International Journal of Multimedia and Ubiquitous Engineering
Vol.9, No.5 (2014), pp.63-72
http://dx.doi.org/10.14257/ijmue.2014.9.5.06

Research on Model of Distance Education System Based on SIP Protocol

Fu Zhihui

Zhejiang Business College, Hangzhou, Zhejiang, 310053, China
zhihui_fu@aliyun.com

Abstract

Through analysis of mechanism and characteristics of Session initiation protocol (short for SIP), it is found that SIP possesses prominent flexibility and expansibility, which meet the requirement of Internet infrastructure and media flow transmission. To some extent, tight-coupling model based on SIP reflects the fundamentals of distance education and session initiation. Furthermore, while key control and media mixer are functionally separated. A Web server is added to improve mutual communication. The model SIP-based distance education system with three centralized servers are constructed and the corresponding topology structure is proposed. The mechanism and education function of the model are embodied and realized through several aspects, such as distance class creation, participation and termination, state information notification and education resource control.

Keywords: *distance education system; SIP; tight-coupling model; topology structure*

1. Introduction

In recent years, the rapid development of information technology, the thought impact of lifelong education, the surge in demand for popular education and the access to quality educational resources, all of which give birth and promote the development of modern distance education, but they also ask for better flexibility of modern distance education. As a signaling control protocol of application-layer, in terms of session, the SIP (Session Initiation Protocol) is flexible, convenient and easy to expand, which is being widely concerned in the field of multimedia. In view of this, combining the characteristics of SIP, the author here discusses and studies distance education system and its model based on SIP.

2. Current Situation of Distance Education

Modern distance education is a new kind of education which is generated with the development of modern information technology. Distance education is the main form of distance education, unlike traditional teaching, its notable features are: "teaching" and "learning" activities can be carried out at a different time and place. As shown in Figure 1 [1, 2], for the purpose of reaching a two-way transmission and real-time interaction, it uses Internet to transmit multimedia teaching information such as text, graphics, images, sound, video and so on.

ISSN: 1975-0080 IJMUE

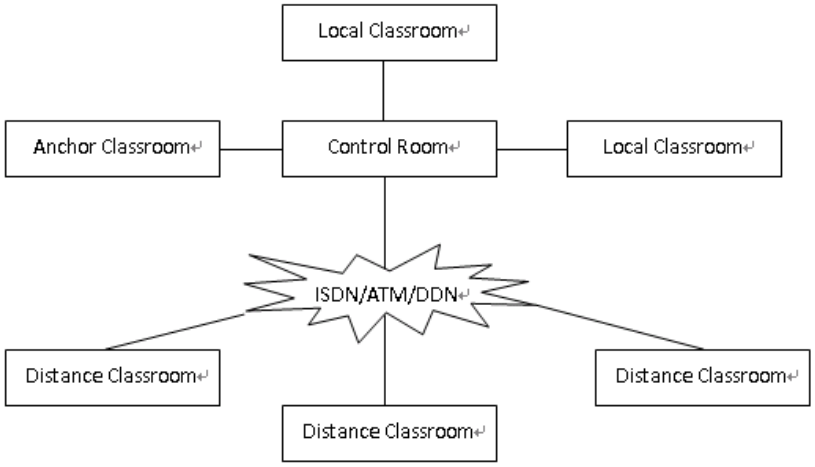


Figure 1. Distance Education Sketch

Distance education system is the carrier of distance education. Depending on the H.320 or H.323 protocol, the current distance education system is built on the basis of expensive hardware facilities, so that only part of primary or secondary schools as well as some universities which have excellent financial condition can have it. Expensive cost, high-bandwidth requirements, and poor expansibility, all of which severely restrict the popularity of distance education [3, 4]. Fortunately, the characteristics of SIP on which the distance education system builds its basis may be a better solution to this problem.

3. The Profile of SIP

Being different from the H.323, by supporting multimedia session, SIP is a signaling control protocol of IP network proposed by the IETF (Internet Engineering Task Force). SIP is an application layer protocol, which is independent of the transport layer, and used to describe, create, modify and terminate sessions between multiple participants. It uses a text representation that is simple and easy to implement. And it has good functional extensibility and network expansibility (Wang Yanlin, 2005). SIP message can carry a message body of any format. By carrying a different message body, it can perform different data services. Through the definition of new methods and message header fields, it can enrich call control of SIP. The main functions of SIP include: resource location, joining the service session and the negotiation of session parameter, *etc*.

As a control (signaling) protocol of application-layer for multimedia communication, SIP is possible to create, change and terminate multimedia sessions. The SIP operation usually involves a user agent client (UAC), a SIP proxy server, a user agent server (UAS): UAC normally initiates a request, then SIP proxy server finds the agent as the position of the end user, then UAS receives or responds to the call. SIP can be used to initiate a new session, which can also be used to invite members to join the already established session [5].

The architecture of SIP is totally different to H.323 (or H.320). H.323 (or H.320) is designed for local area networks which has complicated structure, so there are more limits in the application of it, fortunately, the SIP belongs to the application layer

protocol of OSI, it has architecture of Client-Server like the HTTP, and it can take advantage of the existing packet data of HTTP during the packet handling, there is no need to retain a lot of information transmitted like H.323 packets, so SIP is ideal for transmission architecture of WAN.

4. The Basic Model

Distance education is a video communication participated by multi-point. Compared to other models, the tight coupling model has advantages such as good security, easy to manage, support heterogeneous terminals, etc., so here the author will learn from the tight coupling model to build SIP distance education system model, wherein, the core member is Focus used to maintain signaling connection of SIP with each member. As shown in Figure 2 [6, 7], we usually select star topology.

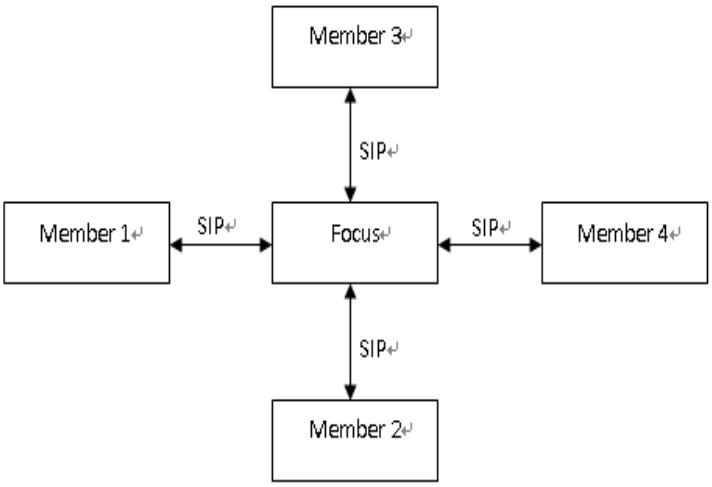


Figure 2. SIP-base tight coupling model for distance education

Focus is a SIP user agent indicated by the URI (Universal Resource Identifier), which can be used to identify a distance education classroom. As a logical functional entity, Focus is responsible for maintaining contact with each member of the signaling distance learning of SIP, for implementation of the relevant policies, and for the guarantee that each member receives appropriate and available media streams. Normally, the mixed output of media stream is performed by one or more Mixers, which are properly configured by Focus indicated by media policies.

5. Improved Model

Considering the practical requirements and characteristics of distance education system, here we make some improvements to above model, we physically separate the functions of core control part and the media mix part. Meanwhile, in order to facilitate end-user's interaction with the distance education system, we add a web server, then the distance education system model based on SIP protocol is constructed as shown in Figure 3.

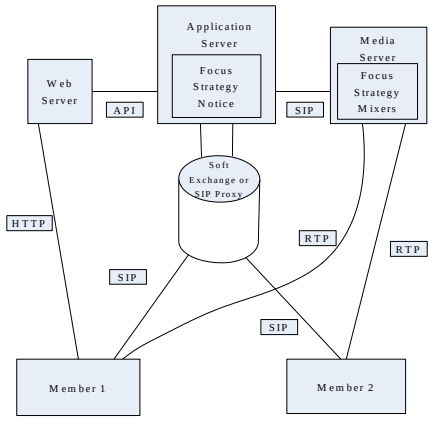


Figure 3. Distance education system model

Above Figure shows that the whole distance education system includes three centralized servers: the application server, the media server and he web server. Among them, the application server is responsible for handling member and media strategies, and maintains signaling connection with each member. The media server achieves the actual media mixing function. Besides the modules of Mixer function, the media server further comprises a Focus and a policy server, without notification. Media Server has a default member strategy, which can receive all request messages that are sent from the upper application server. The policy server receives any control command from application server. Focus in the application server routes members' media streams to the media server for processing, by the method of the third party control. If the application server receives a command of policy control from one client, then it will instruct the media server to perform the associated media strategy.

Web server is developed based on API technologies (such as SIP Servlet API) provided by application server, with two main functions: first one is to provide web-based interface, users can easily interact with the distance education system for functions of remote teaching control or applications of strategy modify, as long as they login the web page. Secondly, through the generation environment of the specific applications, the web server shields the development details underlying the application server of SIP, and also resides some logic. According to end users' operations of web, it is easy to generate a command to invoke the application server of SIP to perform the relevant operations.

6. Operational Principle

6.1. Creation of Distance Education Classroom

Distance education system based on SIP supports two types of classroom: the instant distance education and the distance education by reservation. The classroom of instant distance education can be created via multimedia terminals: users only need to specify the URI of distance education classroom to send request of IN2VITE, then the new URI resulted accordingly will be brought back by header field of contact responded by 302.

The classroom of distance education by reservation can be created through Web management system. After a successful reservation of distance education classroom, a record will be inserted into the database of the curriculum of distance education system. Web management module controlling the server is periodically scanning the records of table, if there is a new record of distance education classroom, in accordance with predetermined requirements, the web management module will generate a new node and add it onto the list.

6.2. Join the distance education

In general, there have 5 modes to join the classroom of distance education:

(1) Call-In mode: through E-mail, Web, and instant messaging, etc., users can prior notice the URI of distance education, then URI will send a message as INVITE to request you to join in.

(2) Call-Out mode: when the distance education starts, the control center sends a message as INVITE to the user to invite them to join in. This mode requires that the URI list of the user has been stored in the control center in advance.

(3) In order to trigger the control center, the 3rd party sends request as REFER to URI to invite users to join in the distance education.

(4) A 3rd party sends a request of REFER to the user to trigger them to initiatively join in the distance education.

(5) If the user does not know the URI but it is still possible that they obtain a session ID through other means, then they can join in the distance education by sending a message as INVITE with the header field of Join.

6.3. Multicast based on SIP

SIP is a call model having a distributed design and the function of distributed multicast, which not only facilitates the meeting control of multicast, but also simplifies the user location, the group invitation and the broadband. As shown in Figure 4.

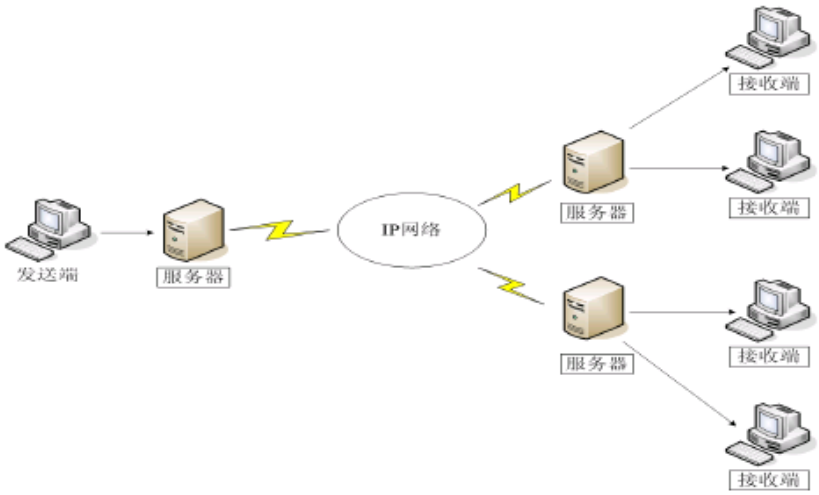


Figure 4. Multicast based on SIP

In the SIP system, the UAC sends a request as INVITE with multicast messages, inviting clients to participate in the corresponding session, routing by the via domain of protocol head, recording the routing by the protocol header to assure the information of multicast reach all of the domain servers, and distributing the information to the receiving end by the proxy way of domain server. The core server and domain server are both agencies reserving call state, recording the paths from the beginning request as INVITE to the end demand of BYE. Therefore, they are always in a path transmitting messages of SIP for the selected end-user. Different processes and paths are designed for unicast messages and multicast messages, the following two charts (Figure 5, Figure 6) made a detailed comparison:

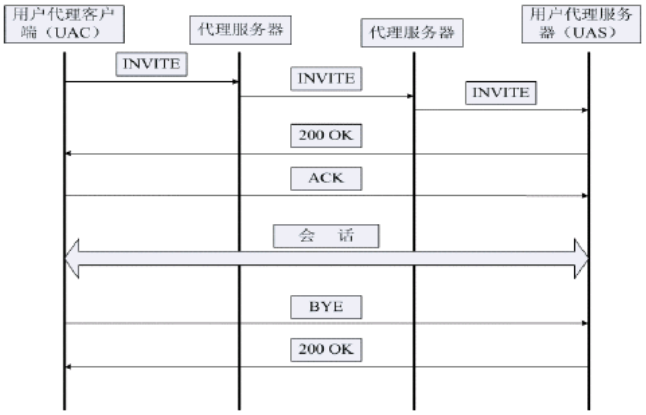


Figure 5. Paths under Unicast

In the state of unicast, the proxy server stays at a non-reserved status, the user agent client (UAC) finally locates the user agent server through proxy server(s) (single or multiple), later the messages are passed directly in between the two ends, no additional proxy server is needed.

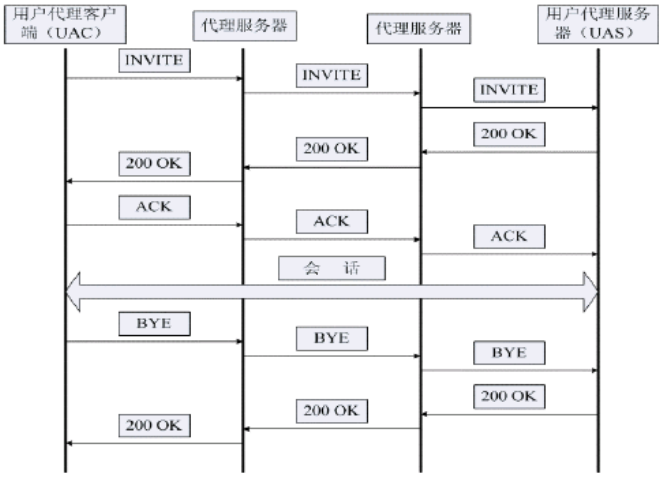


Figure 6. Paths under Multicast

In the state of multicast, the proxy server stays at reserved status, after the user agent client (UAC) locates the user agent server through proxy server(s) (single or multiple), the proxy server is still needed to pass the messages in between two ends, until transmission of request (BYE) is completed. Although this method of transmission increases the load on the proxy server, it can ensure the realization of multicast.

6.4. Notification mechanism of distance education status

In the process of distance education, through the Community Notification Service (CNS), teachers and students can obtain the status information of distance education events. After joining in, they can send a request as SUBSCRIBE to the control center to book service of interested events or status notifications. When the state of certain event

or distance education is changed, the server will generate a packet of status report to notify the subscribers about the changes via sending a request of NOTI2FY.

6.5. Control mechanism

Floor Control refers to the access control of shared resources, such as voice, video and other public resources. Control messages are passing between teachers, students and the server, including the control commands and the control events. Control commands packaged by the format of SOAP take INFO message of SIP as the bearer of messages. Messages of event control are transferred by the notice mechanism of state information.

Control command is a request to change the state of resources, which is sent to the server by teacher or the authorized participants, its content involves: the adding of resources of distance education classroom, the request of using the resources, the approval of users or the rejection of requests, and changes of strategy, etc. Meanwhile, the message of control event is a report about the status information of resources, which is sent from the server to the participants, for reporting the information to the participants, including changes in occupancy of classroom resources, policies or media configurations, *etc*.

6.6. End of distance education

Considering the two modes of creation of distance education classroom, accordingly, there are also two ways to end it. Reservation-distance education also pre-sets the end time meanwhile the classroom is created. When the end time comes, if there are students in the classrooms, then control center will send a message as BYE to delete them, and then perform the process of logoff. After the success of cancellation, the corresponding nodes will be removed accordingly.

Although instant distance education does not set end time when creating the classroom, the number of participants in classroom determines the end time. Only when the last participant exits the classroom, the distance education ends and then the process of cancellation will be executed; and the node will be removed after this.

7. Topology structure of distance education based on SIP

According to the improved model as above, basing on SIP, distance education can be designed as appropriate structure of network topology, specifically as shown in Figure 7.

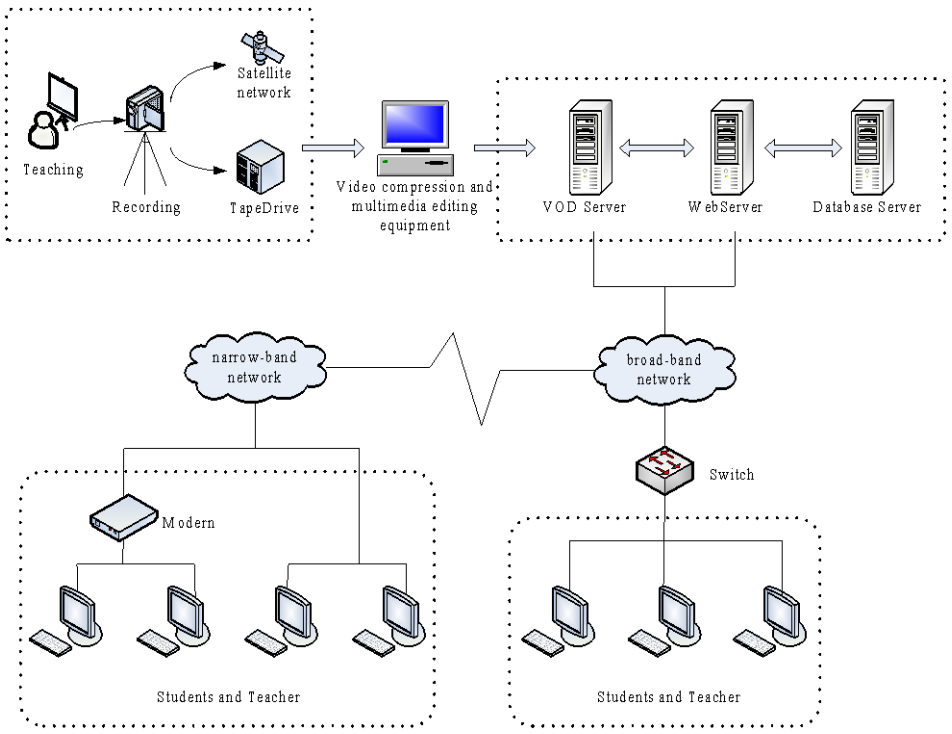


Figure 7. Topology Structure of Distance Education System

Video conferencing system based on SIP is a interactive teaching platform, using advanced and innovative technology of video encoding and voice compression by the fusion of H263+ and MPEG 4; It is compatible with traditional H.323 and current SIP meeting; Based on IP architecture, it is a pure software system that can be used to carry out real-time interactive distance education, training or network video conference.

This system uses architecture as C/S, integrating the instant-office system, which can run in the satellite network, Internet, MAN, LAN, campus network, through a multi-channel, real-time and interactive audio and video, screen broadcast, courseware synchronization, web synchronization, electronic whiteboard, file transfer, recording of courseware, text communication and other functions, to provide a complete, unified multimedia solution of remote and interactive teaching and network video conferencing for schools and related institutions.

With the rapid development of MPEG4 technology, improved resolution enables a clearer picture; the increased color depth (up to 32bit) makes more vivid images. The teaching system of remote video based on software compression is very easy to upgrade, coupled with advanced algorithms of compression and transmissions of network, also the rapid development of control technology, the hardware systems will be reduced gradually. We can say that the way of software can better protect the interests of users. Without high cost of inputs, users can achieve audio and video communication, collaboration, remote interactive teaching, remote training, document sharing, teleconferencing management, remote tutoring, parents' meeting, teaching and research activities, remote synchronization teaching, research review, demonstration classes of public teaching and other functions with high quality and high reliability, and thus effectively save the time and money and improve the work efficiency.

Visibly, SIP-based distance education system mainly suits for education, government, finance, healthcare, corporation, military, etc., especially for the education sectors, universities, teacher's colleges, secondary vocational schools, remote and real-time teachings for primary and secondary schools. Specifically, it is applicable to:

- Interactive teaching: group teaching, real-time teaching, non-real-time teaching, classes online, tutoring.
- All types of video conferencing: conferences for branch campuses, administrative meetings, seminars, training sessions, consultations.
- Research activities: off-site review, evaluation, communication, observation.
- Remote assistance: remote consultation, remote customer service, remote operation.

8. Run Results

When the remote interactive learning activity based on SIP starts, then it creates a distance education classroom, through call-in or can-out, to add in classrooms or observing rooms of different places. While a normal class of main classroom is going on, teaching content (including voice, video and PPT notes, etc.) of off-site classroom keeps synchronization with it. Teachers of master classroom can interact with students of remote classroom. Now we take interactive distance education between three locations of one county as example, the participants are middle school A, middle school B, middle school C and some experts. Actual operating results please see Figure 8.

Figure 8. Demonstration Activity of Interactive Teaching between Three Locations

9. Conclusions

This paper explores the distance education system based on SIP, and proposes the corresponding model architectures and topology structures. This system is either flexible for application access and convenient for customization, but also well-managed and well secured.

As the core protocol for distance education system, SIP has following advantages:

l) Architecture of distance education system is much simpler for easier networking and implementation;

2) Distance education system takes distributed structure, which is easy to expand, and supports the users with huge construction program;

3) Low requirements for the end devices, the ordinary servers are OK for general terminals of SIP;

4) The system is relatively concentrated, which is easy to maintain and manage.

But the architecture of distance education system proposed by us still has many problems and shortcomings:

l) In the case of higher number of network, the certain bandwidth is requested;

2) Since there is no guarantee of QOS in SIP network, therefore, it is still a difficult task to achieve distance education in the public IP network;

3) This article discusses about that each participant connects with the server through SIP terminal to transmit the media, but here we have not discussed about how does the server obtain the status of conference, control the conference, modify the strategy of meeting, etc., via subscription mechanism of SIP events.

Although the SIP protocol itself is still in the process of development and improvement, SIP only solves a small part of the programs of the session, the range of individual application is narrow, and it needs other software to work together to build a distance education system. However, SIP shows a strong flexibility and extendibility when it is used in conjunction with other protocols. It can be predicted that SIP used in distance education system will become an important direction of research.

Acknowledgements

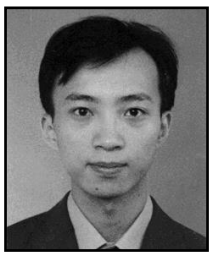
My deepest gratitude goes first and foremost to Professor Wu weie, my supervisor, for her constant encouragement and guidance. She has walked me through all the stages of the writing of this thesis. Without her consistent and illuminating instruction, this thesis could not have reached its present form.

Second my thanks would go to my beloved family for their loving considerations and great confidence in me all through these years. I also owe my sincere gratitude to my friends and my fellow workmates.

References

[1] J. D. Rosenberg and R. Shockey, "SIP: A key component for Internet telephony", J. Computer Telephony, vol. 8, no. 6, **(2008),** pp. 124-139.
[2] Q. Y. Zeng, R. M. Hu and X. G. Bian, "The model and implementation of centralized conference control based on SIP", J. Computer Engineering, **(2005)**, pp. 198-217.
[3] T. Zhang and J. P. Fan, "Research on remote teaching model based on multi Agent", J. Science Technology and Engineering, vol. 22, **(2006).**
[4] X. L. Gao and P. Y. Lu, "Distance Education System, Chinese Aerospace Press, Beijing, **(2004).**
[5] H. F. Wang, "Network Education Technology", National Defence Industry Press, Beijing **(2003).**
[6] R. Mahy, B. Campbell and J. Rosenberg, "A Call Control and Multi-party usage framework for the Session Initiation Protocol (SIP)", IETF, **(2003).**

Author



Fu Zhihui, he received the B.Eng. degree in Mechanical Engineering from Shandong University (SDU) and the M.eng degree in Computer Application Technology from Zhejiang University of Technology (ZJUT). He is currently researching on Next Generation Network (NGN), Grid Computing and Terminal Development in Cloud Computing Environment.

