Using Web Services in TMN Environment

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Abstract

One great challenge that equipment vendors, service providers and network operators confront is how to manage and integrate the complicated telecommunication hardware, software and services in an efficient manner. The integration of TMN and CORBA has been put forward as a solution. But when disparate service providers are distributed in an Internet scale, IIOP packages can hardly traverse firewalls. Web Services, on the contrary, generally use HTTP or SMTP that is allowed by most firewalls. Hence, it’s valid to consider the use of Web Services. This paper introduces an architecture, which uses Web Services in TMN environment and thus allows different service providers to interoperate in a flexible and convenient way. Besides, software vendors and customers could also benefit from this architecture. Implementation details and a prototype system are also given in this paper.

1. Introduction

With the rapid development of today’s information technologies, Telecommunication industry has undergone great growth all over the world. New services, such as teleconference, broadband multimedia services, are appearing to meet various needs of customers. On the other hand, three multiple [1] (multi-vendor, multi-technology, multi-jurisdiction) network environments are becoming dominant. Thus, one great challenge that equipment vendors, service providers and network operators confront is how to manage the complicated hardware, software and services in more efficient manner. In other words, how to achieve interoperability at a higher level is a problem that worthies consideration.

The telecommunication management network standard developed by ITU-T suggests the use of OSI System Management (OSI-SM) to manage networks and network elements in manager-agent way. Distributed object technologies, such as CORBA, provide a framework for integration, which is both platform and language independent. Many efforts have been made to conduct research on using CORBA to solve the interoperability issues of the NML/EML layer [2]. However, in the TMN service management layer, CORBA is not particularly suitable for the integration of different services.

Key motivations for using Web Service in TMN environment are the following. Different business domain and administrative authorities must interoperate to achieve integrated service management [2]. However, these management domains usually have different enterprise policy, underlying framework, and with the protection of firewalls. These protection measures cause trouble in the interoperation with other service providers. CORBA’s dynamic allocation of address and the object reference make it impossible for IIOP to traverse firewalls [3]. Web Services, on the contrary, use standard-based Internet protocol such as HTTP or SMTP [4] that is generally allowed by most firewalls. Hence, it’s valid to consider the use of Web Services in the interoperation of TMN in an Internet scale. Besides the service providers’ interaction, vendors and service providers need to meet customers’ demands on creating new features and services promptly [5]. The characteristics of Web Services, such as XML-based, loosely coupled and coarse-grained, make it qualified for the rapid deployment of new telecommunication value-added and revenue-generating services. Last, another group of people can benefit greatly from the use of Web Services in TMN environment, that is, the telecommunication management software vendors. When software failures happen, they usually go to and fro the equipment site to locate and debug the problem. With pre designed port exposed by Web Services in different TMN management layer, it will facilitate their process of
diagnosing problems remotely, which is much more cost-effective and efficient.

In this paper, a solution that maintains the full strength of CORBA and provides a smooth migration towards using Web Service in TMN is proposed. The presented architecture allows different service providers to interoperate in a flexible and convenient way. Customers and software vendors could also benefit from this architecture.

The rest of the paper is organized as follows. Related work is discussed in section 2. Section 3 describes the integrated architecture of using web services in TMN and analyzes three specific kinds of applications. Section 4 presents details of the implementation procedure and the prototype system based on TMN, CORBA, and Web Service. Finally, section 5 closes the paper with some brief concluding remarks and future research directions.

2. Related work

The issues of interoperability in TMN environment have previously been discussed in [5]. It focuses on the Q3 interface between EML and NML layer, and proposes a programmable control architecture for Q3 interface. However, its power is limited given the fact that this approach only addressed the problems of inflexibility, without much consideration on the issues of heterogeneity and interoperability.

There are also other approaches like [6] [7] [8], which explore the use of CORBA to replace or mix with conventional TMN architecture to provide an integrated telecommunication service and network management environment. ITU-T has also adopted CORBA as a standard to solve the interoperability problems in multi-vendor environments. However, it's difficult for CORBA to seamlessly traverse firewalls, which is crucial for applications that span enterprises. Special security gateway, which adds an IIOP Domain Boundary Controller component to the existing firewall installation [3], is proposed and realized to solve the above problem. But it is inconvenient and has not been widely used.

Web Services [9] represent a general trend to simplify the integration and access of heterogeneous services on the Internet. In [10] [11], the difference between CORBA and Web Services is compared. Tentative approaches are proposed to apply Web Services to telecommunication and several usage scenarios are given.

The contribution of this paper is that we propose a TMN architecture mixed with Web Services from the viewpoint of TMN logical layered architecture and specify its usage for three kinds of purposes. Through the implementation of a prototype system, we verify the validity of the coexistence of CORBA and Web Services in TMN environment.

3. Architecture of TMN using Web Services

3.1. Architecture overview

The Web Service-based TMN architecture, as shown in Figure 1, is not a totally replacement of current distributed object technologies, but a mix model with all of them. Various levels of abstraction in TMN are
achieved through arranging network management functions into five different management layers [12]. This architecture only subsumes four of them, namely, network equipment, element management, network management and service management. The basic framework is consistent with TMN logical layered architecture. It consists of multi-vendor’s network element, different network operator’s network management system for managing the telecommunication network, and disparate service provider’s service management system to offer and some value-added services to customers.

Each equipment vendor provides its own element management system that usually makes use of proprietary protocol to operate and manage the network element. In the higher level of network management system, the problem of integrate different vendor’s element management system appears. According to legacy experience, the management interfaces between the NMS and EMS are Q3 interface using CMIP or IIOP protocol. Service management is logically resides above the network element and network management layers. Functions performed at this level are accounting, quality of service management, customer management and so on. Network equipment, element management system, network management system and service management system are usually built within an intranet that belongs to one specific service provider. As figure 1 illustrated, Web Services facilitate the interoperability in TMN environment in three aspects as follows.

3.2. Interoperable services between different service providers

When two telecommunication operators exchange information, for commercial and security reasons each of these operators will try to hide the internal structure of its network from the other operator, only those pieces of management information that are absolutely necessary will be exchanged. This kind of interaction usually needs to traverse the protection of firewall. Dynamic allocation of address by CORBA and the invalidation of addressing information in the object reference when crossing firewall make IIOP impossible to pass through [3]. One efficient and convenient way of solving this problem is to apply Web Services to the interoperation between different service providers.

Figure 2 displays the interaction pattern of using Web Services. Among the two service providers, one is act as “Provider TMN” whereas the other one is “Customer TMN”. At the side of “Provider TMN”, the OSF (Operation System Function) of the service management layer contains the portal exposed to potential customers. “Provider TMN” uses WSDL document to describe the interface of services. Usually an adapter between legacy system and the service implementation is needed. When services are successfully created and deployed in the web server, the “Provider TMN” notifies the “Customer TMN” about the WSDL document. The “Customer TMN” can then use this WSDL document to invoke the Web Service. Due to the relative stable characteristic of this kind of interaction, the interface is not published in public registry, on the contrary, it’s announced in advance by email or other ways to minimize the time spent on finding and discovering during runtime. The OSF in the “Customer TMN” side is supposed to develop a SOAP client as well as an adapter for connecting the legacy system with the new features developed by Web Services. The soap address is usually hard-coded in the program.

3.3 Value-added services for customers

Value-added telecommunication services are telecommunications for which suppliers “add value” to the customer’s information by enhancing its form or content or by providing for its storage and retrieval. This kind of services usually refers to on-line data processing, on-line data base storage and retrieval, electronic data interchange, email, or voice mail. Except the telecommunication operator, third parties might provide such new services by integration and reprocessing the information obtained from basic telecommunication services. So it comes to the access to the telecommunication infrastructure issues. Instead of complete and arbitrary access, telecommunication operators want to provide a limited access in controlled fashion. SOAP seems to be a natural choice to solve this problem. SOAP messages could be used to tunnel request between firewalls. And Also Web Service is
very flexible and easy to meet the changeful demands of application-specific domains.

The strategy here is to publish basic data services offered by different telecommunication operators in a UDDI Registry. Third parties query the UDDI Registry for the telecommunication services. Once located the desired services, they obtain information of the location of a WSDL document from the UDDI registry. Then, Third parties create a SOAP message in accordance with the XML schema found in the WSDL and send a request to the host (where the service is).

A typical application here is the billing inquiry services. Different telecommunication vendors provide different services to customer, such as cell phone, stationary phone, ADSL. They all need to charge money from users. Suppose that these different vendors all wrap their billing inquiry service as a Web Service, then advertising them on a UDDI Registry. Then third party providers integrate all the inquiry services as a unified personal communication charge inquiry services and provide it to users. Further, it can be developed to a common information platform, which takes charge of the payment, inquiry and so on. The realization of this kind of service is certain to facilitate customers greatly.

3.4 Diagnosing Utility for software vendors

The main objective of diagnosing utility wrapped as Web Services is to provide software vendors of the network equipment’s remote access to the OSF of different management layer. By doing so, they can diagnose and debug problems remotely when the system malfunctions, which saves money and time for reaching the site where the telecommunication management systems locate. When developing the telecommunication management software, software vendor define and implement the Web Services ports that may be useful to problem locating. The interaction pattern is very similar to the interaction between service providers. There are only two slightly differences. One is that the developer consumes the web services themselves. Secondly, software vendors keep the WSDL document without being notified by others. They send SOAP request, call the diagnosing utility remotely and try to find the reason why the malfunction happens according to the information return from the SOAP message. To go even further, an automatic testing platform can be developed through these Web Services’ ports. Software vendors can use this automatic testing platform to monitor and prevent faults.

4. Implementation of prototype system

According to the architecture of TMN using Web Services, we developed a prototype system. It's partially based on the OMC system of CDMA department, ZTE Corporation. Among the five major TMN management functionalities, we choose performance management to verify the validity of the architecture proposed above. Due to the similarity of basic principle of three different type of Web Service usage, we only realize the third type, that is, diagnosing utility for software vendors. Figure 3 shows the software infrastructure of Performance Management System in TMN that utilizes Web Services.

![Figure 3 Prototype Implementation of TMN using Web Service](image-url)
The network equipments here refer to CDMA 95/1X related equipment, such as BSC, BTS, etc. There are agent programs resided on the NE. The element management system and WSF (graphic user interface) are developed in J2EE environment. Usually equipment vendors develop this system to manage and maintain the network equipment through the interaction between manager (element management system) and agent (network equipment). In order to integrate disparate equipment vendors’ systems in a higher-level, we provide the CORBA interface implementation of performance management subsystem. The design of performance management’s IDL interface is in accordance with the definition and requirement of 3GPP [13]. We develop the performance management IRP (Integrated Reference Point) in two steps.

1. First, find the difference between the performance management subsystem in element management system and the CORBA interface that is consistent with 3GPP, then design and implement the adapter to bridge the gap between them;
2. Second, implement the performance management IRP according to the required interface. Once the equipment vendors implement the CORBA interface, the higher-level telecommunication operator can integrate disparate different vendors’ system and develop the network management system.

For the purpose of facilitating the fault locating and diagnosing remotely, we develop the performance management system’s diagnosing utility upon the element management system. Diagnosing utility is wrapped by Web Services. The development of such a diagnosing utility involves four procedures as follows:

1. Analyze the performance management subsystem, design possible interface that may facilitate the debugging process;
2. Write WSDL document to describe the operations and ports;
3. Implement the ports defined in the WSDL document;
4. Design the remote testing use case according to the WSDL document;
5. Develop remote software vendor’s remote auto-testing platform based on the portal provided by the element management system.

When the performance management subsystem of element management system partially fails, the software developer of the system can run the auto-testing platform to test the system remotely. Through analyzing and evaluating the testing result, programmers can diagnose where the problem is. Of course, it can only apply to certain kinds of context. However, it’s can be an efficient and cost-effective tool when faults happen.

In terms of software development, the performance management subsystem of element management system is developed in J2EE environment. The open source CORBA implementation, Jacorb, is employed as the CORBA application server. Tomcat and Axis are used as the web container and SOAP engine in developing the PM Diagnose Utility. The performance management auto-testing platform is developed on the basis of JUNIT framework and ANT.

5. Conclusions and future work

This paper describes a software architecture that combines the technology of Web Service with CORBA in TMN environment. The goal is to solve the interoperability problems exist in TMN environment. The key idea is to maintain the full strength of CORBA, while using Web Services to realize the higher level integration between disparate service providers, provide problem diagnosing utility for software vendors, and create new value added services to meet the customs demands promptly. The implementation procedures are given to illustrate how this goal can be achieved. A prototype system which utilizes Web service, CORBA, J2EE technologies is implemented to illustrate the validation and usefulness of this architecture.

The future work is to extend the functionally and improve the fault tolerance capabilities of this prototype system. Additionally, the ongoing work focuses on providing support for security issues, such as authentication, authorization, and confidentiality.

References


[13] 3GPP TS 32.101 v5.3.0(2003.03): "Telecommunication management; Principles and high level requirements".