technology-based environment includes basic support services such as networks, which incorporate servers and communication protocols, and so on. Technologies refer to the type of software or hardware tools used.

1.4.3 Service-oriented Environment

A Service-oriented Environment is defined as a collaborative, shared and open community in which agents utilize its infrastructure and technology to carry out business activities, such as product sales, service deliveries and information retrieval. It has at least four components: agents, business activities, infrastructure and technology.

- Agents (buyers, sellers/providers, users, websites or servers)
- Business activities (product sales, service deliveries, marketing or information sharing)
- Infrastructures (networks communications)
- Technologies (service publishing, discovery, binding and composition).

It is a *collaborative environment* because it is not a closed walled individual operation as carried out in a traditional business sense. Online users are often anonymous but help can be provided for each of them by posting and answering questions on the Web, and carrying out collaborative business, research or industrial processes.

It is a *shared environment* because agents share information on the Web about unknown agents, unknown products, unknown service providers, or merchants.

It is an *open community environment* because agents attach themselves to or leave the community as they need to rather than having a predefined set of agents listed within the community servers. Also, everything is on the Web, coupled with emerging trust technologies that ascertain the behaviour of sellers, producers, merchants, manufacturers including service providers using ratings by all kinds of online users, or other buyers, sellers, and so on.

Figure 1.5 depicts the service-oriented environment and its major entities.

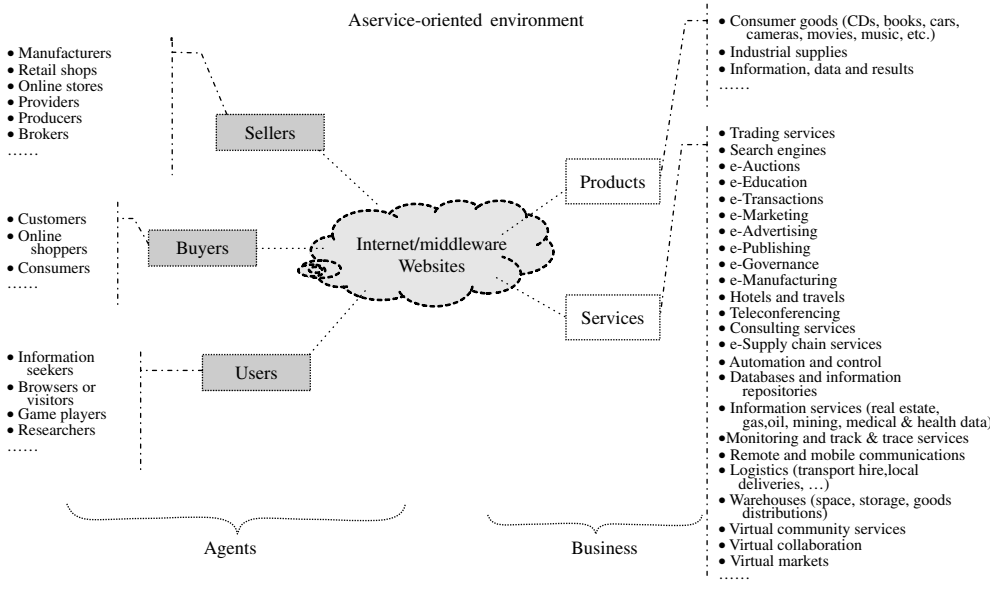

Figure 1.5 Major entities in service-oriented environments

The *Service-oriented Environment* has the following characteristics:

(a) multiple channels of sales, marketing, purchasing and information inquiries;
(b) a collaborative approach between sellers, buyers, users and service providers;
(c) high connectivity and electronic handling of information, data and documents;
(d) strong information infrastructure that extends beyond the *original physical* individuals and businesses;
(e) provision of products, services, end-user interaction and utilization of information services;
(f) self-organization and reconfiguration to meet dynamic business needs;
(g) capturing business intelligence through trust, reputation and smart information sharing; and
(h) value-added consumer relationships, customer service and strengthened small-medium businesses.

The *service-oriented environment* redefines the old industrial business models by means of new Internet-based technologies in order to maximize productivity, customer value and QoS.

1.4.4 Issues in Service-oriented Environments

Trust plays a crucial role in anonymous, remote, heterogeneous service-oriented environments and business communications, where the transactions and services are carried out. It involves several issues that need to be understood and addressed, such as the following:

- It is hard to assess the trustworthiness of remote unknown entities over the Internet.
- It is difficult to collect evidence regarding unknown transactions, unknown service providers, unknown consumers or unknown products.
- It is hard to distinguish between the high and the low quality of services on the Internet.
- It is possible to allow people to assess a much wider range of cues related to trustworthiness in the physical world than is currently possible through the Internet.
- Short-cut communication for which the information provided is not comprehensive and sometimes incomplete, for example, insufficient information about the service providers, goods or products as well as published services; and online users and consumers often have to take 'risks' that can leave them in a vulnerable position.
- An attractive website offers little evidence about the solidity of the organization behind it.
- The online user or consumer has no opportunity to see and try out the products, or 'squeeze the tomatoes before you buy'.
- The provider or seller, on the other hand, may not know whether he or she will get paid properly or on time by the customers or consumers.
- Trustworthiness systems have their own way of carrying out data entry or enquiry and can have different representations, interaction styles and trust rating scales. Some use five stars, some use four stars, some use a scale of 1–10, some use percentages, and some use unbounded integers;
- The fewer the number of people participating in a trustworthiness rating system, the more inadequate the opinions or recommendations provided by the system.
- The effectiveness of any recommender system is dependent on many factors, not just the quality of the algorithm [5].
- The heterogeneity in the distributed network.
- Catering for anonymous, pseudo-anonymous and non-anonymous agents interaction in the public and open environment.

1.5 Agents in Service-oriented Environments

1.5.1 Agents in Service-oriented Environments

In *service-oriented environments*, we refer to the interacting parties as *agents.* An *agent* in a service-oriented environment is an *intelligent autonomous entity,* capable of making decisions. It

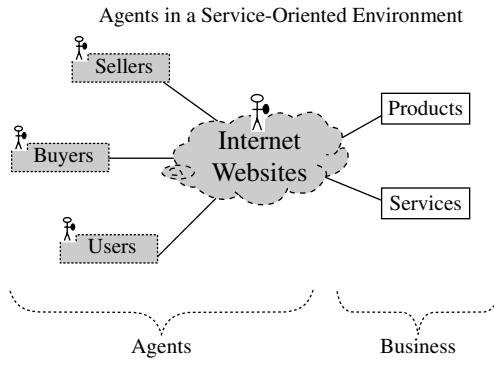

Figure 1.6 Agents carry out business (sell goods or provide services) in a service-oriented network environment

can be a buyer, a seller, a supplier, a merchant, a website, a service provider or an interacting peer, a software construct, or an intelligent server running behind the scenes on the network.

An agent on the network can be the trusting agent or trusted agent. For example, if a website is a virtual bookstore, when a customer (the trusting agent) ranks the trustworthiness of the bookstore, the bookstore is a *trusted agent*. However, the bookstore may have thousands of book suppliers, and the bookstore (trusting agent) can rank its supplier (trusted agent). The bookstore can also rank its customers; therefore, the customer becomes the *trusted recommending peer*. However, the context for which they measure or predict the trustworthiness is different in each of the above situations. Note that a particular agent can be both a trusted agent and a trusting agent in different contexts.

Figure 1.6 depicts the agents in a service-oriented environment.

1.5.2 Sellers

Sellers in the service-oriented environment are the agents making the sales. They could be *businessmen, brokers, dealers, merchants, retailers, auctioneers, online stores* or *shops, and salesmen or tradesmen*.

Note that *manufacturers* or *service providers*, and so on, can also be *sellers* if they want to sell their products or services and do not use intermediary agents. Many manufacturers do sell their products directly to the public. The most important thing here is that, over the Internet, we are primarily concerned with agents who interact with customers. From the customer or online user's point of view, the most important party is the one that is involved in the direct interaction with the customer. For example, if we want to buy a pair of running shoes, we are concerned more with the shoes and from whom we bought them, rather than where the factory that produced them might be. We seldom interact with the factory for most goods that we purchase.

1.5.3 Buyers

Buyers in the service-oriented environments are *purchasers, clients, consumers, customers* or *shoppers*. Buyers can also be business entities, such as in B2B e-commerce. The buyer is a very important entity in a service-oriented environment, because the buyer raises many of the issues that create business, infrastructure and technological needs that we are dealing with today such as security and trust and protecting consumer rights and privacy.

1.5.4 Users

Users in service-oriented environments are information *seekers, browsers, information requesters, game players, researchers, patrons* or *shoppers*. They could also be customers, buyers, sellers or

providers. We separate users from buyers or sellers because the population of online users is much larger than buyers or sellers.

1.5.5 Websites

Finally, we define *websites* as agents. Websites are normally *service providers*, such as *business brokers, merchants, retailers, shopping centres* or *information databases* or *repositories*. They may provide a single service or multiple services. They, themselves, may have suppliers who provide goods for sale or they may be manufacturers who sell their own products, such as computers, or service providers who sell services, such as consulting services for e-learning.

This is because a *website* in a service-oriented environment is an intelligent entity on the Internet with a unique URL address. By incorporating and utilizing software technology and hardware infrastructure, it can carry out communication with other agents and achieve business objectives such as enabling sales and service deliveries.

Before concluding this section, we would like to summarize that an agent over the service-oriented network environment can be a trusting agent or a trusted agent, and an agent can measure or predict the trustworthiness of another agent or agents.

1.6 Business in a Service-oriented Environment

In a service-oriented environment, *business* refers to business activity and includes all the management processes and workflows that enable a company or resource provider to sell or deliver the products and services through the use of new technologies and infrastructure to maximize consumer confidence and business value.

From Figure 1.6, we note that there is a high-level decomposition of two types of activities in a service-oriented environment, namely, *product sales* and *service delivery*. These are discussed in the following text

1.6.1 Products

Products in a service-oriented environment are *goods* or *finished products* that are sold to or are for sale to consumers. A product could be any software or hardware, even an information kit, results, data sets, documents, experiment output and material products such as DVDs, cars or bags. A product could be purely information such as weather information or drug information.

We also define that some *information* retrieved from service-oriented networks are also products, regardless of whether they are free or not, because results, reports, documents or information are produced and may be the products of research or development, or an information provider's products. They may sell the information as a form of product. For example, IEEE has one of the world's largest scientific article collections, and they sell scientific papers as products.

The *quality of a product* can be evaluated or rated by consumers who use the product or customers who bought the product. They give the *quality of a product* rating based on their opinion(Figure 1.7).

1.6.2 Services

Services in a service-oriented environment are jobs, duties, tasks or activities that a business or a service provider offers to customers or consumers, such as logistics services (they have trucks or trains that can deliver goods or products for you; however, they do not own or produce the

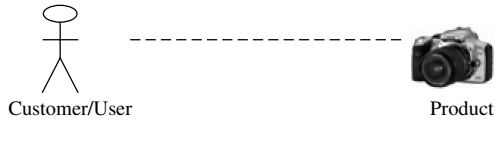

Figure 1.7 Customer or user gives an opinion on the quality of the product

goods), warehouses (such as space rental, refrigerated rooms or air-conditioned space), access to information databases, and so on.

From Figure 1.5, we see that services include (but are *not limited* to) the following: trading services, search engines, e-auctions, e-education, e-transactions, e-marketing, e-advertising, e-publishing, e-governance, e-manufacturing, hotels and travel, teleconferencing, consulting, e-supply chain services, automation and control, databases and information repositories, information services (real estate, gas, oil, mining, medical and health data), monitoring and track and trace services, remote and mobile communications, logistics (transport hire, local deliveries), warehouses (space, storage, goods distributions), virtual community services, virtual collaboration, and virtual markets.

From the above list, you may notice from the characteristics of services that they are not products; the service may or may not be free, and there may be a payment for using it; and service items, such as information services, may or may not be free.

1.6.3 Quality of Goods

In most countries, the consumer has to pay *Goods and Services* Tax on each transaction. This shows that sales of *goods and services* are key business activities. When you buy goods or services online, it is the same as if you buy them offline.

With the most popular products, their properties are easily ascertained even without extensive measurement. With some it may be necessary to use sophisticated measurements. However, with some others, such as software or buildings with hidden defects, it may be more ambiguous and require expert arbitration. In general, the room for the 'interpretation' of the quality of goods is much smaller.

Millions of product categories exist. Similarly, there are millions of types of services available. Nowadays, you can find or purchase most of these *goods and services* online.

1.6.4 Quality of Service

Quality of Service (QoS), in a service-oriented network environment, is defined as the *fulfilment* of the *service agreement* or *mutually agreed service.*

In a service contract or agreement, a service is defined by its context or functions, coupled with the terms and conditions, and is normally set by the agreement between the service requester and the service provider. In other words, a service agreement describes a mutually agreed service, and states that both the customer and the service provider have agreed upon all the terms and conditions. QoS can then be measured against the fulfilment of the mutually agreed service as specified in the service agreement. A service in the service agreement is clearly defined so as to have a clear context or functions and a set of terms and conditions that are tailored to the customer's requirements.

If there is no *service context* and there are no *terms and conditions* (or *requirements and constraints)*, there would be no protection for either party. An *agreement* implies that the service context and *terms and conditions* are specified, understood and agreed to by both parties and especially that the customer has understood before signing the service agreement. It implies a mutually agreed service that contains obligations for both the parties, such as that the trusting agent has to pay the agreed amount within a given time and that the service provider has to deliver the service according to what has been agreed upon with the customer. Its purpose is to provide protection to both the parties from fraud or cheating in a service interaction, and in many situations, though the purpose of the service agreement appears as protection for the customer it fundamentally serves to protect the service provider. Consider the cases of, 'bank loan', 'house insurance', 'mobile phone service', 'car rental agreement', 'employee contract' or 'bugs in a SAP software module', and so on. Frequently, the customers may not get what they have understood or expected because of the hidden meaning or hidden costs contained in the terms and conditions, colloquially referred to as *fine print* in the agreement.

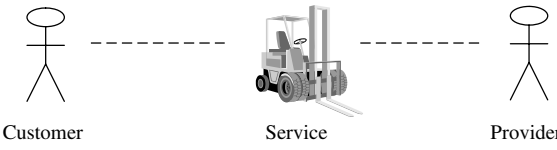

Figure 1.8 *Quality* of service is measured by considering the customer's input as well as input from the service provider with respect to the level of service in the service agreement

1.6.5 Quality of Goods Measure

An *important* point to note, however, is that the quality measure of *goods and services* is quite different. Measurement of a goods' quality is generally much easier than measurement of the QoS. This is because when we give an incorrect measure or comment about the goods or a product, it is much easier to verify this against the specification. However, when we measure the quality of a service or give a rating to the quality of a service, because a *service* involves another intelligent entity, we cannot just accept one side of the judgement. Therefore, one side of the story may not count as much until both sides of the story are heard. This creates a *big challenge* in measuring or quantifying the *QoS* over the service-oriented environment.

1.6.6 Quality of Service Measure

A *service* always involves two parties: the service provider(s) and the service consumer(s). Therefore, it is always accompanied by a service agreement between the two parties. A service agreement may be very simple or very complex; this is dependent on the size of the job. *A service agreement* contains, among other things, *terms and conditions*. It contains both parties' responsibilities, for example, that the service customer should pay the right amount at the right time and that the service provider should deliver the QoS according to terms agreed.

QoS is determined in relation to the fulfilment of the service agreement. Normally, when a service contract is signed, it implies that both the parties understand the service agreement and mutually agree with all the terms and conditions in it. By default, the *service provider* should deliver the mutually agreed service to its *service customer*. The measurement of the QoS needs to take into consideration input from both the customer as well as the service provider, as the service agreement binds both the parties (Figure 1.8).

The judgement on delivery of QoSs and fulfilment of a service agreement is a much more complex issue. This is particularly true when the service agreement has complex terms and conditions that could sometimes even provide for a lower service level under circumstances beyond the service provider's control. An example of this could be a fixed delivery time of, say, two days for the delivery of the goods by a transporter. This could be softened a little in the contract in the event of inclement weather. There are also important issues related to the service receiver's expectations in relation to the level of service in the agreement and the service provider's interpretation of the service level.

1.7 Infrastructure in Service-oriented Environments

In service-oriented environments, the *infrastructure* mainly refers to the *Internet* and associated infrastructure. In the early days of e-commerce, business and transactions were mostly carried out over client–server environments. Since then, many other forms of network infrastructure have come into use. Even though not all the infrastructures are totally mature, they are regarded as the next generation of e-commerce or e-business platforms. The network infrastructures that can be used in service-oriented environments are as follows:

- Client–server network
- Peer-to-peer network

- Grid service network
- Ad hoc network
- Mobile network.

Any one of these network infrastructures, when provided within a service-oriented environment, permits e-Business (total e-solution), e-commerce (online transactions) and e-service to be carried out.

1.7.1 Client–Server Network

In the client–server network, one computer acts as the server and others act as clients. Thus, in the client–server network, there is only one server and the roles of communicating parties (either clients or server) are clearly defined from the beginning. For example, a client cannot be changed to a server for the same transactions once the infrastructure is set up.

1.7.2 Peer-to-Peer Network (P2P Network)

The Peer-to-Peer (P2P) network is totally different from the traditional client–server network. Each computer has the same roles and functions [6]. A P2P network distributes information among the nodes directly instead of interacting with a single server [7]. Moreover, a P2P network platform is independent. In other words, it supports heterogeneous systems [8]. Each node has its own repository for distribution to other nodes. There is no central repository in a P2P network as information is automatically spread in the network [6]. The number of nodes in a P2P network is dynamic. Nodes can enter and leave the network at all times. Napster, Gnutella, Kazaa and Freenet are among the most popular P2P applications [9]. To access the P2P network, a node can be anonymous (no user name or ID can be identified), non-anonymous (user name and ID can be identified), or pseudonymous (users use nickname(s) instead of real names). For an anonymous network, the identity of the node is unknown [10], while in a non-anonymous network, the identity of the node is known and the name of the node can be linked to a physical identity [10]. However, in most cases, nodes are pseudonymous. Nodes provide their identities at the beginning, and they use pseudonyms to connect with other nodes. As anonymity can lead to the breakdown of intellectual property [10], the anonymous network is not so common. Among the four most popular applications, as previously mentioned, *Freenet* provides anonymity in accessing the network [9].

P2P networks (such as [11]) are regarded as the next generation of the service-oriented networks. As a result, it changed the whole scenario from a centralized environment to a distributed environment. The main difference between P2P networks and the client–server environment is that P2P networks transfer the control from the servers back to the clients. In the P2P network, the users or business providers can carry out interaction in one of three forms:

- Anonymous (no name is to be identified in the communication)
- Pseudo-anonymous (nickname is used in the communication)
- Non-anonymous (real name is used in the communication).

1.7.3 Grid Network

The basic idea of a grid network is to assemble the existing components and information resources in order to be able to share them among the users [12]. The grid network provides the resource-sharing paradigm for clients. In particular, in the grid network, there is a collection of servers and clients working together [13]. Each node is autonomous. There is no central management. A grid network is similar in a few respects to P2P in that they both provide the sharing of resources and components among the nodes in the network. Unlike P2P, in the grid network, each node has a distinct role: either as a server or as a client. Both P2P and grid networks support heterogeneous systems. However, the heterogeneous nature of the resources is to some extent a distinct barrier for

a grid network [14]. Even though, the grid network supports heterogeneous systems, to integrate enormous numbers of heterogeneous components and resources is expensive and with the current available technology this poses difficulties.

1.7.4 Ad hoc Network

An ad hoc network is a Local Area Network (LAN) or small network, where the connection is temporary. The communicating parties are in the network only for the period duration of a specific communication session [30]. An example of an ad hoc network is communication via Infrared transmission with mobile telephones.

1.7.5 Mobile Network

Nowadays, mobile devices play an important role in everyday life. In recent times, the number of mobile phones and wireless Internet users has increased very greatly. A mobile network is a kind of ad hoc network. Mobile networks provide users access to whatever they want without being tied to a fixed location PC, as they change their geographical location, using compact devices such as PDAs, smart phones and Internet appliances [15].

The *first generation mobile networks only provided* voice and data communication at low data rates while *second generation* (2G), digital multiple access technology provided enhanced features including paging and fax services [16]. For sending text messages over the mobile device, with Short Message Service (SMS) [17], 2G technology is used. The General Packet Radio Service (GPRS), a 2.5G technology, supports flexible data transmission rates, and is a radio technology for Global System for Mobile communications (GSM) [16]. *The third generation (3G)* technology seeks to connect users anytime, anywhere at high transmission rates and at low cost [18]. 3G technology is based on radio transmission. However, it is still developing towards the next generation in order to offer such superior services.

1.8 Technology in Service-oriented Environments

1.8.1 Service-oriented Architecture (SOA)

A typical Service-oriented Architecture (SOA) consists of the interactions between three roles, as shown in Figure 1.9, namely, service providers, service requesters and service brokers. It also involves three distinct activities, namely, (i) *description and publishing*, (ii) *finding and discovery* and (iii) *binding*. We explain these terms in more detail in the following text.

Service provider: The major task of the service provider is to have their services deliverable, *described* and *published*. Such publishing could be by registering with the service broker or making them available to service requesters directly [19].

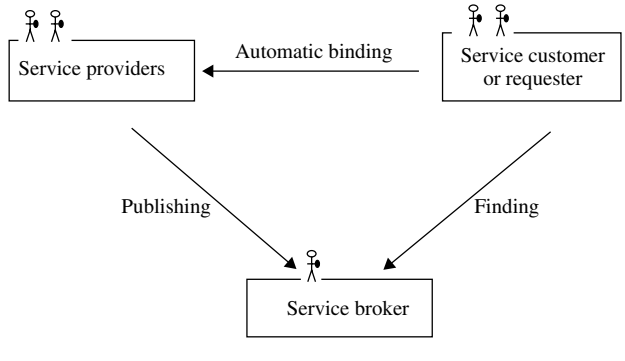

Figure 1.9 Service-oriented architecture

Service requester: Service customers or requesters may be either machines or humans. The service requesters *find* or *discover* the desired services from the service brokers or directly from service providers. Then they request those services, by sending messages, to either service brokers or the service providers directly. Once the service provider has been located, the service customers or requesters then *bind* to those services directly with the service provider.

Service broker: Service brokers provide central repositories or directories for *services* published by service providers. Basically, there are two types of service brokers: public brokers and private brokers. Public brokers are publicly available through the Internet or for open community, while private brokers are limited in access for only authorized groups or a closed community. A service broker has to be centralized in this regard, but service binding is distributed.

As mentioned above, *description and publishing, finding* and *discovery* and *binding* are the underlying principles of the SOA framework.

Description and publishing: Service providers have to provide a precise description of the services and the mechanisms by which they are accessed and publish their services with the broker or central registry.

Finding and discovery: A service requester or customer looking for a particular service does so by putting out a request for the service providing a precise description of the service. This could be responded to by the broker or central registry or alternatively by the service provider directly.

Binding: Calling or invoking a service such as *GetLastUKTradePrice*. This invocation will be transmitted over the network and bring the answer or delivery of the service to the customer or service requester.

1.8.2 Web Service

Traditionally, e-business is carried out through the use of a *Web application* to handle the communication between the provider and the consumer. Users need to provide some input to the Web application in order to get the result from the provider. There is no problem if one is working with only one provider. However, consumer requirements have become more and more complex and dynamic. Dynamic e-business has been emerging as a new phase of e-business development [20]. Essentially, dynamic e-business requires an infrastructure to integrate several providers in order to supply such a superior service [21]. In other words, we need a platform for automating both the provider and customer ends of the transaction [22].

In recent years, *Web services* have emerged with important underlying features, such as interoperability and loosely coupled models. Web services use a *service-oriented architecture*. Using a Web service, one can automatically invoke applications running in other businesses. Multiple applications communicate with each other regardless of the platforms on which they are. Therefore, by means of Web services, the company can effortlessly link its applications with those of its partners, customers and suppliers . However, Web services do not tend to replace the traditional infrastructures. Indeed they are complementary in order to offer the services. Thus, we clearly see that Web services are one of the key mechanisms that represent a significant advance in the e-business of the future [23].

The primary focus of this book is ‘trust’ and ‘reputation’, and not ‘Web services’. However, there is a large amount of material available about Web services. Here, the authors would like to refer readers to a very easy to read and content-rich book on Web services [24], or to the W3 website at www.W3.org/TR/wsa-reqs, for more details on Web services.

Measuring or rating the quality of *goods and services* is important in modern service-oriented environments. It is reshaping the world of e-business by providing *trusted business* processes and the reputation of services and service providers. The next generation of the Internet must have some degree of control over business conduct in the Internet through measuring or rating goods and services and agents.

1.8.3 Web Service as Software Technology

Defining the term 'service' is the key to clarifying *Web services* in the technological sense.

Service in software or object-oriented systems is defined as a *method, process* or *communication* within an application or software. These 'services' or 'methods' are operations of the application that target some business need.

Web services, a specialized term, is defined as a middleware technology that offers standard communication interfaces that allow ease of communication between heterogeneous applications over the distributed network environment. Web services provide *inter-application* operability, inter-organization collaboration and business integration to achieve wide commercial objectives.

There are many technical definitions of Web services in the literature, not all of which are consistent with each other. A good working definition is provided by Web Service Activity Group of the W3C, which defined a Web service as '*a software application identified by a URI, whose interfaces and binding are capable of being defined, described and discovered as XML artefacts. A Web service supports direct interactions with other software agents using XML-based messages exchanged via Internet-based protocols'* [25]. There are several key features here, namely, that the application is open and capable of being defined, described, discovered and interacted with by external software agents; and that it uses standards-based interfaces that rely on XML messaging. Currently, these include XML, SOAP, WSDL and UDDI [29] standards. These are briefly described in the following text:

XML provides declarative semantics to the data through the use of tags for the data.

SOAP specifies the communication message format that defines a uniform way of passing XML-encoded data [26]. The SOAP messages support '*publish, bind* and *find'* operations for a services-oriented architecture. SOAP lets an agent or application invoke another agent or application by using an XML message over the Internet [27].

WSDL is known as *Web Services Description Language*. It is used for describing the services available in the broker or in the service registry (for service publishing and finding). It gives the location of a *Web service*, the functions and operations of the service and their data type information. From the *service provider's* perspective, they use WSDL to describe what services they can provide in order for other people to find their services and use them. From the *service requester's* point of view, they use WSDL to describe what service the requesting agent is looking for.

UDDI is known as *Universal Description, Discovery and Integration* [28] (for service publishing and finding). It provides three main and crucial functions:

1. It collects all the services available on the network to the *service broker* or *central registry*.
2. It then acts like *Yellow Pages* in that it clusters similar services under similar headings for the clusters and lists them individually.
3. Then, it provides publish/find functions for service providers and service requesters/customers.

Therefore, UDDI provides **u**niversal common **d**escription of services and allows search, query, **d**iscovery or the ability to locate the services and enables run-time or automated dynamic binding or **i**ntegration between the service requester and service provider.

Services are carried out by sending messages and communication between the agents. A tailored Web service protocol is known as *Web Service Protocol Stack,* and this has four functional layers that offer the following (Figure 1.10):

1. Sending messages between agents or applications via HTTP. This layer is called the *Transport Layer*.
2. Encoding messages into XML format so that the messages can be understood by all agents in the *Web Services* environment. The commonly used protocol is Simple Object Access Protocol (SOAP) . The tailored name for this layer is called *XML messaging*.

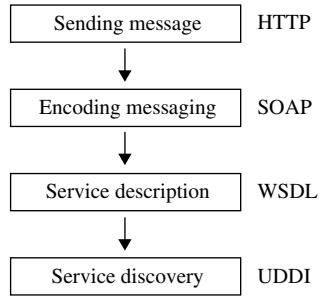

Figure 1.10 Web service protocol

3. Describing the services available in the service registry with WSDL in XML vocabulary. This layer is called the *Description Layer*.
4. Querying the broker or registry and obtaining service information, support interaction and negotiation between the agents and application and the facilitation of dynamic binding, through UDDI. This layer is called the *Discovery Layer*.

The above use of the term 'service' appears to be borrowed from the business term. Fundamentally, the purpose of IT is for business, not for IT itself. In companies, we often have business units telling us 'We do not want technologies, we want business solutions'. This viewpoint should impact on how we perceive Web services. Should we stop at the technology level, or lift its potential to incorporate the business sense? If so, Web services and the SOA will have more influence in the business world.

Despite the popularity of the *SOA, Web services* have not been widely adopted in inter-organizational situations. We believe one factor is the limitation of its use in technology environments rather than in business environments.

It is important to note that *not* all the *Web services* need to use the Web. For example, in the intra-organization communication situation, most companies have heterogeneous software components within the organization that *do not* talk to each other, or *do not easily* talk to each other. By adopting Web service technology, old legacy systems are wrapped with a Web service interface (standard interfaces). These *heterogeneous* software components now become *homogeneous* software components. For example, all of them use XML as the communication medium. Intra-organization applications can now be seamlessly integrated. In this situation, the organization uses Web-service technology without the Web. It is also conceivable that not *all* services (business) on the Web are based on Web services (technology). Because of the specialized definition of Web services, we hope the technology will evolve and the two separate terms designating services (business and technology terms) will progressively coalesce because they both ultimately should serve business and commercial needs.

1.8.4 Web Service as a Business Solution

Since the introduction of the term *Web services*, we must begin to distinguish between two kinds of services that exist within the service-oriented environment. One is 'service' in a real business sense, and the other one is 'service' from a technology point of view. However, if we think about what technology is used for, it is not hard to integrate the two kinds of service perspectives into one, because the purpose of the technology is not for technology itself, but for business. Therefore, it is wise to understand the linkage between the technology term of 'Web services' and real-world business service.

Web services provide a state-of-the-art middleware service that enables different business applications from different business organizations across the Internet to work together to achieve seamless information exchange and business transactions over the distributed environment. It provides dynamic and automated application integration service via the following:

- Standard homogeneous interfaces
- Standard computing languages
- Standard communication protocols.

These allow an organizational application to invoke or to be invoked or to be discoverable and accessible across the Web to carry out business services.

Even though, the service broker is centralized (Figure 1.11(a and b)), the inter-company communication is distributed and works in a peer-to-peer communication fashion (Figure 1.11c). Figure 1.11 (a–c) show how Web services achieve a service-oriented architectural framework for business.

We can view Web services as business solutions because they utilize an SOA. Web services are loosely coupled, cost beneficial, provide ease of use, privacy and security protection, help in the creation of a trusted community, automation and intelligence as well as reshaping of IT application development methodologies.

Loosely coupled: Traditional middleware is centralized. Only one of the business organizations involved needs to install it. For Web services, only the broker is centralized, while the actual binding of services is distributed and there is no need for a fixed connection (Figures 1.11(a–c))

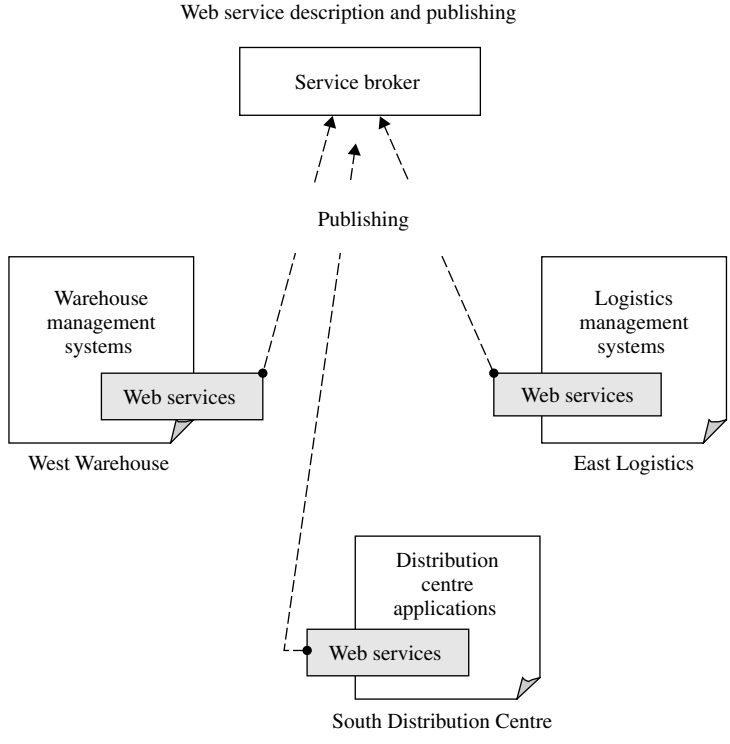

Figure 1.11(a) Service providers can publish their *business services* through *Web service*s (a standard interface) to the service broker

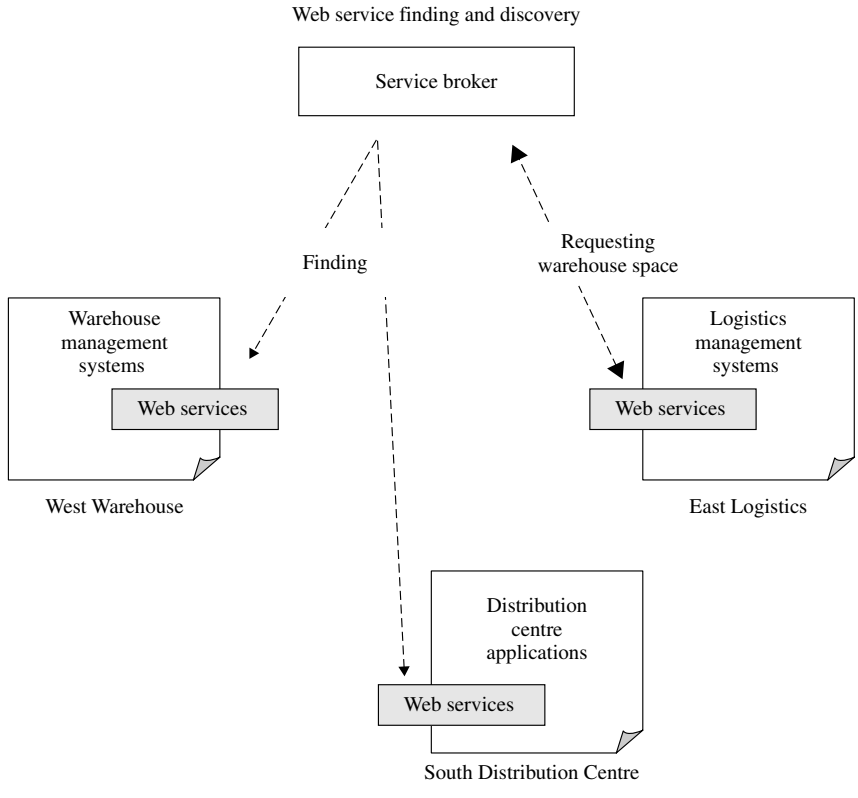

Figure 1.11(b) Service requester (East Logistics) sends a *request* for special services to the broker and the broker helps *find* the suitable service providers

Cost beneficial: Historically, the distributed application integration is achieved by using different middleware or different application brokers. This is acceptable for a closed community, where few organizations are partners, and business is carried out only between them. However, since the Internet provides much wider business opportunities, one organization may have to use a number of different middleware to integrate with another organization's applications and the development is costly. Web services avoid this.

Ease of use: Web services are standardized and published over the Web and all organizations have an equal chance to learn and use them. This is different from the use of other kinds of middleware, as here you only need to learn one.

Privacy and security protection: Web services provide multiple standardized middleware interfaces, and every organization has one. When communication takes place there is no centralized control. Unlike traditional middleware (e.g., a B2B broker that is centralized and several organizations use one middleware), whoever has it will be able to tap into the middleware and monitor the system-wide communication and transactions (Figure 1.12(a and b)). This creates a concern for organizations about their privacy and security, especially data security and their protection.

The creation of a trusted community: Since Web services are loosely coupled and there is no central control, it permits the use of the P2P communication model. There is no concern about where a middleware has to be located or who should have the middleware with the potential advantage that this might bring. It creates trust between companies because Web services are not centralized middleware.

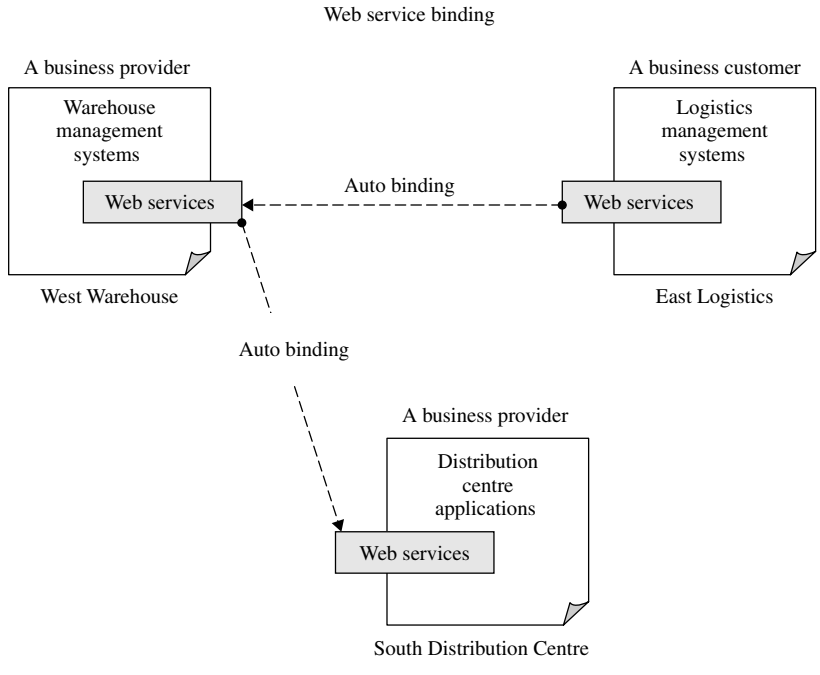

Figure 1.11(c) Binding *business services* via *Web services*

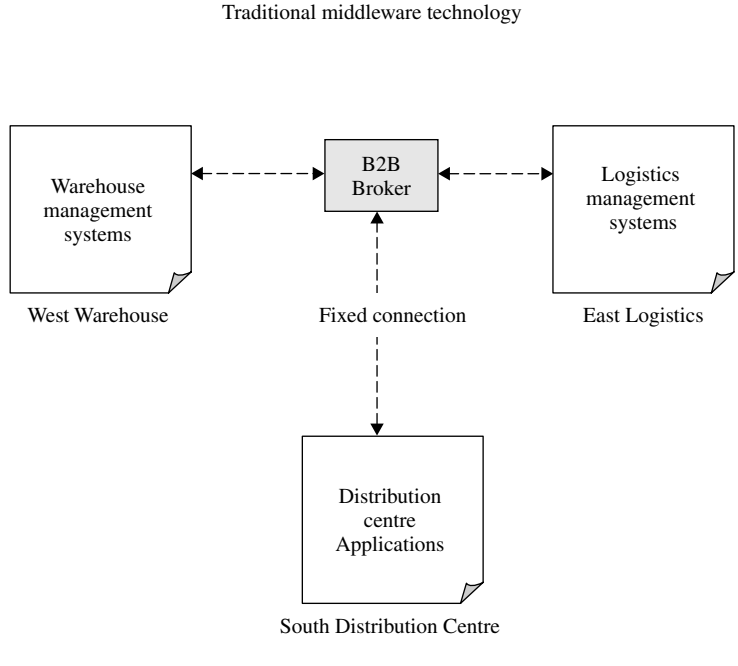

Figure 1.12(a) Traditional middleware technology only one middleware, and location of it has to be decided

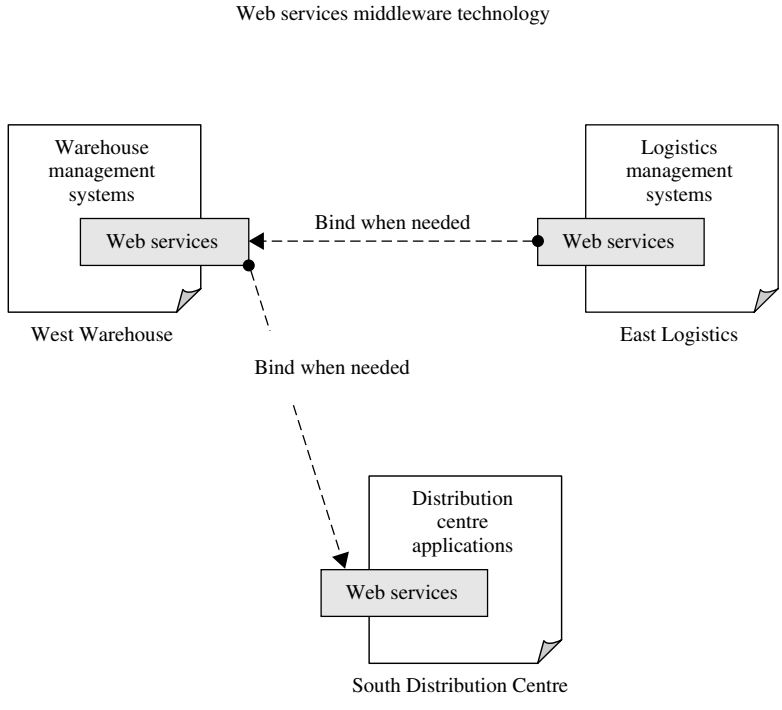

Figure 1.12(b) Web service middleware technology with *multiple* homogeneous interfaces

Automation and intelligence: Each service is an autonomous agent and is able to respond to enquiries and accomplish the task automatically and independently.

Reshaping the IT application development methodologies: The advances in SOA are reshaping IT application development and design by considering everything as services, rather than as objects or entities or procedures or functions. This is a big step towards business and IT integration.

1.9 Trust in Service-oriented Environments

A Web services broker has a strong client–server flavour. The Web service requester and provider, on the other hand, can communicate in a P2P communication fashion. Alonso *et al*. [24] state that *'Peer-to-peer interactions are likely to be the accepted interoperability paradigm for business in the future. Web services are indeed a natural solution to the standardization problem. Web services enable a company to open its IT infrastructure to external partners. Web service technology is still evolving and the ultimate goal is to provide the infrastructure for business transactions, sales and services to take place over the Web'*.

The goal of Web services is to allow automated clients to browse the service registries, find adequate services and service producers, and automatically discover how to interact with the service, and finally invoke the service. All of this is done automatically without human intervention. Simple Object Access Protocol (SOAP), UDDI and Web Services Description Language (WSDL) form the basic infrastructure. Through continuing development and enhancements of Web service technology, it should become a reliable platform offering all the necessary functionalities for electronic commerce and e-business. Through a rich and structured descriptive language, the use of a business ontology (ontology is agreed and shared knowledge) and yet additional layers of software, it should be possible to entirely automate the discovery and interaction among Web services and business operations [24].

The service-oriented environment is an unstructured open community environment. The trend has resulted in a move from a small closed community involving direct interaction and static binding towards open indirect and dynamic interaction. In such an environment, trust and QoS are major concerns. Introduction of trust and trustworthiness technology including recommendation and rating systems provides some degree of control and QoS. These rating systems address the QoS and give buyers aggregated information about the provider, and provide some degree of reliability and assurance. Measuring trust, prediction of trust and rating and certifying services as well as sellers or providers facilitates the dynamic service selection process. The actual service is directly invoked by calling the selected service provider.

1.10 Chapter Summary

In this chapter, we discussed the following:

- Why trust is important to e-business
- The difference between trust and security
- What is a service-oriented network environment?
- Issues in service-oriented environments
- The components in service-oriented environments
- The technology in service-oriented environments
- The infrastructure in service-oriented environments
- What are agents, buyers, sellers, customers, users, website, products and services?
- What is Quality of Service (QoS) and quality of products?
- The service-oriented architecture
- Web service as a technology.

Unlike the traditional e-commerce platform, the new set of *trustworthiness technologies* and *systems* for service-oriented environments is reshaping business intelligence through building trust relationships with end-users and consumers, learning from customers and competitors and improving customer service and business performance through creating trust, reputation and consumer confidence. The new set of technologies provides a platform for sellers, service providers, websites, manufacturers, business partners, customers, buyers and end-users to learn from each other about their trustworthiness and reputation.

From a service provider's point of view, such an automated system would assist business in finding out what customers/consumers really want, finding both their likes and dislikes, and taking customer's/consumer's input as an opportunity to improve the relationships with them.

From a consumer's point of view, such an automated system provides for online sensations such as being able to 'squeeze the tomatoes before you buy' or enables them to seek other opinions before they undertake a deal or make a transaction.

The adoption of such a technology and systems becomes more and more important in today's e-business, as many large sites have already started utilizing a portion of the technology. It is such an important technology that every online business and service provider will have to take advantage of it to maintain his or her competitiveness. This is because it may provide the necessary technology to improve customer service, to boost consumer confidence and to help with a business's reputation. It may also enhance consumer learning and facilitate them to seek the best value online. In this chapter, we have provided an introduction to the service-oriented network environment and some of the issues it brings up in terms of trust, trustworthiness and reputation of agents, products and services. We also distinguish these ideas from the more familiar one of security.

In the next chapter, we introduce the basic concepts and model for trust.

References

[1] amazon.com. (2004) *Web Service*, Available: [http://www.amazon.com/gp/browse.html/103-6530699-8373443?node=3435361] (Aug 24, 2004).

[2] Hassler V. (2001) *Security Fundamentals for E-commerce*, Artech House.
[3] Algesheimer J., Cachin C., Camenisch J. & Karjoth G. (2000) *Cryptographic Security for Mobile Code*, IBM Research, Zurich, Switzerland.
[4] Carrol A., Juarez M., Polk J. & Leinger T. (2002) '*Microsoft Palladium': A Business Overview*, Microsoft whitepaper, June 2002. http://www.microsoft.com/PressPass/features/2002/jul02/0724palladiumwp.asp.
[5] Swearingen K. & Sinha R. (2002) 'Interaction design for recommender systems'. In *DIS 2002*, ACM Press.
[6] Tomoya K. & Shigeki Y. (2003) 'Application of P2P (Peer-to-Peer) Technology to Marketing', in *Proceeding of International Conference on Cyberworlds (CW 2003)*, Singapore pp. 1–9.
[7] Parameswaran M., Susarla A. & Whinston A.B. (2001) *P2P Networking: An Information-Sharing Alternative*, *http://crec.mccombs.utexas.edu/works/articles*.
[8] Schneider J. (2001) *Convergence of Peer and Web Services*, Available: [http://www.openp2p.com/lpt/a/1047] (Oct 6, 2004).
[9] Tsaparas P. (2004) *P2P Search*, Available: [www.cs.unibo.it/biss2004/slides/tsaparas-myP2P.pdf] (3/10/,2004).
[10] Foster I., Iamnitchi A., (2003) On death, taxes, and the convergence of Peer-to-Peer and grid computing. *Proceedings of 2nd International Workshop on Peer-to-Peer Systems (IPTPS'03)* Springer-Verlag LNCS 2735, pp. 118–128.
[11] Napster. (2004) http://www.napster.com/ntg.html.
[12] Roure D., (2003) Semantic Grid and Pervasive Computing *GGF9 Semantic. Grid Workshop*, Chicago, pp. 70–76.
[13] Berman F., Fox G. & Hey T. (2003) *Grid Computing – making the global infrastructure a reality, (eds book)*, Wiley, pp. 1000
[14] Gannon D., Ananthakrishnan R., Krishnan S., Govindaraju M., Ramakrishnan L. & Slominski A. (2003) Grid web services and application factories in Berman F., Hey A. & Fox G. (eds.) *Grid Computing – Making the Global Infrastructure a Reality*, John Wiley & Sons, pp. 251–264.
[15] Weisman C. (2002) *The Essential Guide to RF and Wireless*, 2nd ed, Prentice Hall PTR.
[16] Toh C.K. (2001) *Ad Hoc Mobile Wireless Networks: Protocols and Systems*, Prentice Hall PTR.
[17] ITU. (2003), http://www.itu.int/home/.
[18] Alcatel, (2004), *Mobile Network Evolution: From 3G Onwards'*, http://www.bitpipe.com/detail/RES/1074104543_898.html.
[19] Roy J. & Ramanujan A. (2001) Understanding web services, *IT Professional* vol. 3, no. 6, pp. 69–73.
[20] Xiao Feng J., Junhua X., Hua Z. & Zuzhao L. (2003) A realizable intelligent agent model applied in dynamic e-business. *Proceedings of the 2003 IEEE International Conference on Information Reuse and Integration, IRI 2003*, Las Vegas, NV, USA http://ieeexplore.ieee.org/xpl.
[21] Huy H.P., Kawamura T. & Hasegawa T. (2004) Web services gateway – a step forward to e-business, in *Proceedings of the IEEE International Conference on Web Services (ICWS'04)* San Diego, California, USA.
[22] Aissi S., Malu P., Srinivasan K (2002) E-Business process modeling: the next big step, *IEEE Comput* **35**(5), pp. 55–62
[23] Cruz S.M.S., Campos M.L.M., Pires P.F. & Campos L.M. (2004) Monitoring e-business web services usage through a log based architecture, in *Proceedings of the 2004 IEEE International Conference on Web Services (ICWS'04)*. San Diego, July 6–9, pp. 61–69.
[24] Alonso G., Casati F., Kuno H. & Machiraju V. (2004) *Web Services: Concepts, Architectures and Applications*, Springer, Berlin.
[25] W3C. Web Services Architecture Requirements Oct 2002, http://www.w3.org/TR/wsa-reqs.
[26] Cerami E. (2002) *Web Services Essentials*, O'Reilly & Associates, Inc, Sebastopol.
[27] Hess D. (2002) *Simple Object Access Protocol (SOAP) and Web Services: An Introduction*, *Gartner*.
[28] Universal Description, Discovery and Integration. *(UDDI)* 2000 (2004) Available: [http://publib.boulder.ibm.com/infocenter/wsphelp/index.jsp?topic=/com.ibm.etools.webservice.consumption.doc/concepts/cuddi.htm] (Sep 10, 2004).
[29] Alston J., Hess D. & Ruggieo R., (2002) *Universal Description, Discovery, and Integration (UDDI) 2000*, Gartner.
[30] *What is ad-hoc network*. (2003) Available: [http://whatis.techtarget.com/definition/0,289893,sid9_gci213462,00.html] (7/10/2004).