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TECHNOLOGIES OF DATA TRANSMISSION IN VIDEO CONFERENCING SYSTEMS

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Анотація. Досліджено методи і технології передачі відео- та аудіоданих у системах відеоконфе-ренцзв'язку. Розглянуто існуючі проблеми у сфері передачі даних у системах конференцзв'язку че-рез Інтернет і методи їх вирішення. Проаналізовано найбільш поширені технології передачі відео-та аудіоданих у системах відеоконференцзв'язку через Інтернет. Розглянуті поняття телепрису-тності і особливості систем відеоконференцзв'язку, що її забезпечують. Зроблено висновки про доцільність використання різних технологій передачі відео- та аудіоданих залежно від типу сис-теми відеоконференцзв'язку.
Ключові слова: відеоконференцзвязок, телеприсутність, вебінар, базовий протокол «floor control», H.323, Flash-технології, RTMP.

Аннотация. Исследованы методы и технологии передачи видео- и аудиоданных в системах видео-конференцсвязи. Рассмотрены существующие проблемы в сфере передачи данных в системах конференцсвязи через Интернет и методы их решения. Проанализированы наиболее распростра-ненные технологии передачи видео- и аудиоданных в системах видеоконференцсвязи через Интер-нет. Рассмотрены понятие телеприсутствия и особенности систем видеоконференцсвязи, кото-рые его обеспечивают. Сделаны выводы о целесообразности использования различных технологий передачи видео- и аудиоданных в зависимости от типа системы видеоконференцсвязи.
Ключевые слова: видеоконференцсвязь, телеприсутствие, вебинар, базовый протокол «floor con-trol», H.323, Flash-технологии, RTMP.

Abstract. The methods and technologies, associated with video and audio data transmission in video con-ferencing systems were discovered. Existing problems in the field of data transmission in conferencing systems via the Internet and methods for their solution were considered. The most widely used technolo-gies of data transmission in the video conferencing systems via the Internet were analyzed. The concept of telepresence and features of video conferencing systems that it provides were considered. Conclusions about the appropriateness of using different technologies of video and audio data transfer depending on the type of video conferencing system were made.
Keywords: videoconferencing, telepresence, webinar, Binary Floor Control Protocol, H.323, Flash-technologies, RTMP.

1. Introduction

Conferencing is a technology that performs the ability of synchronous (simultaneous) communi-cation between several interlocutors. Current technology has great popularity in the modern world due to providing wide range of possibilities. Conferencing connects users, placed at great distances from each other (in different parts of the world). Provided communication is not limited by few users: conferencing allows performing simultaneous connection between huge numbers of participants. Conferencing is a duplex technology that is means that all conference participants have the ability to talk and hear each other. Considering all presented features the conclusion can be made that the technology of conferencing is required for meetings, workshops and different kinds of conferences. The distance education is also based on the current technology.

In the nearest past the only device, which allows performing conferencing, was telephone. Usage of telephone allows conducting of audio conferences: the participants can hear each other, can talk and express opinions, consult with each other and discuss new ideas, but the visual contact is not available. They can't see interlocutor, send each other different kinds of tables and

images that are necessary to perform complete work and obtain quality results. So the next stage of the development of conferencing is the video conferences, which were designed in 1970th.

Video conferencing is a communication technology, which provides interaction of two or more subscribers and the exchange of audio and video data between them in real time mode. Video conferencing is applicable in many areas, such as business, distance education and medicine and performed using video conferencing systems [1]. Personal video conferencing systems provide the opportunity to communicate "face to face" or "one to one" between two users in real time mode. Group video conferencing systems enable videoconferences, where huge numbers of interlocutors, situated all over the world, can take part.

There are several methods of arrangement of communication between interlocutors. The most available and the cheapest method is Internet. However the technologies of conferencing via Internet are not standardized that has negative impact on the interoperability, depending of platform and security issues. The investigation of the different technologies of data transfer in conferencing via Internet is presented in the paper.

1.1. Related work

The communication channel between users is the basic element of videoconference. There are several methods of arrangement of communication channels, such as ISDN, technology IP VPN MPLS and Internet. ISDN (Integrated Services Digital Network) is not widely used due its' significant disadvantages, such as low recovery efficiency of communication channels, difficulties in breakdown control and high price. IP VPN MPLS technology is the most secured method due to usage of additional protection technologies, such as VPN (Virtual Private Network) and MPLS (Multiprotocol Label Switching). VPN allows creation of one or more secure network connections (logical network) over another network. MPLS is data transfer mechanism which emulates various properties of circuit switched networks over packet switched networks. IP VPN MPLS is used in case of high priority of data protection. However the most available and the cheapest method for organization of communication channel is Internet. On the other hand usage of Internet has some disadvantages [2]. The quality of communication session can be low, because the Internet is not guaranteed channel for audio and video data transmission. The problem of data protection is also critical in case of using Internet as the communication channel. The technologies, which provide data transfer in video conferencing system via Internet, must consider these possible problems. Other problems, associated with technologies of video conferencing via Internet, appear due to the lack of standardization. The task of ensuring the interaction between video conferencing systems, developed using different data transfer technologies, is important for emerging communication technologies.

1.2. Purpose

The aim of the current paper is to consider the most widely used technologies of video and audio data transmission in the video conferencing systems via the Internet, to investigate their features, advantages and disadvantages and to analyze the appropriateness of using different technologies of video and audio data transfer depending on the type of video conferencing system (webinar, teleconference etc).

2. Investigations

To solve the problems, connected with video and audio data transmission via Internet, the additional technologies of data transfer should be applied. One of the possible ways of solution is usage of video conferencing protocols [3]. Video conferencing protocol is a set of arrangements that defines data communication between different software. The protocols determine the way of the data transfer and processing of network errors, and also enable the development of standards

that are not linked to a particular hardware platform. To perform audio and video conferencing over telecommunications networks ITU-T (International Telecommunication Union - Telecommunication sector) has developed a series of recommendations H.32x (H.320, H.321, H.322, H.323, H.324) [4].

2.1. Recommendation H.323

H.323 is a recommendation, developed by ITU-T (International Telecommunication Union - Telecommunication sector) that determines the set of standards for multimedia data transfer in packet switched networks [4]. Recommendations of ITU-T, included in H.323 standard, define the order of functioning of user's terminals in networks with the divided resources and not guaranteed quality of service (QoS). Standard H.323 is not connected with IP protocol, however, the most of implementations is based on it. The set of recommendations determines network components, protocols and procedures that allow organizing of multimedia communication in packet switched networks.

H.323 standard identifies different H.323 entities as the functional units of a complete H.323 network that allow conduction of bilateral (point-to-point) and multilateral (point-multipoint) multimedia conferences. There components are terminal, gateway, gatekeeper and MCU (Multipoint Control Unit) [5].

Terminal is a PC or other self-contained unit that is capable to perform multimedia application. Terminal must provide sound communication and can additionally support video and data transmission. H.323 terminal should support such protocols: H.245 for negotiation of connection parameters, Q.931 for establishment and control of connection, RAS for interaction with gatekeeper, RTP/RTCP for optimization of delivery of audio/video flow and H.450 set of protocols for support necessary for H.323 additional types of services.

Gateway is not necessary component of H.323 network. It is required only in case when the connection with the terminal of different standard should be established. Such communication is provided using the translation of protocol of connection installation and rupture and data transmission formants.

Gatekeeper is a centre of calls processing in area of its determinate zone and performs basic functions of calls management. Zone is defined as the set of all terminals, gateways and MCU that are controlled by one gatekeeper. Gatekeeper is not necessary component of H.323 network, but if it's present in the network, terminals and gateways should use it services. The basic services of gatekeeper are address translation (mapping), access control, bandwidth management, management of connection establishment process, authorization, calls control etc.

Multipoint Control Unit provides connection of three or more H.323 terminals. All terminals, participated in conference, establish connection with MCU. MCU server maintains conference recourses, determines possibilities of terminals in audio and video data processing, and determines audio and video data streams.

Recommendation H.323 provides bandwidth management, interoperability, platform independence, support of multipoint conferences, multicast transmission and addressing, codec's standardization.

Recommendation H.323 contains [5]:

– standards H.264, H.263, H.261, which define methods of video data encoding and decoding;

– standards G.722, G.711, G.728 et al., which determine methods of audio data encoding and decoding;

– standard H.225, which defines methods of audio, video, data and control streams multiplexing and demultiplexing and management of call, access, registration of participants and identification of the current state;

– standard H.245, which determines alarm, management and control, including multipoint conferences;

Fig. 1. Complete H.323 protocol stack

– standards of T series (T.120 et al.), which determine the interaction of software and hardware during the data exchange.

Complete H.323 protocol stack is shown in figure 1.

The emergence of standard H.323, which describes the mechanisms of interaction between devices providing the transmission of voice and video over IP networks, allows combining devices from different manufacturers in one network that is effective for specific communication network. Video conferencing systems, based ob the H.323, perform high quality of service (QoS) and provide wide range of features and opportunities, including TelePresence [6]. TelePresence is videoconferencing technology, which provides the maximum possible effect of the presence of the interlocutors in the same room (or study hall.) It allows user get an impression that he is located and acts in a position different from his physical location. However, technology of TelePresence is not popular due high cost of required equipment. Despite the high quality of communication and obtained data, video conferencing systems, developed using H.323, are not widely used for the same reason, especially in case of multipoint conference. MCU and other entities of H.323 conference often are not available for small companies, so they prefer usage of other systems that do not require additional costs for software and hardware, and are available through Internet browser. Current type of video conferencing systems is called webinar [7]. Systems of webinars show lower quality of communication and do not guarantee the security of transmitted information, but are widely distributed due it high availability and large number of OpenSource applications. Webinars systems are not based on H.323 and often developed using Flash technology and RTMP protocol.

2.2. Flash-technologies and Real Time Messaging Protocol (RTMP)

Flash is a multimedia platform, developed by Adobe to design web-applications and multimedia presentations. Nowadays it is widely used for design of animation and games and to reproduction of video and audio data on the web-pages.

Adobe Flash enables work with vector, raster and three-dimensional graphics using the GPU, and supports bidirectional streaming of audio and video broadcast. The special software, named Flash Player, is required to perform Flash-content. Basically, Flash Player is a virtual machine, which performs code of flash-application, downloaded from the Internet. Vector morphing that is gradual "overflow" of one keyframe to another, is a foundation of Flash animation. The performance of Flash in browsers is better than the performance of Javascript machine, but it worse than the performance of the applications working without virtual machines.

The standard extension for compiled flash-files (animation, games and interactive applications) is. SWF (Shockwave Flash). Videos in Flash format are presented as files with the extension FLV or F4V. In this case Flash is used only as a container for video. FLA extension matches the format of the working files in the development environment.

The main disadvantage of flash-applications is the excessive load on the processor associated with the ineffectiveness of the Flash Player virtual machine. The second major drawback of flash-applications is the lack of errors control, which leads to frequent failures of the

applications, and, in some cases, of the browser. However Flash-technology is used in popular OpenSource webinar systems, such as OpenMeetings and BigBlueButton.

The Real-Time Messaging Protocol (RTMP) was developed for high-performance transmission of audio, video, and data between Adobe Flash Platform technologies [8]. Adobe's Real Time Messaging Protocol (RTMP) provides a bidirectional message multiplex service over a reliable stream transport, such as TCP, intended to transfer parallel streams of video, audio, and data messages, with associated timing information, between a pair of communicating peers. (RFC RTMP) Different classes of messages received different priorities, which impact on their order in transport stream when transportation options are limited.

The RTMP is Adobe technology and RTMP server has high cost. However the Red5 OpenSource server was designed using Java and widely used in modern web-applications to perform RTMP. Red5 server provides audio and video data streams (FLV and MP3), recording of client data streams (FLV only), shared objects, live stream publishing.

The most widely used OpenSource webinar systems OpenMeetings and BigBlueButton are developed using Flash-technology and Red5 server.

2.3. The Binary Floor Control Protocol (BFCP)

To solve existing problems of video conferencing via Internet IETF created working group, named "Centralized Conferencing" (XCON). The target of XCON is to establish standards of video conferencing including development of such technologies as basic «floor control» protocol Binary Floor Control Protocol (BFCP), the mechanism of the membership and authorization, the mechanism of management of combination of different types of media files (audio, video, text) and its description, the mechanism of notification about the related to the conference events / changes (e.g. changing of protocol).

Floor control is a management of joint or exclusive access to shared resources in a (multiparty) conferencing environment [9]. Floor control also completes functions, realized by other protocols, such as conference and media session setup, conference policy manipulation and media control. During a conference, the applications require to control access to shared recourses (e.g. right to send media to a particular session). Floor control provides the ability for such applications to coordinate shared or exclusive access to the resources.

A floor control protocol is used to perform transmission of the floor control messages between the floor chairs (moderators), the floor control server and the participants of the conference. A centralized architecture with one key point, transmitted all messages (the floor control server), is used. Processing of the floor control requests is performed by floor chairs or by server (depending of the policy) [10]. The performance of Binary Floor Control Protocol (BFCP) is shown in figure 2.
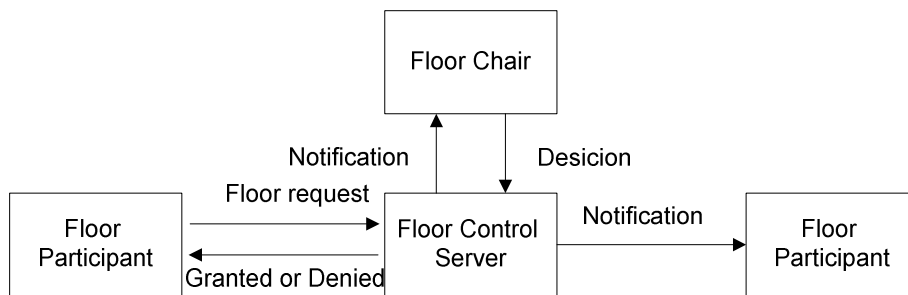
Floor participants send floor requests to floor control servers. Floor chairs send floor control server decisions about floor requests. Floor control servers permit (or deny) requests to access a required resource from floor participants and inform floor participants and floor chairs about the status of request.

Fig. 2. Binary Floor Control Protocol

3. Conclusions

Due to the existing problems, associated with transmission of video and audio data via the Internet, such as data protection and unstable communication channel, the additional technologies for multimedia data transferring should be used to provide the work of video conferencing systems. Several technologies are used to perform data transfer via Internet in video conferencing systems; the most frequently used are H.323, Flash and RTMP. H.323 standard (communication protocol) provides the highest quality of service, including the quality of video signal, security of transferred data and implementation of TelePresence. However current technology is used mostly in closed expensive systems and required high cost software and hardware that make it not available for widespread use. Another existing type of video conferencing systems is called webinars, performs using web-browser and has OpenSource editions. OpenSource webinars systems, such as OpenMeetings and BigBlueButton, are mostly implemented using Flash and RTMP (Red5) to perform video and audio data transmission. Webinars systems have low quality of service and don't provide data protection, but are preferred due to low cost and high availability.

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