A Brief Discussion on the Construction of Cloud Video Conferencing Systems: Postprint

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Abstract

In 2020, the COVID-19 pandemic spread rampantly. To combat the epidemic, the demand for online cloud video conferencing increased dramatically. As a crucial means of remote real-time video communication, cloud video achieved rapid development and extensive application during the pandemic prevention and control period. This paper, through exploratory application of multiple technical methods, provides a reference for the promotion and use of video conferencing functionality on mobile internet platforms.

Full Text

Preamble

Title: Preliminary Exploration of Cloud Video Conference System Construction

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Abstract: The COVID-19 pandemic in 2020 triggered a dramatic surge in demand for online cloud video conferencing. As a critical means of real-time remote video communication, cloud video technology experienced rapid development and widespread adoption during the pandemic prevention and control period. This paper explores the application of various technical approaches to provide a reference for promoting video conference functionality on mobile internet platforms.

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1.1 Background

In the early stages of IT development, proprietary hardware systems such as mainframes and minicomputers—closed systems comprising dedicated hardware and software—emerged to meet stringent requirements for standalone system security and stability. These systems became the preferred choice for critical applications in large organizations, but their high cost, complex operation and maintenance, and limited scalability imposed significant burdens on users. Traditional video conference systems represent a classic example of such proprietary closed systems.

Video conferencing officially entered China in the mid-1990s, when the post and telecommunications bureaus began constructing dedicated network (E1)-based video conference systems, initially serving the State Council and ministries and provincial-level government departments [1]. The 2003 SARS outbreak brought devastating disaster but simultaneously thrust video conferencing into the public spotlight, triggering a development boom in China. The technology reached a new milestone in 2006 with the advent of high-definition (HD) video conferencing, and particularly after the 2008 Beijing Olympics, "HD" became the industry' s most prominent buzzword.

The COVID-19 pandemic in 2020 prompted the Central Epidemic Response Leading Group to convene multiple meetings calling for increased online work and reduced personnel gatherings, establishing a framework for normalized pandemic response preparations. Government agencies at all levels actively responded by deploying various remote collaboration tools to ensure business continuity while controlling the epidemic. As an essential tool for real-time remote video communication, cloud video technology experienced rapid development and widespread application during this period.

Cloud video technology, built on internet platforms and primarily software-based, has received extensive promotion from major telecom operators and industry-leading companies. Numerous vendors—including Huawei, DingTalk, Tencent, Xiaoyu Yilian, and Feishu—have launched relevant solutions, creating a highly competitive market. Overseas internet giants such as ZOOM, Webex, and Teams also compete for market share in China. The arrival of the 5G era has further accelerated cloud conference adoption. Leveraging mobile internet platforms, these products overcome the high hardware costs of traditional TV conferences, transforming the conventional room-to-room model into more flexible room-to-person and person-to-person configurations. These systems offer strong usability, broad coverage, and continuously improving audio-video quality, thanks to enhanced capture capabilities of mobile devices.

1.2 Advantages of Cloud Conferencing

(1) Addressing Pain Points of Traditional Video Conferencing for Internet and Mobile Scenarios. Cloud systems employ a flattened cloud platform architecture that abandons the traditional MCU tree-cascading approach of conventional video conferencing. This design enables arbitrary expansion of downstream access nodes and parallel collaborative unit visual access nodes, solving difficulties in horizontal video application integration. The advanced platform architecture and scalability can fully satisfy diverse video application requirements, achieving comprehensive "vertical to the bottom, horizontal to the edge" coverage through vertical and horizontal deployment.

In 2013, as 4G mobile internet gradually achieved commercial availability and technologies such as SVC flexible layered encoding, cloud computing, and general virtualization matured, cloud video systems seized significant development opportunities. With high reliability, availability, excellent performance, and flexible usage, these systems have gained increasing recognition from government agencies, enterprise groups, and financial institutions, gradually replacing traditional video conferencing systems.

That same year, the "Prism Gate" incident triggered global concerns about information security, prompting China to pilot domestically controllable electronic document systems. In recent years, China' s information technology application innovation industry has risen to prominence, aiming to establish independent and controllable IT industry standards and ecosystems by reconstructing all aspects of IT software and hardware [2]. Like other information systems, cloud video conference systems must comply with various requirements under this new policy framework and meet the standards of "information technology application innovation."

(2) Leveraging Public Cloud Providers' Overseas Internet Service Capabilities. This approach addresses challenges faced by private deployments —including network conditions, system security, and equipment aging—while reducing costs. Currently, major cloud conference vendors have deployed overseas acceleration nodes in the Asia-Pacific, Europe, America, and Middle East regions. By relying on these vendors' high-quality overseas network capabilities, they can solve network quality assurance challenges for global business users, addressing the operational pain point where traditional conference backends require private/local deployment but cannot guarantee network quality.

(3) Comprehensive Multi-Platform Solutions. Vendors provide solutions based on mainstream Android and iOS mobile systems, as well as Windows or Mac operating systems for PCs, with some also offering web-based access for rapid deployment. Cloud conferences already possess all functions of traditional TV conferences, supporting unlimited meeting reservations and creation, host control management (invite, hang up, mute, lock meeting, set main venue, end

meeting, etc.), recording, live streaming, downloading/sharing recorded videos, statistical meeting information (viewing/exporting meeting details), and contact list management (querying terminal information and online status).

Beyond these traditional audio-video and dual-stream functions, cloud conferences offer collaborative interaction modes unavailable in traditional hardware video conferencing. Many vendors have developed simultaneous interpretation capabilities to address difficulties in global personnel exchange caused by the pandemic, providing strong support for hosting global online summits. Numerous vendors have also embedded features such as online voting, cloud recording, cloud live streaming, and AI-based automatic meeting minutes transcription, offering comprehensive functionality that fully leverages their technological advantages in AI intelligence and big data processing.

However, video conferencing is a comprehensive technology requiring long-term technical accumulation and continuous functional iteration to maximize adaptation to diverse user requirements. Such applications generally exhibit characteristics of "high specification, large scale, and diverse types," demanding higher-definition audio-video effects, superior meeting experiences, simpler meeting control operations, and more comprehensive support services. Simple "internet + software client" cloud video solutions struggle to satisfy users across multiple dimensions including application effects, full-scenario access, security, and operation/management control.

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2. Common Problems

With continuous strengthening of information technology investment across systems and units over the years, dedicated network-based TV conference systems have become standard equipment for daily meetings in major organizations. However, due to limitations in network security, dedicated hardware codecs, dedicated video conference cameras, and other software/hardware and network aspects, their usage scenarios are mostly restricted to larger collective meetings in dedicated video conference rooms. Since networks cannot connect to the internet for security reasons, they typically cannot interface with mobile cloud video scenarios. When important emergency meetings arise, ensuring that mobile cloud video users can connect with dedicated network video conference users becomes a significant challenge for many dedicated system users.

2.1 Solutions

Solution 1: Back-to-Back Interoperability Method. Mobile users can install the cloud conference vendor' s meeting App or client on PCs, mobile phones, or tablets to access the vendor' s public cloud platform via the Internet (see Figure 3 [Figure 3: see original paper]). Deploy a hardware conference terminal registered to the cloud platform; this terminal calls into the cloud meeting room while other mobile users also join the same cloud meeting room.

Through audio-video interface docking between this hardware terminal and one hardware terminal of the dedicated network TV conference system, back-to-back cascading is achieved (see Figure 4 [Figure 4: see original paper]), with each side pushing audio-video images to the other, thereby realizing interconnectivity between cloud and dedicated network conferences.

This approach does not change the existing network structure, requires no connection between the dedicated network conference system and external networks, offers high security, and needs no modification to the original video conference system configuration—only requiring the addition of a cloud conference access terminal that can access the internet to connect to the cloud conference system. However, this solution' s drawbacks are also prominent: each set of back-to-back terminals can only support one meeting simultaneously. When users have multiple simultaneous meeting needs, multiple sets of back-to-back equipment must be deployed, creating considerable inconvenience in both deployment and usage. Additionally, this solution demands high operational skills, requiring operators to manage two meeting rooms simultaneously in both the cloud conference and dedicated network conference systems.

When user dedicated network conference systems and networks cannot be configured or debugged, this back-to-back connection method can be adopted to achieve integration between the two video conference systems. The author' s organization attempted this solution during the 2020 pandemic period, using Xiaoyu Yilian' s cloud conference product with Huawei' s TV conference system. By renting Xiaoyu Yilian' s cloud conference product, they addressed the usage needs of Xinhua News Agency headquarters departments and domestic/overseas branch users who lacked access to the dedicated network video conference system. Users were distributed across the Asia-Pacific, Middle East, Europe, and Africa regions. Xinhua News Agency staff joined the cloud conference system via Xiaoyu Yilian' s mobile and PC clients, while headquarters used a back-to-back cloud conference terminal that also joined the cloud meeting room. Through back-to-back docking with the dedicated network system, audio-video and dual-stream interaction in video conferences was achieved with good results. Particularly during the most severe pandemic period, this back-to-back solution provided crucial support for Xinhua' s editorial, human resources, and other operations.

Three Integration Schemes Comparison:

The paper presents three integration approaches with distinct characteristics. The H5 page method offers minimal workload and rapid implementation but cannot achieve deep customization. UI SDK integration requires relatively small workload and provides ready-made interfaces, but modification is difficult. Native SDK integration enables flexible customization to meet deep customization needs but demands relatively large development workload.

Main Advantages of This Solution: (1) The system employs cloud computing technology and general virtualization deployment, separating the appli-

cation layer from underlying hardware to achieve efficient resource scheduling and utilization. (2) The system adopts H.264/H.265 SVC flexible video encoding architecture, adaptively adjusting calling rates to accommodate various network accesses and dynamically adjusting video bitrates according to bandwidth changes to ensure meeting quality. (3) The system provides cloud-to-end unified management, with high automation bringing standardized management and reducing maintenance workload. (4) The system' s cloud architecture deployment allows rapid increase of computing and bandwidth resources based on the number of access users and regional distribution, enabling elastic and flexible expansion, reducing application deployment costs, improving system utilization efficiency, and saving internal investment. (5) The system' s deep integration with user mobile office platforms, based on unified contact management, can maximize user experience improvement while ensuring video conference quality and achieving deep integration between room-type application scenarios and mobile application scenarios. (6) The solution addresses network security issues when dedicated network conference systems open to the internet.

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3. Issues Needing Attention

Through integrated application of cloud conferences, various user needs can be satisfied, including video conferencing, command and dispatch, video consultation, remote training, and service supervision, providing strong impetus for user mobile office. Although cloud conferences offer numerous advantages, current challenges remain in both technology and internal promotion [4].

3.1 Concerns about Cloud Video Conferencing

With the rapid development of public cloud technology and related services, people's perception of cloud services is gradually changing. The global pandemic, in particular, has driven increased demand for online cloud services, especially for users with global overseas operations whose needs are particularly urgent [1].

3.2 Security Aspects

Since cloud conferences are provided through the SAAS model, users typically pay special attention to video data security. Key considerations include whether end-to-end security encryption is implemented, whether terminals perform encrypted encoding during audio-video transmission, whether hardware/software terminals can select appropriate bitrates based on network conditions and processing capabilities, whether encrypted communication with authentication is adopted between client and server, whether the client can verify server identity while preventing data leakage and tampering during communication, and whether complete recorded videos are stored with encryption.

For video storage security using public cloud services, users must consider whether complete recorded videos are encrypted and whether keys and encrypted storage files are located on different servers to achieve complete physical isolation, maximizing video file security. Currently, mainstream cloud conference service providers have all achieved Level 3 security protection capability, enhancing user confidence regarding data security, end-to-end business security, storage security, and database security.

3.3 Daily Operation and Maintenance Management

Regardless of which integration scheme is adopted, cloud conference system construction imposes new requirements on traditional TV conference system operation and maintenance units. Operators must manage system scheduling from a usage perspective while exercising strict control over meeting content management. All technical means are passive, and technical security requires human subjective intervention [4][1].

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Note: Figure translations are in progress. See original paper for figures.