Dynamic Collaboration of Businesses Using Web Services

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ABSTRACT This paper describes the trends of Web service technologies that support 'Dynamic Collaboration.' For the realization of collaboration in business, five important features are shown: (1) connectivity and interoperability, (2) security and safety, (3) robustness and reliability, (4) dynamism, and (5) contract. There are various specifications proposed on Web services and ebXML, which is a complementary technology of Web services. This paper categorized these specifications into the above features, and gives a brief explanation of each technology.

KEYWORDS **Web services, SOAP, WSDL, UDDI, ebXML, Security, Reliability**

1. INTRODUCTION

Before the Internet became popular, communication between enterprises used a leased line service provided by common carrier. In those days, the enterprise communication was conducted by and limited to a small set of large companies, such as banks and chain stores, which had tight and strongly contracted relationships.

This situation was drastically changed when business began to use the Internet as communication media. In the 1980s, students in the universities began to use electronic mail and news mainly for information interchange for their research, and then enterprises also accepted the use of e-mail in their business. In the late 1980s, business began to use e-mail as advertisement media. After a while, WWW appeared in the mid 1990s, and students arranged their own pages for introducing their research using HTML documents. In the beginning of the WWW, Web pages were written statically in HTML, and then changed to be automatically generated from applications or databases. Since security protocol over HTTP, such as HTTPS, was developed, business transactions have been common in WWW, and many pages have been created for business activities, such as online shops, auctions, and market places. At present, various kinds of business are engaged in WWW using Web browsers for accessing remote contents, although a few use data transfer through the Internet. At the moment, Web services have been developed for more easy data communication and remote invocation of services through the Internet.

Web services are technologies based on service oriented architecture, which connects loosely-coupled services in a network by using, mainly, SOAP[1], which is an XML-based messaging method. The biggest advantage of using Web services is utilizing the Internet not as information interchange media for human beings, but as service network or data access network for systems. Web services enable data communication between enterprises to migrate from a leased line service to the Internet, and enable a variety of business with a variety of companies on demand — that is, 'Dynamic Collaboration.'

Although Web services are expected to raise network connectivity between enterprises and support business based on the concept of 'Dynamic Collaboration,' there are some concerns about security and robustness of the services. It is required for Web services to be more secure, safe, and robust, as they aim for the realization of Internet business using open network environments, which are sometimes instable and fragile.

This paper describes the trends of Web service technologies which support 'Dynamic Collaboration,' breaks them down into five categories, and also introduces NEC's activities relevant to Web services. Section 2 classifies Web service technologies from the aspect of requirements for enablers of 'Dynamic Collaboration.' Section 3 explains the trends of Web services in accordance with the categorization described in Section 2. Section 4 gives an outline of ebXML, which stands for Electronic Business Using eXtensible Markup Language[2], as a complementary technology of Web services. Finally, Section 5 discusses future issues.

2. REQUIREMENTS FOR THE REALIZATION OF DYNAMIC COLLABORATION

The term 'dynamic' possesses various meanings, such as on-demand, real-time, optimal, wide-ranging, and so on. With the diversity of the meanings of

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'dynamic,' 'Dynamic Collaboration' symbolizes a business concept which aims at the realization of collaborative business in various manners, on various levels, in various time ranges, and with various partners. Dynamic service collaboration, to which the term 'Dynamic Collaboration' directly refers, is an inherent function of Web services, and Web services is expected to be one of the key components for realizing the concept. This section examines the features of Web services required for a technology which supports the realization of the business concept. The features are categorized into five, as follows.

(1) Connectivity and Interoperability

It is a minimum requirement that services are connectable to the partners through the Internet, even though the partners may have completely different systems on different servers under their respective conditions. Conformity to the specification might not be enough to guarantee connectivity, but the interoperability verifications between actual systems might be required.

(2) Security and Safety

It is necessary to pay adequate attention to security and safety, since using an open network like the Internet involves many security risks. Not only are encryption and signature of messages important, but authentication, authorization, and trust technologies are also very important. Privacy protection is another focal point of technologies, since convenience for the users must be given the highest priority.

(3) Robustness and Reliability

People sometimes have experience of finding access failures of Web pages and retrying them many times, while accessing the Internet with browser. Such failure is more critical to Web services, since the Web services send and receive business data in the background. Thus, mechanisms of automatic retry and duplicated message elimination are critical functions in message-level stability. Additionally, system-level stability is required for the Internet systems, since they cannot stop their work at any time, even during the night.

(4) Dynamism

In order to collaborate with suitable business partners, discovery services are used to ascertain their services and business background. The discovery services provide two functions in these situations; one is for people to find business information good enough to select their partners, and the other is for systems to find exact locations of the services at run time.

(5) Contracts

Before executing business, companies usually need some kind of contract with each other. Some are related to legal conditions, and others are related to system-level conditions, such as communication requirements, security requirements, business protocols, and so on. These contracts make business collaboration smoother.

Although there exist other relevant technologies, such as exchanging semantic descriptions of their services, managing common ontology, and service-level agreement, this paper focuses on the above five features.

3. TRENDS OF WEB SERVICES

Web services are component-based services spread through the Internet. The concept of Web services comes from a service-oriented architecture, in which three actors such as service provider, broker and consumer work together. The basic technology standards of Web services are SOAP (Simple Object Access Protocol, as the previous name), WSDL[3] (Web Services Description Language), and UDDI[4] (Universal Description, Discovery and Integration). **Figure 1** shows the service-oriented architecture and Web service technologies. The service collaboration scenario is as follows. First, a service provider implements his service and then generates an interface definition of his service, represented in WSDL. After that, the provider restores the WSDL document into a location, which is accessible from the Internet using URL, and

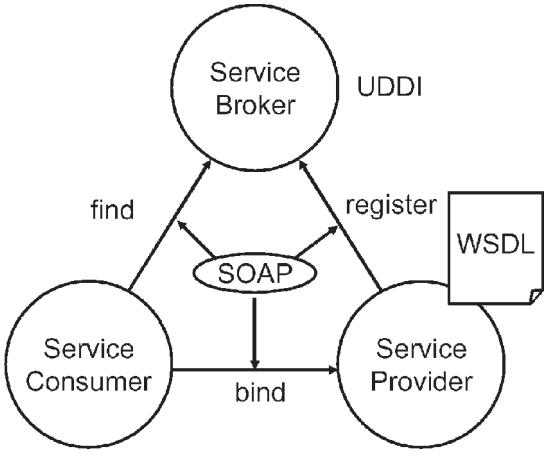

Fig. 1 Service oriented architecture.

registers his business and service description, and the reference to the above location, into a service broker, such as UDDI. A service consumer looks up a service at the UDDI, and gets the WSDL document. Finally the consumer generates a client program for accessing the service, and directly invokes the service. In most cases, SOAP is used for registering to the UDDI, looking up at the UDDI, and invoking services.

In addition to the basic standards, various kinds of extended protocols are to be proposed. The main standardization bodies of Web services are W3C (World Wide Web Consortium), OASIS (Organization for the Advancement of Structured Information Standards) and WS-I (Web Services Interoperability Organization). Additionally, a business alliance of Microsoft, IBM and BEA for designing composable Web services specifications[5,6], and Liberty Alliance Project[7], which specially focuses on identity management such as authentication federation and privacy protection, and other committees are working to make relevant specifications. The remaining parts of this section introduce some of them, classified into the five categories.

3.1 Connectivity and Interoperability

Connectivity and interoperability between different systems are eminent features of Web services. These features mostly come from WSDL and SOAP.

WSDL is a service interface definition language for Web services. The WSDL document defines data types of service parameters and return values, message organizations, operation combinations, bindings to underground messaging protocols, and service endpoints. WSDL 1.1 is currently wide in use, and W3C is making a new version of WSDL, such as WSDL 2.0, whose working draft is now open to the public.

SOAP is a common messaging protocol for Web services. SOAP is independent of underground transport protocols. For example, we can use HTTP, HTTPS, and SMTP as transport, but most cases, however, use HTTP or HTTPS, which is a secure version of HTTP. Data in SOAP are represented in an XML document, called SOAP envelope. The envelope has two child elements; SOAP header and SOAP body. The SOAP header is an area for storing extended protocols such as encryption, signature, transaction control. The SOAP body is an area for storing a messaging body which might be a combination of a service name and parameters when calling, and return values when returning. Fault information of service invocation is also returned in a SOAP body. A widely-used version of SOAP is SOAP 1.1, and SOAP 1.2 is newly proposed by W3C.

It is often said that SOAP over HTTP can easily go beyond a firewall of networks without changing network managing parameters and policies, but this definitely depends on the messaging direction. SOAP messages can deliver from the inside of the firewall to the outside, but not vice versa. Those wishing to receive inbound messages of SOAP must set a proxy or open a port of communication at their firewall. Keeping such network management is hard for medium and small size companies. In such a case, SOAP over SMTP is a promising candidate for adoption.

Although it is said that Web service technologies are independent of system hardware, software and programming languages, there exist incompatible problems between different software vendors' products, since specifications of the technologies have many options for implementation, and also have ambiguity and inaccuracy. WS-I was founded to resolve interoperability issues in Web services in such a situation. In August 2003, WS-I published a Basic Profile 1.0[8], BP 1.0 in short, as a basic interoperability guideline. BP 1.0 refers to widely-used Web service specifications, such as SOAP 1.1, WSDL 1.1 and UDDI 2.0. It resolves ambiguous descriptions in these specifications and defines interoperable regulations between the specifications. For example, one of the biggest problems in SOAP 1.1 was that SOAP was designed before XML Schema was completed, so that SOAP adopted original data encoding schema, so called SOAP encoding, rather than XML Schema. This nonstandard way of encoding caused confusion in implementation of SOAP products. To resolve the encoding problem, BP 1.0 prohibits use of SOAP encoding, and enforces use of XML schema as an extensible data schema language. Software providers have been announcing new products which support BP 1.0, and NEC announced that ActiveGlobe WebOTX supported BP 1.0. Situations of interoperability are improving.

3.2 Security and Safety

Although HTTPS is a basic security infrastructure of the Internet for protecting data on the wire against peeping and changing by others, there remain security problems, such as that this protection is not permanently effective for data, but only effective for on-the-wire data, and the data can be peeped at in the intermediary node. XML signature[9] and XML encryption[10] were developed to protect XML documents permanently. XML signature guarantees integrity of the documents, and provides non-repudiation capability to users. On the other hand,

XML encryption provides confidentiality of the documents. A special feature of XML signature and XML encryption is that those security operations can be applied to a document in whole or in part. Using this feature, we can control who can see each part of a document, or we can compose a document whose parts are signed by respective persons who are responsible for the parts. It enables fine-grained privileged control.

WS-Security[11] enhances SOAP messaging to provide message integrity, using XML signature and XML encryption, and also provides a mechanism for associating security tokens, like SAML assertion[12], with messages. These extensions are put in SOAP headers.

In case of dynamic collaboration, plural enterprises might join in a project, in which a new business activity is starting. In such a case, critical issues of security are not only encryption and signature, but also account management, authentication, authorization, and access control. Liberty Alliance Project has worked on these issues. The technological target of this project is identity management, in which authentication federation and privacy information exchange mechanisms are specially considered. Specifications of the first phase of the project focused on authentication federation, such as single sign on. These specifications were submitted to Security Services TC, which are working on making SAML 2.0 specification. In November 2003, Liberty Alliance Project announced it would publish the specifications of the second phase. These new specifications refer to privacy information exchange protocols using Web services. As a future plan, the project will define common personal services, such as presence, wallet and geolocation services.

On the other hand, Microsoft, IBM and BEA published a roadmap document of security and reliability[5,6]. In the roadmap, several key specifications for extended Web services protocols were introduced. WS-Federation[13] is one of the specifications, and refers to authentication federation, which is similar to that of Liberty Alliance. Identity management is a very hot area, so it is hard to know how to merge these technologies into a single common technology.

3.3 Robustness and Reliability

The base of 'Dynamic Collaboration' should be the Internet, since flexibility is a first priority requirement of the collaboration. However, the Internet is not so stable since it often fails to connect to services. Web services also use HTTP in the Internet, so a protocol for guaranteed message delivery is essential.

There is a reliable message delivery protocol, called WS-Reliability[14] conducted by OASIS. This specification defines automatic retry of messaging at the sender side when no acknowledge message is received in a certain time, elimination of duplicated massages at the receiver side, and guaranteed message order.

Grid computing is a technology for enhancement of service stability and availability. The technology virtualizes and manages resources, such as computation, storage, and communication bandwidth, in order to provide a framework of continuous computation at system down, overloaded capacity, or in case of disaster striking. Global Grid Forum, which is a major standardization body of grid computing, proposes Open Grid Service Architecture[15], called OGSA in short. The architecture is based on Web services. Open Grid Services Infrastructure, called OGSI in short, is a base of OGSA. It provides a function of Grid service creation, a service locator, and so on. Additionally, security or operation managing services are constructed on the infrastructure for realization of highly available and highly reliable services.

3.4 Dynamism

UDDI plays two roles in Web services. One is for looking up partners and their services by hand-operated, and another for a run-time naming service for finding a service endpoint. The former is similar to search engine sites of WWW, and the later is similar to DNS.

The newest version of UDDI is 3.0. This version strengthens business-use functions. First, a single registry with multiple nodes is specified. The data replication keeps several nodes to have the identical data. These nodes with replicated data might work valuably, when continuous services are required, but some of the nodes are broken down. Second, UDDI version 3.0 supports a subscription function, which enables clients to get notification from servers when questionable data are changed. The subscription can be used to manage hierarchical registries, in which changes in superordinate registry are delivered to subordinate registries. Third, UDDI version 3.0 supports XML signature. Services registered with XML signature in UDDI can be certified by their identity using their issued certification and signature, and then it totally raises reliability and trust. ActiveGlobe WebOTX UDDI Registry supports UDDI versions 2.0 and 3.0.

3.5 Contract

WSDL is a kind of contract, since this defines an

interface for invoking services between enterprises. In addition to WSDL, business processes or protocols are required for businesses to collaborate smoothly with each other. BPEL4WS[16], which stands for Business Process Execution Language for Web Services, is a recent technology for representing business process. This language can be used for two purposes; one for executable process definitions, and the other for abstract process description which defines business protocols between enterprises. Activities in a process are Web services, represented in WSDL, and the process integrates these activities and generates a higher-level Web service. ActiveGlobe BizEngine/BP supports BPEL4WS.

OASIS conducts WSBPEL TC, which is the Web Services Business Process Execution Language TC and is going to specify BPEL4WS, while W3C conducts WS-Choreography WG, which is going to specify a business protocol definition language, which is similar to BPEL4WS. The differences and similarities of these specifications are shown in reference [17].

WS-Policy[18] is a wide-use language for declaratively describing the conditions or properties of Web services. WS-SecurityPolicy, for example, is a derivative language that can describe security requirements.

4. OVERVIEW OF ebXML TECHNOLOGIES

The ebXML initiative was founded in 1999 as a joint project between UN/CEFACT and OASIS to establish XML/EDI standards. After 18 months' work on standardization, they published the first version of ebXML specifications in May 2001. The specification involves two views; BOV is a Business Operational View, and FSV is a Functional Service View. The former includes common business object and business process language, and the latter includes messaging protocols and their agreements. At the beginning of the project, messaging was designed independently of SOAP, but after SOAP became popular, messaging specification was substantially rewritten based on SOAP. The ebXML should be used in a relatively stable data communication area, like catalog exchanging and ordering.

4.1 Connectivity

The BOV of ebXML specifies a framework of common core components of business documents (CC: Core Components) and core business processes of business scenarios (BPSS: Business Process Specification Schema), and gathers and stores instances of such components and processes into a repository. These outputs help us to design interoperable business XML documents, and business protocols.

Message Service Specification Schema, MS in short, defines protocol and structure of messages in the ebXML, which is based on SOAP with Attachments. Various properties for business communication, such as sender, receiver, message ID, conversation ID, CPA ID, and signature, are stored in the SOAP header part. The business documents are stored in attachments, and the references to the documents are stored in the SOAP body part. Any kinds of business documents, including XML documents and binary-data files, can be attached to the ebXML messages according to the business requirements.

Interoperability tests are actively operating in this area. The ebXML IIC (Implementation, Interoperability and Conformance) is a committee in OASIS, and is going to define interoperability specifications. ECOM (Electronic Commerce Promotion Council of Japan), which promotes the ebXML to the market in Japan, conducts interoperability WG, which published interoperability guideline documents, including how to use ebXML messaging and how to test interoperability. This activity expanded to Asian countries, and the ebXML Asia Committee, which is a regional committee to promote ebXML in Asia, started a certification program of ebXML interoperability. The ebXML Asia Committee conducted an interoperability event in early 2003. 14 companies and organizations, including NEC, participated in the event, and succeeded in verifying the interoperability among their products.

4.2 Security and Safety

The specification of ebXML MS defines for messaging to use client and server authentication of SSL in the transport level, and to attach XML signature in XML document level. Unfortunately, the way to attach XML signature is incompatible with WS-Security, since the specification of the ebXML MS was published before WS-Security activity started, and WS-Security is not yet finalized. We expect to merge these specifications into a single one after finalizing WS-Security.

4.3 Robustness and Reliability

The ebXML MS supports reliable messaging, such as retrying sending massages when no acknowledgment is replied, eliminating duplicated messages, and guaranteed message ordering. Acknowledgment messages can be requested to put signature on it, so that a sender confirms that a receiver cannot

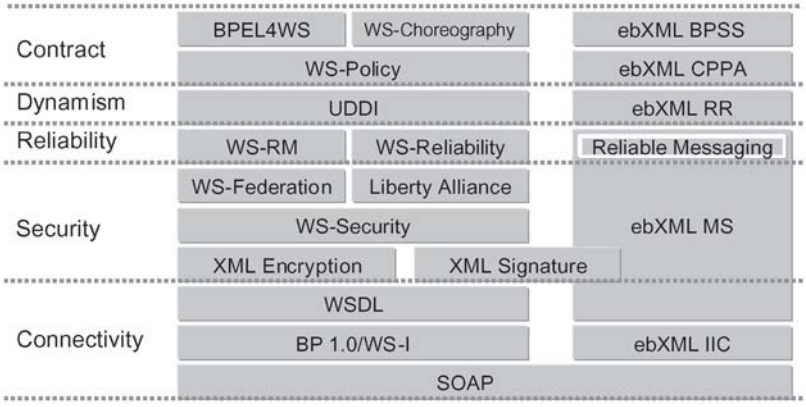

Fig. 2 Technology map of Web services.

repudiate the fact of receiving a message.

4.4 Dynamism

The ebXML has a specification of Registry & Repository, RR in short. In this repository, common core components, business processes and collaboration protocol profiles are stored. The ebXML introduces a typical use case of business when a company starts a new business. First, a person who wants to start a new business, looks up a service description which is similar to his starting business, at RR. If a similar one is already registered, he gets the description and adapts his system to it. Otherwise, he registers his business description into RR. After implementing his business, he registers his messaging profiles in a form of CPP, which are collaboration protocol profiles. A service consumer finds a partner's profile at RR, and makes collaboration protocol agreements, CPA in short, from each other's CPPs, then implements a corresponding system which communicates with the provider's system along the agreement. Finally, they start their collaborative work using the ebXML MS.

4.5 Contract

The ebXML specifies BPSS for defining business protocols, which are referred from CPP and CPA. As described in the above business scenario of the ebXML, an agreement of CPA is generated from both companies' CPPs. The CPA specifies communication parameters, like reliable messaging options, encryption algorithms, so on. Most MS implementation uses CPAs as configuration files for the ebXML messaging.

Figure 2 summarizes important technologies of Web services and ebXML, classified into five categories.

5. CONCLUSION

This paper summarizes the trends of Web services and complementary technology of ebXML, and categorizes their features into (1) connectivity and interoperability, (2) security and safety, (3) robustness and reliability, (4) dynamism, and (5) contract.

Recently, industry groups have started proposing their XML/EDI standards based on the ebXML. For example, the Distribution System Research Institute of Japan announced a new standard of XML business documents, called JEDICOS-XML, which is an update from previous JEDICOS messages, and also announced a messaging guideline for sending and receiving JEDICOS-XML messages, based on the ebXML MS and CPA.

As far as Web services are concerned, basic protocol and interoperability specifications are almost completed, but extended protocols of security and reliability are not yet completed. This area is evolving every day, and these extended specifications will be fixed in the near future.

'Dynamic Collaboration' is a conceptual word in business layer, but IT support is very important for its realization. This paper has described advanced topics in such technology areas. We hope these technologies will be helpful in incubating new business.

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