

Research and Implementation of Hierarchical Control of Large Scale Video Conference based on Conference Management System

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Abstract— The Integrated Video Conference System of State Grid hosts many video conference applications. It is an important office assistant system, comprises a massive number of discrete components. In order to meet the growing demands and expectations of customers, stability and reliability of the system need to be further enhanced. In this paper, we study the system architecture, maintenance routine, system capacity, etc., and propose a hierarchical conference control strategy based on the Conference Management System. The proposing strategy can improve the reliability and efficiency of large scale video conferences via a conference assistant mode, which can guarantee unity of command and achieve hierarchical maintenance.

Keywords- Video conference; Multi Control Unit; Hierarchical Control; RBAC model

I. INTRODUCTION

As State Grid Corporation Collectivize operation continuously strengthened, the contact between all levels within the corporation becomes closer and the demand of the conference across multiple levels increases significantly as well. At the same time, all units are required to be accessed flexibly, and to realize the self-assistant conference [1]. The original video conference system of State Grid Corporation cannot meet all these new requirements.

The Integrated Video Conference System of State Grid was launched in December 2013, which hosts many video conference applications. It has realized the unified management of all kinds of video conferences and resource sharing, which improves the organizing ability and the disaster recovery ability. It also meets various types of conferences requirements, such as emergency, training, administration and so on [2].

Now when an administrative video conference covering province, city and county companies at all various levels is held, all the operation of the conference is concentrated in the headquarters, the system is not open to the provincial and other following companies. This may affect the conference in two ways: on one hand, the conference may cover more than 2000 venues, which is too large for the staff in the headquarters to operate; on the other hand, it is unable to meet the requirements of the subordinate units

In order to achieve the goal of a unified direct and hierarchical maintenance, improving the reliability of the large scale video conference efficiency, this paper explores the control mode and method for operators at all levels in

large scale video conference, and proposes a hierarchical control strategy based on the Conference Management System.

II. VIDEO CONFERENCE SYSTEM DESIGN

A. The Administrative Video Conference System

The Administrative Video Conference System mainly serves for the administrative video conferences in State Grid Corporation. The network of it is divided into two layers: backbone network and province network. The backbone network covers the headquarters, branch companies, and provincial companies, while the province network is connecting networks of provinces, cities and counties together. These two systems are connected via analog transfer mode at the borders among provinces [3] [4].

The Administrative Video Conference System uses two types of connections, namely special line and network line [5]. They are actually two different platforms with different MCUs (Multi Control Unit) and different communication channels [6] [7]. To ensure a high reliability of the video conference, at each venue, two independent video conference terminals are connected to special line and network line separately as the spare for each other.

B. The Resource Pool Video Conference System

The resource pool video conference system is designed based on the conference resource scheduling strategy, which is to share the resources through multiple MCUs, and to achieve the unified deployment, management and interaction of resources as a virtual pool [8]. Based on this strategy, it achieves sharing and backing up of all the MCU resources of the whole network. The multi-group conferences in parallel as well as the self-service conferences can also be hold [9].

The MCU resources are deployed both in the headquarters and in 27 provincial companies. The MCUs in the headquarters are mainly to meet the video conference requirements of the headquarters and the branch companies. They have the ability to convene a conference covering all provincial companies. The MCUs in the provincial companies are mainly to meet the video conference requirements of the cities and counties companies. MCU resource pool of the headquarters and the provincial companies can be deployed unified and backup for each other [10].

III. VIDEO CONFERENCE ASSISTANT MODE

A. The Administrative Video Conference Assistant Mode

Currently, when headquarters holding administrative video conference, according to the organizers requirement, we take direct video conference assistant mode which includes the headquarters, branch companies and province companies. For the cities and counties which just need listening and watching, we use the province companies' own audio and video equipment to switch to subordinate units. All the administrative video conferences have to be previewed half a day before the conference, by checking the devices connection, sound quality, image quality and so on.

B. The Resource Pool Video Conference Assistant Mode

For the resource pool video conferences, the organizers reserve the conference by the OA (Office Automation) system. The OA system will transfer the conference reservation information to the Conference Management system, and then such information will be synchronized to the SMC which is short for the Service Management Center of video conference, so as to realize the automatic video conference. The video conference reservation process is shown in Figure 1.

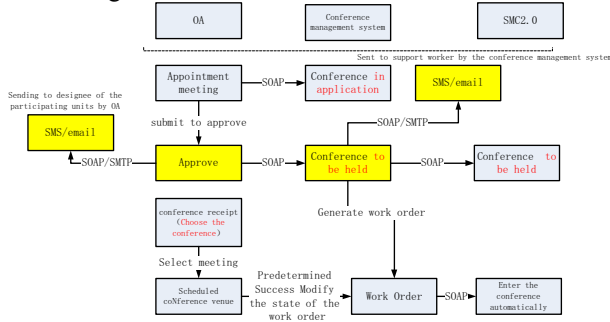


Figure 1. videoconference reservation process

However, the existing assistant mode is that the headquarters' staff is in charge of all the venues, whatever the scale of this conference. If the number of the venues is larger than 300, it is really difficult to manage by only the headquarters. So the hierarchical control strategy has to be developed.

IV. THE CONFERENCE MANAGEMENT SYSTEM

The Conference Management System is the scheduling and management center of video conference in State Grid Corporation, which is the key to realize hierarchical control. All the servers of Conference Management System are running in Active-Active mode in the headquarters, while other companies can login to it for control and management of their conferences.

A. Architecture

The architecture of the Conference Management System is divided into six layers: presentation layer, business layer,

service layer, adaptation layer, access layer, basic data layer. The detailed architecture of the system is shown in Figure 2.

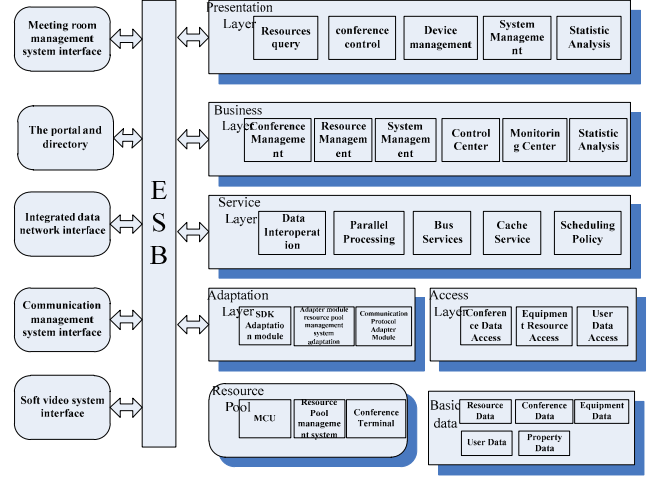


Figure 2. Architecture of Conference Management System

Presentation Layer: is the interface of the application for users. It builds all kinds of functional components on top of the basic data and business layers to achieve the graphical display.

Business Layer: is the core of the whole system, mainly responsible for business implementation, application integration, and application management. It can package the application logic components as services for variety of applications calls.

Service layer: In the Conference Management System, the content of request data from different services is different, so the service layer needs to provide a unified data service, and to complete data interoperability, parallel processing, bus service, load balancing and other services.

Adaptation layer: provides a unified hardware interface module for the upper service application so that the business layer and data layer can control and manage the physical devices from different manufacturers by calling the API.

Access Layer: in charge of packaging the accessing of data sources, and makes the design and implementation of service level to focus on the function of the system itself. At the same time, the access layer changes the different formats from the different manufacturers into a unified data format that make system to process easily.

Basic data: the physical storage layer for the systems business and the base data of conference management system.

B. The Main Application Functions

The organizers of headquarters, provincial, the cities and county-level units can reserve and query the conferences by the OA systems, and allocate resources through the Conference Management System. The function module of the system is shown in Figure 3.

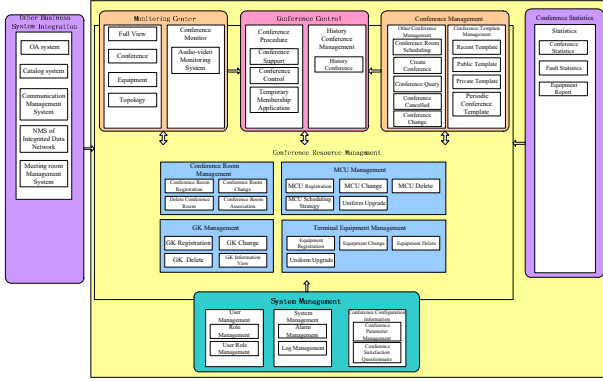


Figure 3. Function Module Diagram of Conference Management System

V. THE KEY FACTORS OF HIERARCHICAL CONTROL

A. System Load Capacity

From the point of view of the system architecture, SMC is developed by B/S architecture instead of C/S architecture to provide web interface. It supports the Internet Explorer browser. Part of the transaction logic is implemented in the front end. The advantage of this architecture is to facilitate the operation and maintenance. However, the main transaction logic is implemented in the server, and the browser exchange data through the Web Server with database. Thus, the operation data load of the application server is heavy. The next step is to change the software architecture and enhance the performance of the server to improve the system capacity.

According to the actual video conference control situation, the Chrome browser gets better results than Internet Explorer browser when controlling large scale conferences. So the performance of browser compatibility should be further improved.

At present, when holding a large scale video conference, the SMC exchanges large amounts of information to all the participants' MCUs and terminals. The real-time information updating leads to slower refreshment of SMC interface. So the unnecessary information interaction should be reduced to guarantee the stability of the system.

B. Conference Assistant Mode

Take the resource pool system as an example: with hierarchical control, the headquarters' assistant range is only the headquarters, the branches, and the provincial companies. While the every provincial company focus more on their subordinate cities and counties venues.

When we use Conference Management System to achieve hierarchical control, a number of participants should be set as a threshold. For example, if we set the threshold as 300, the hierarchical control function is turned off when the participant number is less than 300. When the participant number is more than 300, the Conference Management System will send SMS to alerts participating companies to

assign the hierarchical control staff and open the hierarchical control function in the system.

C. Conference Management System Information Interaction

The Conference Management System interacts with the external systems based on Web Service. The interactive interface is realized by SOAP (Simple Object Access Protocol). It is developed and implemented through the integrated environment based on application platform. According to the direction of information flow, we can distinguish interfaces into receiving interface and transmitting interface. The transmitting interface connects the Short Message Service (SMS), the unified authority management platform (ISC), the Mail System, the Information Management System (IMS) and the SMC system. The receiving interface connects the OA [12], the integrated network management platform. The specific information interaction diagram is as in Figure 4.

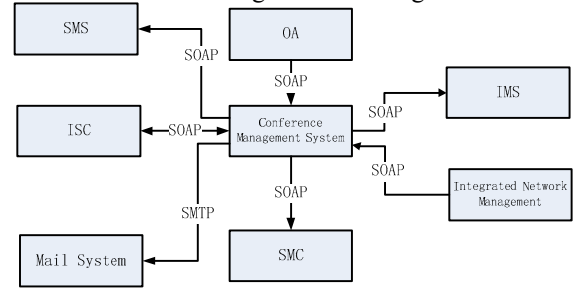


Figure 4. The Information Exchange Diagram of Conference Management System

Through all above interactions, the Conference Management System can schedule and manage all the video conferences unified. All the command on it can be transferred to the physical devices.

D. The Authority Allocation of Conference Assistant Staff

The realization of the hierarchical control by the Conference Management System is mainly through the allocation of the assistant staffs' authority. When controlling the conference by the Conference Management System, all the users call the interface of SMC by the same account of SMC. During the conference, all the branch venues' control authority is determined by the main hierarchical control switch. When the hierarchical control switch is on, all the provincial companies have the permission to call SMC interface for all the control functions. If the hierarchical control switch is off, the control authority of all the provincial companies will be recycled, leaving only the basic functions such as apply for speaking or exit the conference.

VI. HIERARCHICAL CONTROL FUNCTION IMPLEMENTATION AND APPLICATION CONTRAST

A. Implementation of Hierarchical Control Function

The hierarchical control strategy is designed to achieve the two levels of control in headquarters and provinces, in order to improve the efficiency of the video conferences.

When we choose the different states of this function, the authority of the headquarters and the provincial companies are designed as follows:

1) *Hierarchical control switch off - headquarters:*

After the conference starts, the hierarchical control function is off by default. Only the main venue in the headquarters has authority to control all the venues of the conference.

2) *Hierarchical control switch off - the provincial company:*

After the conference starts, the hierarchical control function is off by default. Only the main venue in the headquarters has authority to control all the venues of the conference. At this time, all the other venues have only the basic functions (speech applying, exit from the conference, query conference statistics)

3) *Hierarchical control switch on - headquarters:*

When the hierarchical control function is switched on by the main venue in Conference Management System, the control authority of the main venue remains unchanged, which still have all the control authority of the conference function.

4) *Hierarchical control switch on - the provincial company:*

When the hierarchical control function is switched on by the main venue in Conference Management System, the provincial units have the control permissions to its own subordinate units, which includes: Add / delete venue, call / hang up, watch the venue, venue query, statistics, functional details of the venue.

B. Role-Based Access Control model

We design the Conference Management System based on RBAC (Role-Based Access Control) model, which greatly enhanced the flexibility and self-service of the conference system. Through the establishment of appropriate roles in the system and flexible allocation of these roles in the structure, it greatly simplifies the management of authority. Users can be assigned to the corresponding roles according to its responsibilities and qualifications. Not only the role can be given new authority according to the new requirements, but the authority can also be recycled from a role by requirement.

The RBAC model of the system is designed and implemented based on the principle of least privilege, separation of responsibilities and data abstraction. It can configure the roles to the minimum authority set required to complete the tasks. It can complete the assigned tasks by calling the independent exclusive roles together. Data abstraction can be realized by the abstraction of the authority, instead of the typical read, write and execute permissions provided by operating system. All these principles are reflected by the detailed configuration of the Conference Management System structure.

RBAC model is an extension of the access matrix, which can solve the problem of distribution and control of the access authority in the system.

C. Application Comparison

According to the features of administrative conference, we design a two level hierarchical control RBAC model. The actual test verified that original four levels of MCUs can be

compressed to only two levels on physical, and one level on management. The numbers of MCU decreased to only 28 compared to the requirements of 348 originally. The platform architecture is shown in Figure 5.

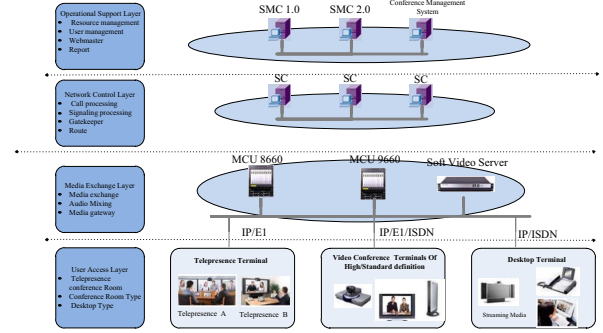


Figure 5. The Platform Architecture of Integrated Video Conference System of State Grid

According to the features of resource pool conference system, we design multilevel grouping hierarchical control RBAC model, which improved the original control mode and method at all levels while holding a large scale video conference. It realizes the unified command and hierarchical assistant on video conference system when maximum participation of the conference scale is more than 4000.

The resource pool system is growing mature. It has successfully held several large scale video conferences which are more than 300 participators since it adopt the hierarchical control function. This function greatly reduces the pressure of headquarters assistant. The advantages of which are reflected in the following three aspects:

1) Shorten debugging time before the conferences. Hierarchical control assistant mode uses only half an hour to finish the debugging session of more than 300 venues. The headquarters' operators only have to pay attention to the venues of the provincial level.

2) All the lower level companies' operations of the venue such as call, add, delete are done by the provincial operators, which enhances the fault handling ability during the conference.

3) By the end of 2016, resource pool system will be extended to cover a wider range-more than 2000 venues. It will bring greater challenges to the conference assistant work. Hierarchical control will support more than two levels control then, to adapt the change of the system scale.

VII. THE CONCLUSION

After the implementation of hierarchical control based on conference Management System, we successfully held more than 20 video conference in the first half of 2016. After the test in production environment, the high stability and feasibility of the conference assistant mode established in this paper has been verified. The hierarchical control conference assistant model can not only distract the stress of assistant staffs in all levels, but also can avoid the signal loss by analog transfer mode and the complexity of the system in the administrative conference we traditionally used. At present, the hierarchical control function of the Conference

Management System is playing an important role in State Grid Corporation's video conferences.

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