Videoconferencing Technology for High-quality PC Multipoint Connections

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Abstract

This article describes the functional configuration of the servers and the four services that are provided as the multipoint videoconferencing service in the PC Communicator (PCC) system. The four services are videoconferencing among PCC clients (personal computers (PCs)), videoconferencing among PCs and a FOMA terminal, a multipoint chatting service, and a multipoint data sharing service.

1. Videoconferencing service

There is growing interest in communication services that use IP (Internet protocol) networks. Services that use ordinary telephones and dedicated terminals as well as services that use personal computers (PCs) are being provided by various companies. Among those services, the multipoint videoconferencing service, which connects multiple places of business, is attracting attention as a killer service. In the past, videoconferencing systems have generally used ISDN (integrated services digital network) lines or large-capacity leased lines. However, the rapid increase in popularity of the broadband network in recent few years has made it easy to use videoconferencing systems on IP networks, too [1]. The functions demanded for videoconferencing systems in the usage scenarios for different fields go beyond the exchange of video and voice among users to include the sharing of application program screen views and remote operation of personal computers. The PC Communicator (PCC) developed by NTT Cyber Solutions Laboratories and NTT Resonant Inc. provides a multipoint videoconferencing service among PCC clients in addition to point-to-point videophone communication.

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2. Configuration of multipoint videoconference server

The videoconferencing service of the PCC system is primarily implemented by a multipoint videoconference server. The server's functional configuration is shown in **Fig. 1** and the functional components are described briefly below.

• Authentication

This function restricts access to the videoconferencing service by authenticating users. In addition to authentication at startup, the PCC client periodically repeats the authentication process to update the authentication status. If either authentication fails, the PCC client disables the buttons related to the videoconferencing service to prevent unauthorized participation in the conference.

• Conference reservation function

This function reserves a videoconference and controls it. It provides the conference organizer with a conference input screen and other user interface elements for setting up a conference. It also sends instant messages or e-mail to notify conference participants of the beginning of the conference.

• Place management function

This function uses SIP (session initiation protocol) to establish a session with PCC clients that are participating in a conference. It also performs diagnostic checks on the sound mixer, video reflector, etc. and manages server availability.

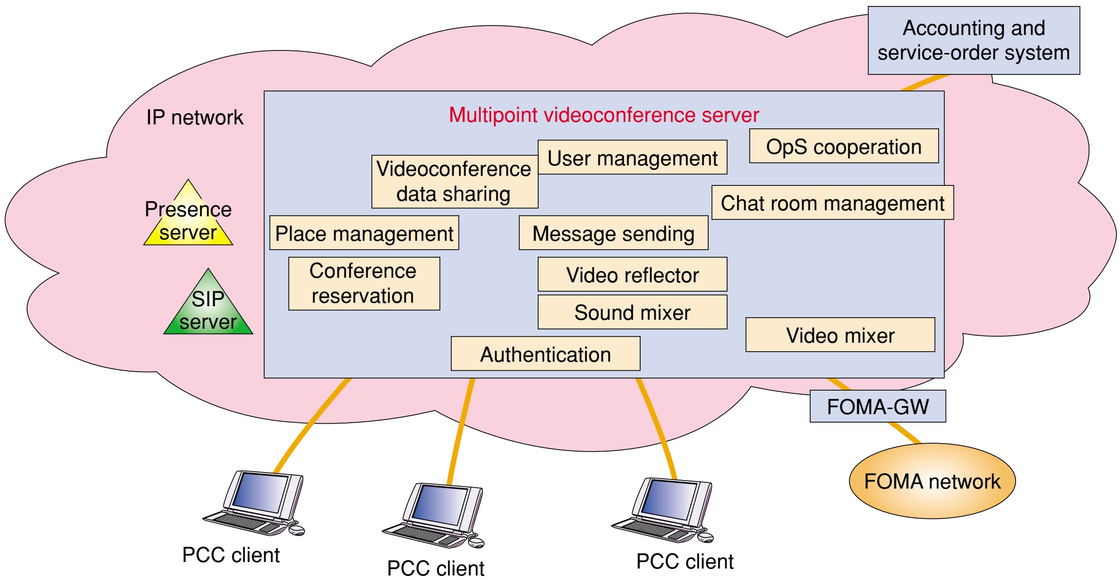

Fig. 1. Configuration of PC Communicator system.

• Sound mixer

This provides a function for sending and receiving audio data.

• Video reflector

This provides a function for sending and receiving video data.

• Video mixer

This provides functions for implementing audio and video services that involve FOMA terminals.

• Message sending

This provides functions for sending conference invitation messages when a conference begins or invitations to other clients to join a conference and for sending multipoint chat messages. The PCC clients are registered with the message sending function at startup, thus allowing messages to be sent.

• Chat room management

This function enables the transmission of multipoint chat messages.

• Videoconference data sharing

This function provides a multipoint data sharing service.

• User management

This function manages user permissions (permission to be a conference organizer or a conference participant) and SIP-URI (uniform resource identifiers).

• OpS cooperation

This function supports cooperation among different operations systems (OpSs). It provides an interface for user information registration, deletion, and accounting and creates an accounting log. The accounting processing that uses the accounting log data is performed by the accounting system.

Table 1. Multipoint videoconferencing service.

Conference size (maximum no. of persons)	Image size (pixels)	Client display (rows × columns)	FOMA terminals
4-person conference	QCIF equivalent (176 × 132)	2 × 2	No
8-person conference	QCIF (176 × 144)	4 × 2	Yes
10-person conference	SQCIF (128 × 96)	5 × 2	Yes
20-person conference	SQCIF (128 × 96)	5 × 4	No

QCIF: quarter common intermediate format
SQCIF: sub-QCIF

3. Multipoint videoconferencing service

The PCC system provides the following four services as a multipoint videoconferencing service.

3.1 Videoconferencing service between PCC clients

This is the basic service and can be used independently of the others. The multipoint chat and data sharing services (see 3.3 and 3.4) are intended to be used together with the videoconferencing service. The conference room sizes (i.e., the maximum number of participants) supported by the videoconferencing service are shown in Table 1. The conference setup is done by the conference organizer via a Web page (**Fig. 2**). The organizer can choose the conference room size when setting up the conference, but once set, it cannot be changed.

The service supports two types of videoconferences: reserved conferences and instant conferences. A reserved conference is conducted at the date and time indicated on the reservation page. For an instant conference, the startup processing begins as soon as the conference has been set up. In addition, e-mail messages are sent to notify conference participants a specified number of minutes prior to the beginning of a reserved conference.

When the conference begins, conference invitation messages are sent to the PCC clients. The conference invitation message contains the conference name, a comment, the organizer's handle name, and other conference information so that the invited participants can know what the conference is about before it takes place. When a PCC client receives a conference invitation message, it displays a screen for the user to see the conference information and confirm whether or not he/she will participate. If the user chooses to participate, he/she inputs his/her own handle name and then clicks the participate button. A SIP protocol INVITE message is then sent from the multipoint videoconference server to the PCC client to enable participation in the conference.

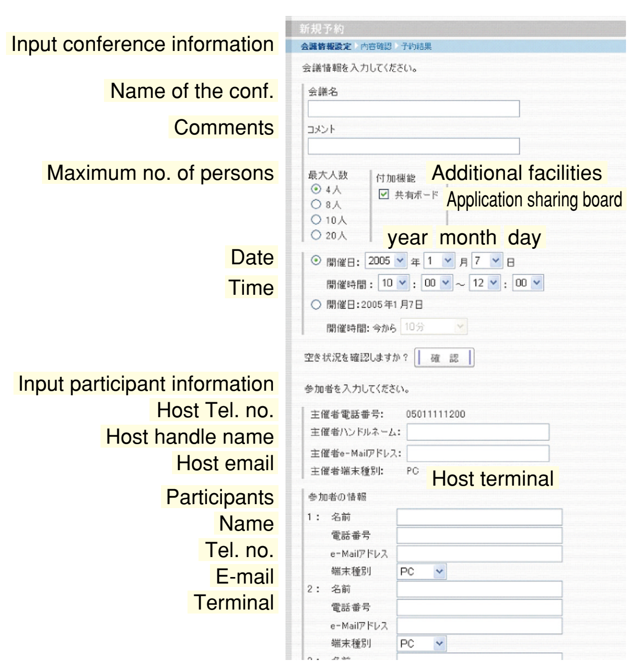

Fig. 2. Conference setup screen.

There are several sound mixers and video reflectors, so the PCC client determines which sound mixer and video reflector to use by referring to the SDP (session description protocol) contained in the INVITE message that was sent via the SIP server. Communication with PCC clients that are participating in other videoconferencing services can be accomplished by exchanging RTP/RTCP packets with the sound mixer and video reflector pair specified by the SDP (RTP: realtime transport protocol; RTCP: RTP control protocol). Furthermore, it is possible to invite additional participants to a multipoint videoconference that is in progress, up to the limit of the conference room size.

The sound mixer synthesizes a G.711 coded audio (3.4-kHz band) signal for all of the conference participants and sends it to each participant with that participant's own voice removed (that is to say, a user's own transmitted voice is not present in the received composite sound). The variation in arrival times of the packets generated in the IP network may cause interruptions in the voice and degradation of sound quality, but the server-side sound mixer and the PCC clients both incorporate buffers to absorb the differences in packet arrival time to reduce these effects.

The video reflector reproduces the video signal for each conference participant (excluding the receiving party's own video) and sends it to each participant.

3.2 Videoconferencing service with FOMA terminals

The videoconferencing service can handle the voice and video from one FOMA terminal. The service concept is illustrated in **Fig. 3**. When making a conference reservation, the conference organizer can register the FOMA telephone number in addition to the 050 telephone numbers of the PCC clients. When the conference begins, a voice-and-video call is made from the server to the FOMA terminal. When the call is received at the FOMA terminal, the video for one of the PCC client participants is displayed on the screen via the video mixer and the voices of all the participants are mixed. The video of the participant displayed on the FOMA terminal can be switched to that of another by pressing a key on the FOMA terminal. The person participating from the FOMA terminal can use this function to browse the video displays of the other participants and select the desired one. The key pressing is detected by the video mixer by means of DTMF (dial tone multi-frequency). The service for conference participation by a FOMA terminal is implemented mainly with the video conversion function and the call connection function.

The video conversion function converts the MPEG-4 Simple Profile Level 0 video from the FOMA terminal to MPEG-4 Simple Profile Level 3 for display on PCC clients. It also converts the video display size. The FOMA video size is QCIF (quarter common intermediate format) size, whereas the size used for PCC client multipoint videoconferencing may be either QCIF or SQCIF (sub-QCIF), depending on how the conference was set up. The images sent from FOMA terminals are also changed in size by the video conversion function, so they are displayed at the same size as the video images of all the other PCC client participants. For FOMA terminals, the video of other participants is displayed at QCIF size. For SQCIF-size conferences, the SQCIF video of the PCC clients is displayed on the FOMA terminals in QCIF size with margins added.

The call connection function establishes a SIP session between the place management function and FOMA-GW (gateway between a FOMA network and IP network) and sets up a voice-and-video call between the sound mixer and video reflector and the video mixer (which provides the video conversion function). An example of a screen in a multipoint videoconference that includes a FOMA terminal is shown in **Fig. 4**.

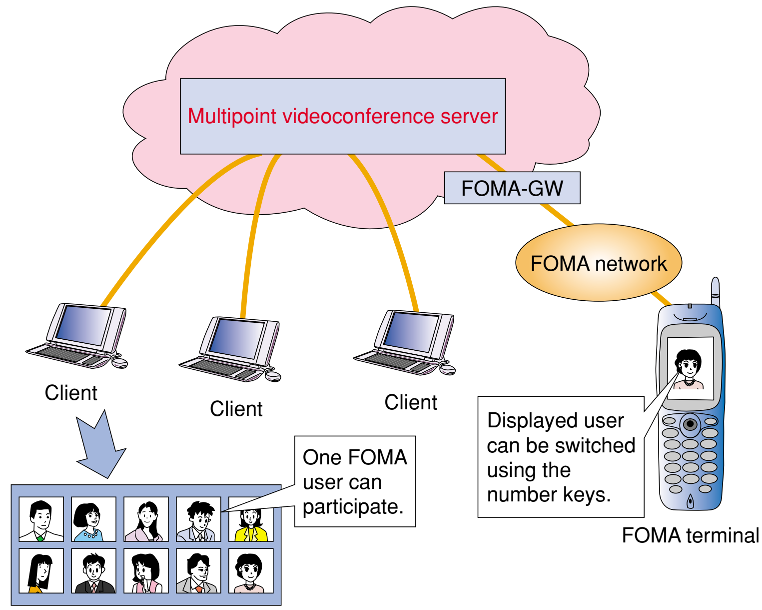

Fig. 3. Multipoint videoconferencing service with FOMA terminal.

Fig. 4. Example of FOMA user participating in an 8-person conference.

3.3 Multipoint chat service

The multipoint chat service provides a function for sending messages to all videoconference participants. Messages that have the same content are sent to all participants, including the sending party. The handle name of the sender that was set when the sender joined the conference is also displayed.

3.4 Multipoint data sharing service

The multipoint data sharing service provides functions for sharing materials with all videoconference participants while a voice-and-video conference is in progress. The four functions that make up this service are described briefly and their implementations are explained below.

(1) Web sharing function: sends any selected Web content on the Internet to all PCC client participants in a conference at the same time. The link-following, screen-scrolling, and form-filling-out actions can also be synchronized.

(2) File sharing function: displays conference material possessed by one conference partici-

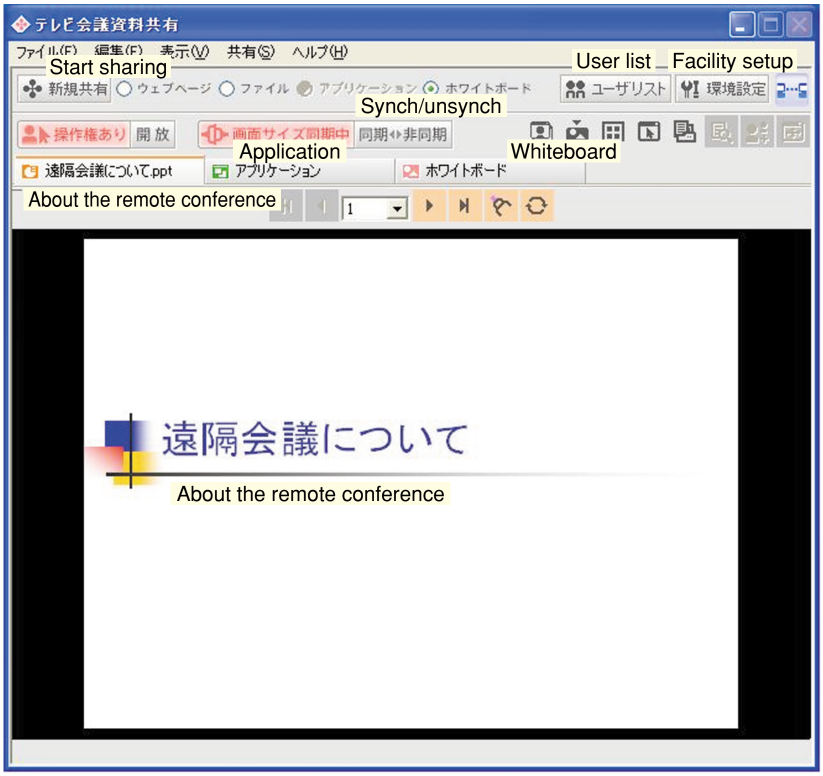

Fig. 5. Example of the data sharing service screen.

pant for all other conference participants to see. Sharable materials include Microsoft Word documents, image files, and PDF files.

(3) Application program sharing function: allows the screen of any application software that is running on the PCC client of a particular conference participant to be displayed on the PCC clients of all the other participants so that they can see the screen display generated by that application. Control of the application software can also be transferred to other PCC clients.

(4) Whiteboard function: allows Web content, files, and application software screens to be copied to a whiteboard that is shared by all PCC clients. Participants can also draw simple diagrams, text, line markers, etc. on the shared screen, which may be simply a blank whiteboard. The multipoint data sharing service makes the above four functions available at the same time.

Furthermore, in a multipoint videoconference, the multipoint data sharing service is implemented with the server-client model, so the shared information is all sent to the PCC clients via a server. A screen image of the data sharing service in a multipoint videoconference is shown in **Fig. 5**.

4. Conclusion

We have briefly explained the videoconferencing service of the PCC system, which takes advantage of a broadband communication environment not only to implement an advanced collaboration environment, but also to achieve a ubiquitous communication environment through cooperation with a cellular telephone network. In future development, we will continue to improve system functionality on the basis of feedback from users and service providers and develop services that are even easier to use.

Reference

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