A Web Services based Communication Services Framework for Collaborative Work

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Abstract. This paper considers the problem of integrating communication services that support group collaboration systems. Past experience has shown that heterogeneous communication services are extremely difficult to be integrated into collaboration environment and extended to meet continuous changing requirements. This paper aims at proposing a common, interoperable framework based on Web Services technology for integrating communication services in a collaboration environment. This framework allows the implementation of reusable communication services components that can be plugged into the collaboration system and be invoked on demand according to communication requirements of collaboration applications. Based on this framework, a prototype system called Rich Media Collaborative Workplace is developed. This system provides an integrated collaborative workplace with benefits of increasing productivity, saving cost and improving efficiency.

1 Introduction

In today's extremely competitive environment, success of business is the result of collaboration of corporate groups. Efficient collaboration relies on effective communications. With the information technology revolution, computer supported collaborative work (CSCW) [1] system becomes the popular tool to support people work together anywhere and anytime to solve a common problem. A typical CSCW system integrates the control and presentation of heterogeneous types of data channels, such as text, image, audio and video, to enhance the quality of distributed collaborative work. From the perspective of communication services, CSCW system has a broad range of requirements. In the last decade, enterprises focus on building communication infrastructures in order to meet the ever-increasing requirements for intra-enterprise and inter-enterprise communications. In this perspective, enterprises have brought together various communication technologies and applications to facilitate and improve the collaboration. Hence at present most collaboration systems must adapt a heterogeneous communication environment, which are not designed in the approach of a unified communication subsystem. It will bring substantial benefits to users if we can build an integrated communication services environment for collaborative work system, which combines various communication services as well as other collaboration applications into a single easy-to-use environment. Therefore, it is

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important to create a more general framework to integrate wide range of communication services into a collaborative work system.

In this paper, we define such a common, interoperable framework based on Web Services [2] technology for integrating communication services in a collaboration environment. Based on this framework, we developed a Rich Media Collaborative Workplace system, which integrates various communication services including instant message, email, telephone and audio conference in a heterogeneous environment.

The remainder of this paper is organized as follows: Section 2 introduces the motivation of building a Web Services based framework of communication services for collaborative work. Section 3 describes the communication services framework for collaborative work. Section 4 introduces the implementation of Rich Media Collaborative Workplace system as the prototype. The conclusion is given in section 5.

2 Using Web Services to Build a Communication Services Framework

2.1 Collaborative Work Model

To achieve a goal with a collaborative approach, people need to cooperate towards a common purpose, to coordinate for organizing themselves and to communicate for exchanging thoughts. These three concepts, cooperation, coordination and communication, consist the 3C model (Figure 1) for collaborative work [3]. They surround the working group, which is the centric role of this model, to provide desired services for collaborative work.

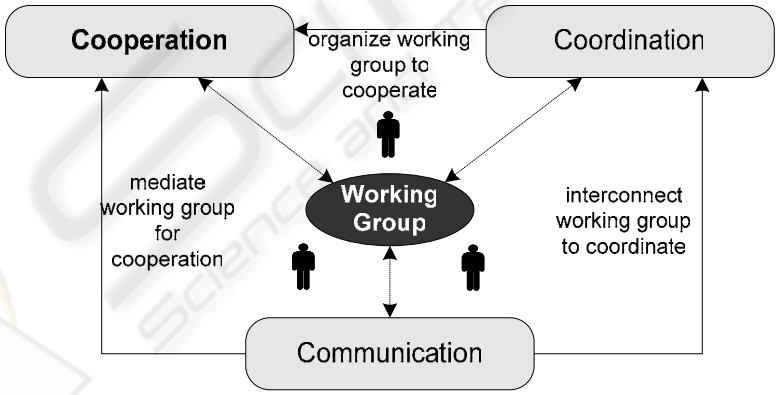

Fig. 1. 3C Model for Collaborative Work

Cooperation services provide means for a group of people working together towards a common purpose. It support users with the mechanisms and means they need in order to perform their collaborative tasks within dislocated working groups. Members of groups could be spatially separated from each other. The inter-member

cooperation is implemented by means of groupware, which are combinations of software and hardware that efficiently support group people in their collaborative works. There are two essential factors for successful cooperation: well-understood goal and organized process. They are ensured by communication and coordination services.

Coordination services provide means for organizing working group members and bringing them order. Coordination service is accomplished by one entity (known as the coordinator) disseminating coordination context to group members to complete a task corporately. From previous research work [4], we can that the ability of group members to reach and maintain a superior coordination relies on the efficiency of communication service. And the performance of coordination can be improved by increasing the potential of using communication services.

Communication services provide group communication facilities to working members for transmitting and exchanging information. These services include: text-based instantaneous exchange of messages (Instant Message Service), individual electronic mail exchange (E-Mail Service), peer-to-peer voice-based conversation (Telephone Service), prearranged or ad-hoc meeting for discussion (Conference Service), etc. Communication services are important for collaborative work. Working group members must share information as widely as possible. Effective communication helps members understand how their works fit the objective and perform collaboration work in order. Otherwise, individuals in a working group tend to work independently, often in conflict with one another.

Thus, we can say that communication is the foundation for collaborative work. It is the basic element and provides support for cooperation as well as coordination.

2.2 Challenges to Communication Services

Development of communication services in collaborative work environment is evolving quickly. At the same time, challenge of heterogeneity to communication services also comes out. In the last decade, computer supported communication improved the performance of collaborative work by enabling working group to collaborate in ways of distributed cooperation. Therefore, there are a large number of communication systems are built to meet the ever-increasing user requirements. In these systems, there are various communication technologies and applications exist to facilitate and improve the collaboration. This situation brought the big challenge of heterogeneity to communication services for collaborative work system [5]. The heterogeneity is represented not only by the variety of hardware, operating system platform, programming language, but also by the diversity of underlying communication protocol, software architectures and models. This heterogeneity is the barrier to services interoperability and usability. It causes different perspectives and needs for cooperation and coordination services, which leads to incompatible design specifications for collaboration workspace solutions. Hence, developers of collaboration systems usually face this complex problem which must be efficiently solved. It is desired to build an integrated communication services environment for collaborative work system, which is easy to combine various communication services as well as other collaboration applications into a single easy-to-use environment.

2.3 Using Framework as a Solution

Above subsections indicated the heterogeneity challenge of communication services for collaborative work, which brought the complexity problem to developers of collaboration system. Managing this complexity in collaboration system development is essential for the success of the system. Here we propose to use a Communication Services Framework (CSF) to support integration of communication services in the development and implementation of a collaboration system. The CSF makes it easier to integrate sophisticated communication services supporting collaborative work. The CSF seeks to abstract the developer from the specifics of the underlying communication services platforms, applications and protocols. It eliminates the need for the developer to fully understand the detailed operation, configuration and integration of communication services in a collaborative environment. Thus, making use of the CSF can simplify the design, development and implementation of collaboration system. Developers can use it to accelerate the development process, leading to shorter time, lower cost, higher product quality and stronger competitiveness. To achieve this, the framework should have the following features:

- Integration solution for consolidation of heterogeneous hardware, software and protocols.
- Flexibility architecture for combination different communication services to meet various requirements.
- Standard-based interface for interoperation between different technology vendors.

2.4 Web Services: the Best Choice

We proposed our new concept that is to combine different communication services into a collaborative environment using an integrated communication services framework above. This framework should have following capabilities: integration, flexibility and standardization. From those perspectives, Web Services [2] seems to be the best candidate for this framework.

Web Services is a standard technology of integrating Web-based applications using a set of open standards (XML, SOAP, WSDL and UDDI) over an Internet protocol network. Web Services provide a way to describe and publish application's interfaces to allow client applications invoke them. It supports different applications from different sources to communicate with each other. Following benefits from Web Services make it as the best choice to be used to build the communication services framework for collaborative work.

- Web Services is a simplified solution to integrate applications regardless of the device, platform and protocol that they use. Web Services works with standard Internet and Web protocols such as TCP/IP, HTTP and XML. The Web infrastructure is widely built in a significant number of companies for collaboration system. People have had sufficient knowledge and experience in using and managing it. So Adopting of Web Services can potentially improve collaborative process efficiency and reduce IT implementing cost.
- Web Services is designed as a flexible solution with loosely coupled feature. By adopting XML protocol, Web Services allows applications written in different lan-

guages on different platforms to communicate with each other in a standard way. So it is an ideal technology to orchestrate various information exchanging processes for supporting collaborative work.

- Web Services is based on industry standard protocols with universal support. The full life cycle of Web Services are covered by standards including describing, publishing, discovering and invoking. It makes Web Services to support the development of interoperable applications across a wide array of environments. The open standards help to reduce technology cost and increase service quality by wide choice of suppliers.

3 Web Services based Communication Services Framework

With the framework concept and benefits of Web Services, we propose a Web Services based Communication Services Framework (WS-CSF) to support integration of communication services in the development and implementation of a collaboration system. Figure 2 shows the five-layer architecture of WS-CSF framework. They are transport layer, access layer, collaborative presentation layer, mediation layer and communication middleware layer. The WS-CSF allows the implementation of reusable communication services components that can be plugged into the collaboration system and be invoked on demand according to aommunication requirements of collaboration applications. In this framework, communication services are wrapped into an independent component to hide the complexity of underlying communication networks, platforms and protocols. This component exposes a defined set of Web Services interfaces to use supporting communication services, such as message, telephone and conference services.

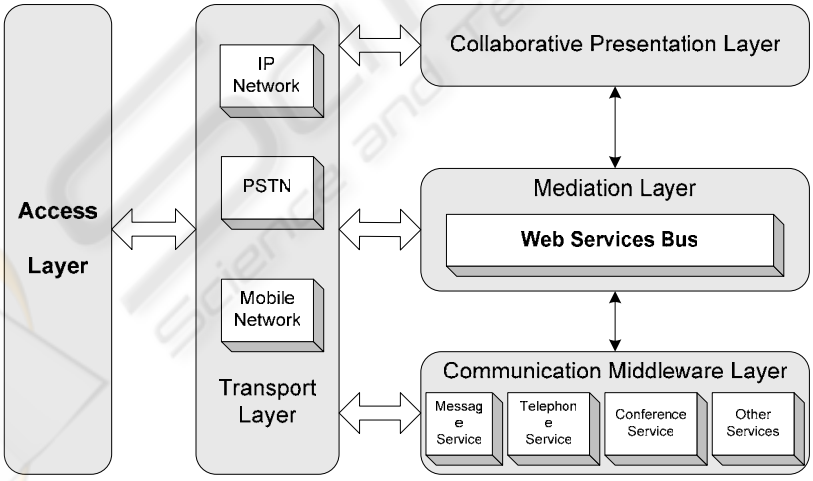

Fig. 2. WS-CSF Framework

Access Layer: This is the application interface layer for end users. This layer provides user interaction interfaces with the collaboration system. It contains different kinds of application endpoints to participate collaboration sessions, such as computer, telephone and PDA. Since different application endpoints have their own signaling and media protocols for participating, we abstract them as an access interface between access layer and transport layer.

Transport Layer: This layer is the carrier component to interconnect other layers. It provides capabilities to reliable transmit information from a source to single or multiple destinations. This layer comprises a collection of transportation networks, such as IP network, Public-Switched Telephone Network and Mobile network. Each network is responsible for supporting a communication service to meet a specific requirement.

Collaborative Presentation Layer: This layer provides a collaboration portal to end users for the aggregation of different collaboration services. It is a container of various collaboration applications for collaborative work. The main concerns of this layer are the representation of collaborative information and integration of various collaboration methods. It takes care of visualizing the collaboration service interfaces to the user in a way that is adapted to the application endpoint that the user is used. Users can customize the layout of their collaboration portal. With this layer, it is easy to integrate various collaboration services into a consolidated workplace. These services can be installed and removed dynamically by using service configuration facilities.

Mediation Layer: This layer is the mediator between collaborative presentation layer and communication middleware layer. It brokers interconnections and bridges communication services requestor and provider between these two layers. The purpose of introducing this layer is to conceal the heterogeneity of communication services by offering a unified interface. The main component of this layer is a Web Services Bus. This bus offers an enhanced environment for conducting dynamic communication services invocation with Web Services. It receives service requests from requestor (i.e. applications in collaborative presentation layer) and dispatches requests to corresponding service providers (i.e. servers in communication middleware layer) to accomplish a communication process.

Communication Middleware Layer: Below the mediation layer, the communication middleware layer provides the core communication facilities to access supporting communication services. It contains the engines of communication services. This layer comprises a group of service server that is responsible for providing a specific communication service. Each service server offers capabilities to collaboration applications for accessing underlying communication resources. These capabilities are exposed as Web Services interfaces to be invoked through Web Service Bus in mediation layer. The service request conveyed in Web Services message is mapped to specific protocol by service server and transmitted into transport layer.

4 Implementation of a Prototype System

Based on WS-CSF, we have built a Rich Media Collaborative Workplace prototype system that is used for worldwide collaboration work. This system integrated following communication services into a single collaborative workplace: synchronous communication for real-time interaction including voice-based (telephone) and text-based (instant message), asynchronous communication for users not available simultaneously (email), pre-scheduled and ad-hoc voice conference and white board. Figure 3 shows the system architecture of Rich Media Collaborative Workplace.

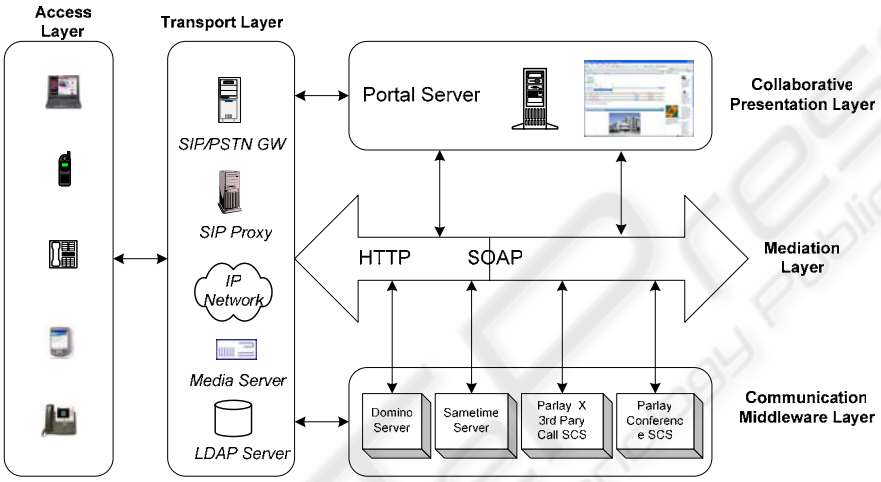

Fig. 3. Rich Media Collaborative Workplace Architecture

We built a converged IP network based communication infrastructure as the transport layer. In this infrastructure, we construct a SIP-based VoIP network to provide voice communication capability for users. Session Initiation Protocol (SIP) [6] is an application-layer control protocol for creating, modifying and terminating communication sessions with one or more participants. The SIP proxy and SIP/PSTN gateway create a VoIP domain, which is bridged with traditional voice network, for voice terminals to perform voice communication. Additional servers including media server for voice mixing and LDAP server for user information storing provide supplemental functions. The converged transport layer offers diversity data and voice channels for user to access this collaboration system. Users can use computer, mobile phone, PSTN phone, softphone and SIP phone to access collaboration services.

We implemented this system using a flexible componentized architecture, which makes it easy for using, managing and extending. The system provides a collaboration portal to users to aggregate different collaboration services into a single workplace. It is built based on a portal server which contains various collaboration portlets [7] for each collaboration services. Users can customize their collaboration portals by adding and removing collaboration portlets and changing the layout of their workplace portal. With the power of portlet administration tool, the system administrator can easily integrate various communication services into workplace by dynami-

cally installing and uninstalling portlets. In addition to existing Domino portlet for email and Sametime portlet for instant message, we developed two kinds of portlets for telephone call control and conference services. These two portlets are built with Web Services adaptor for encoding and decoding request to SOAP [8] message. Through the SOAP connection on mediation layer, the collaborative workplace portal can invoke Web Services provided by service servers in communication middleware layer. We implemented two communication middleware servers by leveraging Parlay Web Services technology [9], which is a set of standard APIs that enable third party to access resources of communication network. After receiving request routed from mediation layer, communication service server translates the high-level commands to signaling messages of underlying protocol (i.e. SIP messages) and sends them to corresponding collaboration clients or feature server through transport layer.

With this system, we provide an easy-to-use web interface for users to perform collaborative work. In addition to text message and email, users can start voice conversation and conference by a single-click through workspace portal. Figure 4 shows the scenario of using this system. We can see that a user invite another user into a voice conference by choosing an option of context-aware menu through clicking people's name. And the conference status can also be seen in a popup window.

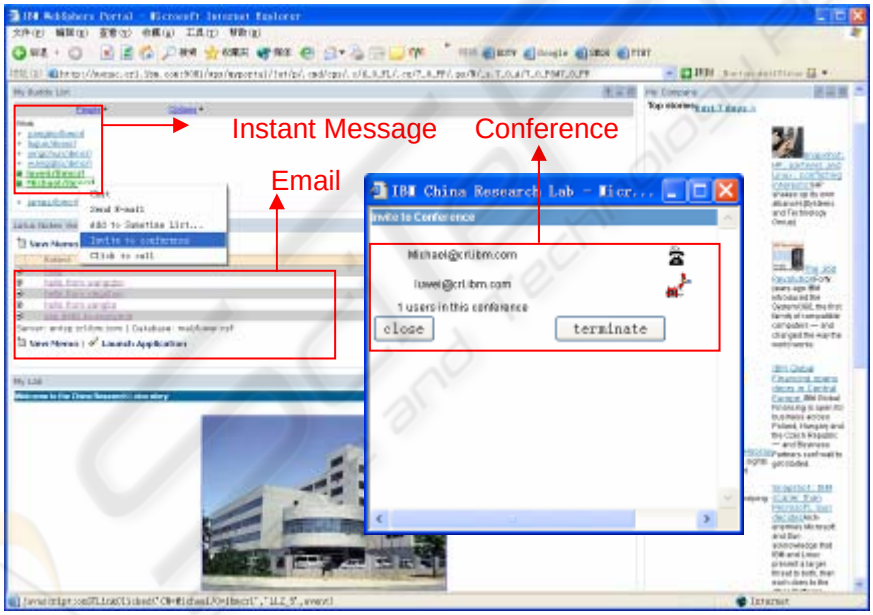

Fig. 4. Usage Scenario of Rich Media Collaborative Workplace

5 Conclusion

For years, computer supported communication services have been converged into collaboration systems. It is changing the way how workers interact and perform collaborative work. By adopting enhanced communication services, companies can improve efficiency of collaboration and increase productivity for business growth. In this paper, we presented a Web Services based Communication Services Framework (WS-CSF) to support integration of communication services in the development and implementation of a collaboration system. This framework has five-layer architecture to solve the heterogeneity problem in a collaboration environment. Under the WS-CSF framework, various communication services can be integrated into a single collaboration workplace to meet various communication requirements. Based on this framework, we have developed a prototype system called Rich Media Collaborative Workplace. This collaboration system provides an integrated collaborative workplace with multiple communication channels including instant message, email, telephone and audio conference. It can benefit users by increasing productivity, saving cost and improving efficiency.

References

1. Grudin J.: Computer-Supported Cooperative Work: History and Focus. IEEE Computer, 27(5) (1994), 19-26
2. Booth D., Haas H., McCabe F., etc.: Web Services Architecture. W3C Working Group Note (2004)
3. Fuks, H., Gerosa, M.A. and Lucena, C.J.P.: The Development and Application of Distance Learning on the Internet. Open Learning - The Journal of Open and Distance Learning, 17(1) (2002), 23-38
4. Miller J.H., Moser, S.: Communication and Coordination. Santa Fe Institute Working Papers (2003)
5. Kogiomtzis G., Martakos D.: Integrating Heterogeneous Communication and Messaging Systems in an Object-Oriented Middleware Framework. Proceedings of the 8th International Conference on Object-Oriented (2002), 488-493
6. Rosenberg J., Schulzrinne H., and Camarillo G., etc.: SIP: Session Initiation Protocol. IETF RFC3261 (2002)
7. Bellas, F.: Standards for second-generation portals. Internet Computing, IEEE, 8(2) (2004), 54-60
8. Gudgin M., Hadley M., Mendelsohn N., etc.: Simple Object Access Protocol (SOAP) 1.2. W3C Recommendation, 2003
9. The Parlay Group: Parlay Web Services Overview. The Parlay Group Specification (2002)