A Cloud Type High-Definition Television Conference Service for Heterogeneous Clients with Various Signaling Control Protocols

Tsutomu Inaba†, Hideyuki Takahashi*, Naoki Nakamura‡, and Norio Shiratori*

†Business Marketing Division, NTT East-Miyagi, Japan
‡School of Medicine, Tohoku University, Japan
* Research Institute of Electrical Communication, Tohoku University, Japan
inaba@miyagi.east.ntt.co.jp, hideyuki@riec.tohoku.ac.jp,
nakamura@med.tohoku.ac.jp, norio@shiratori.riec.tohoku.ac.jp

Abstract - In order to reduce CO_2 emissions, Technologies of "Green by ICT" are now attracting attention from various fields. HDTV conference system is one of the approaches, because movements of automobiles are inhibited by the use of HDTV conference systems. However, the existing HDTV conference clients cannot be connected with each other, if each client is produced by different vendor, due to the issues related to communication protocols.

To solve these issues, this paper proposes a cloud-type interconnection service for heterogeneous HDTV conference clients, named *CISHDTV*, and evaluates the service. The proposal is one of the results of "Kurihara Green Project", which is a subsidized project by the Ministry of Internal Affairs and Communications Japan in 2010. CISHDTV is realized with Multi point Control Unit (MCU) and SIP conversion Gateway, and is provided to HDTV conference users beyond a public IP network.

Our demonstration experiments show a feasibility of the CISHDTV, and achieve a reduction of more than 80% CO_2 emissions in the case of a staff-training in Kurihara-City in Japan, where several branch offices are dispersed widely. We are now discussing the CISHDTV in the multimedia sub working group of TTC in detail, towards an international standardization.

Keywords: HDTV Conference system, SIP, H.323, MCU, Reduction of CO_2 emissions.

1 Introduction

"Green by ICT" is now attracting attention from various fields [1]. "Green by ICT" is an approach to inhibiting movements of automobiles/people, thus it is expected to reduce negative effect on the environment. "*Kurihara Green Project*" [3]–[8] in Japan is one of the projects promoted with "Green by ICT". The project especially forces on reducing CO_2 emissions in rural area instead of metropolitan area [9]. Rural cities such as Kurihara often have a distinctive structure, called "*Cluster-Type*" [10], in where several down towns are located separately. Hence, the people living in such a rural area have to depend on automobiles in their daily life. Therefore, it is important to limit the use of automobiles to reduce CO_2 emissions.

Television conference system is one of the approaches to reduce CO_2 emissions distinctly. Nowadays, several companies and/or communities have been introduced TV conference systems for the purpose of reducing the costs about business trip. However, existing TV conference systems produced by different vendors may not be interconnected with each other. In an interconnection of existing TV conference systems, there are several issues caused by a different implementation of communication protocols [2]. One is the issue caused by that the existing HDTV conference systems support multiple signaling protocols, such as H.323, SIP and SIP extensions. Another is caused by that the implementation of HDTV conference systems are different form one another, even though the systems are implemented based on same standardized protocol. And the other is caused by that each HDTV conference system supports different video codecs respectively. Because of these issues, a group which uses a HDTV conference system has to continue to use the same products.

To solve these issues, this paper proposes "Cloud-type Interconnection Service for heterogeneous HDTV conference clients (*CISHDTV*)". The CISHDTV utilizes "Multipoint Control Unit (*MCU*)" and "Protocol Convergence GateWay (*PCG-W*)". The service is offered for users beyond a public network on their demands. The service makes HDTV conference systems more convenient, and reduces CO_2 emissions significantly.

The rest of the paper is organized as follows. Section 2 explains the overview of the HDTV conference systems, and points out their interconnection problems. Section 3 proposes an interconnection service of heterogeneous HDTV conference clients beyond a public IP network. Section 4 evaluates the proposed service in terms of its feasibility and reduction of CO_2 emissions. Finally, Section 5 concludes the paper.

2 Interconnection Issues in HDTV Conference System

This section describes about the technologies related to HDTV conference systems at first, and then points out the issues of their interconnections.

2.1 Technologies related to HDTV Conference Systems

Screen resolution of High-Vision (HDTV) is 1,920 x 1,080 pixels, thus it requires 786Mbps information transmission rate [13] to transmit images over networks. Therefore, HDTV conference system requires high video compression technique, because current internet access speed by optical fiber (FTTH) is 100Mbps or less. When a HDTV conference is held with more than three sites, MCU is required as a central apparatus for images and sounds.

HTDTV conference system is usually utilized on IP networks such as the Internet. Especially in a business use case, the system is utilized on a Virtual Private Network (*VPN*) to keep the communication's security. Besides the above, the system also can be utilized on Next Generation Network (*NGN*) [11] or *HIKARI Denwa* [12]. NGN is a next generation communication infrastructure, which keeps the reliability and the stability that the traditional public telephone network provides. NGN also keeps the flexibility and the economic efficiency that IP networks provide. HIKARI Denwa is an IP based public telephone service. HDTV conference clients can connect with each other over HIKARI Denwa with the 0AB ～J telephone number.

HDTV conference system generally employs either Session Initiation Protocol (*SIP*) or *H.323* as a signaling control protocol. The SIP can be used for creating, modifying and terminating two-party (unicast) or multiparty (multicast) sessions consisting of several media streams [14], [15]. The existing SIP clients are generally implemented based on RFC3261 or RFC2543. In SIP, since only session control methods are defined, protocols such as the Real-time Transport Protocol (*RTP*)[16] and Session Description Protocol (*SDP*)[17] are utilized to transmit not only video/voice packets but also information of media-ability. The HIKARI Denwa also uses the extended SIP, named *NGN-SIP*, which is enhanced from a viewpoint of securities. However, to prevent security incidents, NGN-SIP does not allow some SIP methods which are generally used between HDTV clients and MCU.

H.323 is a recommendation from the ITU Telecommunication Standardization Sector (*ITU-T*), and defines the protocol sets to provide audio-visual communication sessions on IP networks[18]. Since the recommendation of H.323 was firstly approved in 1996, a lot of H.323 clients have been appeared on the market one after another. H.323 has high affinity with the traditional public switched telephone network. However, because the protocol structure of H.323 is quite complicated, H.323 isn't suitable for internet technologies, and it cannot scale. Therefore, today, the SIP is the major signaling control protocol, instead of H.323.

2.2 Interconnection Issues of HDTV Conference Clients

2.2.1 The Connectivity between Different Signaling Control Protocols

An interworking technology between H.323 clients and SIP clients have been studied since the SIP had attracted the attention. For example, an equipment which helps interworking of the clients, such as "Session Border Controller(*SBC*)" had been produced. As regards the requirements for the interworking technology, RFC4123 was defined as SIP-H.323 Interworking Requirements. However, in the interworking with the SBC, media capability exchange-timing causes a serious issue in an interworking of two clients. Each signaling control protocol defines original session initiation procedure, respectively. As shown in Table 1 and 2, H.323 and SIP have two session initiation procedures with different exchange-timings of media capability.

Table 1: The capability exchange-timings in H.323.

	Capability Exchange-Timings
Fast Start	Client offers its media capability in H.225 / SetUp
Slow Start	Client exchanges its media capability with H.245 / Terminal Capability Set messages. Most H.323 HDTV clients support this method. (General initiation procedure of H.323.)

Table 2: The capability exchange-timings in SIP.

	Capability Exchange-Timings
Early Offer	Client transmits available codecs and bandwidth which is described in SDP of INVITE. Most of SIP HDTV clients support this method. (General initiation procedure of SIP.)
Delayed Offer	Client offers its media capability with 200OK, as a response of the Initial INVITE without SDP (no offer of capability).

As shown in these tables, because H.323 clients and SIP clients support different exchange-timings of media capability, these clients cannot connect each other in many cases. It needs a combination of "Fast Start" and "Early Offer" or a combination of "Slow Start" and "Delayed Offer" to connect H.323 and SIP clients.

2.2.2 Difference between Implementations and Standardizations in the same Protocol

As described in Section 2.1, SIP and its extensions are defined in various RFCs. In addition, SIP relevant protocols, such as RTP and SDP, has been continually revised. These continually-updating standards make it more difficult to interconnect SIP clients, because fundamental standard of SIP client differs according to the time of their development, even if they are developed by the same manufacturer.

Moreover, various implementations of many manufacturers prevent interconnection of clients. The SIP is a text based protocol, thus it can be implemented easily to conference systems. On the other hand, the text based protocol brings about ambiguities of SIP definition. For example, there is no restriction of characters in the SIP description. And the number of strings is not defined clearly. Due to these ambiguities, each manufacturer uniquely implements with their own interpretations. Therefore, the interconnection of SIP clients becomes more and more difficult. Similarly, an interconnection issue is also caused by the original SIP implementations in a communication network infrastructure. For example, several SIP clients are available with HIKARI Denwa. However, these clients cannot be connected with each other, if the vendor

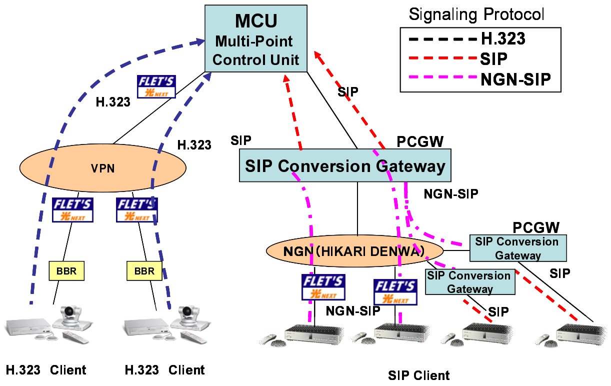

Figure 1: Overview of CISHDTV.

which provides the client differ from each other.

2.2.3 Difference of Implemented Video Codecs

An inconsistency in video codecs or communication rate often causes an interconnection issue of HDTV conference clients. The number of audio codec types is limited. Meanwhile, there are a lot of video codec types such as H.261, H.263, H.263+, H.264 and so on. Therefore, most of HDTV conference clients support a part of these video codecs based on their vendor's policy. As a result, HDTV conference clients cannot be connected with each other, because the clients cannot negotiate video codecs each other.

Similarly, a difference in communication rates supported by clients causes another issue of their interconnection, because each client specifies audio/video communication rate at its negotiation phase.

3 A Cloud-type Interconnection Service for Heterogeneous HDTV Conference Clients

To solve the issues as mentioned in Section 2, we propose a cloud-type interconnection service for heterogeneous HDTV conference clients, named *CISHDTV*, in which heterogeneous clients can be interconnected over public IP networks. Figure 1 shows an overview of CISHDTV. The CISHDTV can improve the users' convenience, in which the users can call a destination client on their demands with the 0AB∼J telephone number, and the cost is charged at a metered rate. The realization of temporal HDTV conference with any destination is greatly expected to stimulate a latent demand of users. As a result, HDTV conference will gradually substitute for traditional face to face meeting, and it greatly contributes to reduce CO_2 emissions.

3.1 Interconnection between Different Signaling Control Protocols

We propose a MCU rental service beyond IP networks for the general public users on their demand. In the service, SIP and H.323 clients interconnect each other through the MCU. MCU generally adjusts to various signaling control protocols, video codecs, transmission speeds, resolutions of picture, and so on. MCU can close not only the gap between SIP and H.323 but also the gap between the different abilities of various clients. Through an intervention of MCU, the issue of the timing of capability-exchange between SIP and H.323 as mentioned in Section 2.2.1 can be solved. In CISHDTV, the usage fee is charged based on the total length of time that the MCU service is used.

H.323 clients generally locate on a closed VPN to keep their conference session secret, because NGN and Hikari Denwa do not provide a conference service for H.323 clients. NGN-SIP clients are directly connected to HIKARI Denwa network with its User-Network Interface (*UNI*), and call a destination client with the 0AB-J telephone number. SIP clients are connected to HIKARI Denwa through a Protocol Convergence GateWay (PCGW) which exchange NGN-SIP to SIP. CISDHTV service provider provides a socket connection interfaces to MCU with PCGW for SIP client users.

3.2 Translations for the Differences of SIP Implementation

We propose the method that PCGW bridges the difference of SIP implementation, to solve the issues as mentioned in Section 2.2.2. The PCGW can translate the SIP based on RFC3261 into the NGN-SIP and vice versa. The PCGW can also bridge the differences of SIP implementation of clients. The PCGW supports both extension call and outside call. The existing SIP HDTV clients can connect to MCU over HIKARI Denwa with the PCGW. In CISHDTV, MCU is connected to HIKARI Denwa through the PCGW with 0AB-J telephone numbers. If a client calls to provider's PCGW with a phone number, the PCGW forwards the call to the suitable MCU, according to the configuration of call forwarding.

The existing HDTV conference clients generally use the SIP INFO Method [21] to transmit various information and control commands. However, the SIP INFO Method is not allowed to use in NGN/HIKARI Denwa (NGN-SIP) because of some security reasons. The PCGW encourages an interconnection of HDTV conference clients by its protocol translation function from SIP to NGN-SIP and vice versa.

3.3 Interconnection of Different Codecs

We propose a method that the MCU adjusts the difference of video codecs and/or communication rates that each client supports, to solve the connectivity problem as mentioned in Section 2.2.3. MCU supports a lot of video codecs and communication rates, so as to connect various clients. Therefore, MCU adjusts a video codec and/or a communication rate to the needs of the opposite client. For example, in the case where the caller A which supports video codec AA calls to callee B which supports BB through the MCU, the MCU negotiates A with AA and B with BB respectively.

4 Experimental Evaluations

In this section, at first we verify the proposed CISHDTV in terms of clients' connectivity through demonstration experiments at Kurihara-city in Miyagi Prefecture ,Japan. Kurihara-city constructs a typical decentralized city, called cluster-typed

Table 3: The list of used equipments

Category	Manufacturer	Equipment	Remarks
SIP client	Panasonic Communications	HD-COM (KX-VC500)	
NGN-SIP client	Panasonic Communications	HD-COM (KX-VC500)	Mode Switching
H.323 client	Sony Business Solution	PCS-XG80	
MCU	Cisco Systems (Tandberg)	Codian4520	20Ports
SIP Conversion GW	NTT Software	Crossway	

configuration. Next, we evaluate it for the reduction of CO_2 emissions based on an environmental assessment method.

4.1 Experimental Environments

Table 3 shows the list of equipment used in this experiments. We adopted a HDTV communication unit "Panasonic KX-VC500"(*HD-COM*) [22] which supports full HD(high definition) quality in a conference. It can select a signaling protocol from either SIP or NGN-SIP mode, by a flip of its switch. We also adopted a HDTV conference system "SONY PCS-XG80"(*XG80*) [23], which supports only H.323. Each client in this experiment is located as shown in Fig. 2. The access line of each location is Flet's Next[24], and it connects the clients to NGN and HIKARI Denwa service. H.323 clients are connected with Flet's VPN Wide, which is a public VPN service. The video codec of HD-COM is the H.264 High profile. Available resolutions of HD-COM are 1,920 x 1,080p, 1,280 x 720p and 704 x 480p. Besides HD-COM supports not only SIP but also NGN-SIP, so it can be used as a HIKARI Denwa client with the 0AB-J telephone number.

We also adopted the *Crossway*[19] as a PCGW. The Crossway is prepared for NGN-UNI (HIKARI Denwa) and NGN-SNI(application Server - Network Interface), thus we can use an existing HDTV conference clients on NGN through the Crossway.

Crossway realizes high connectivity, and it can connect with the policom, the tanbarg, the Sony and the HITACH high-tech clients. These four manufacturers occupy about 94% of share of SIP clients. The Crossway also can connect with the NGN-SIP clients such as the NEC and the Cisco. However the Crossway does not warrant the connectivity with HD-COMs.

4.2 Experimental Results

The evaluation experiments are executed in three steps below.

1) Interconnect test between SIP and NGN-SIP clients

2) Interconnect test between SIP/NGN-SIP client and MCU

3) Interconnect test between SIP/NGN-SIP client and H.323 client through MCU

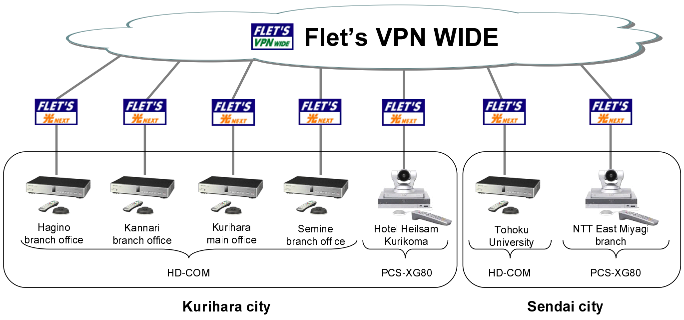

Figure 2: The deployment of HDTV clients.

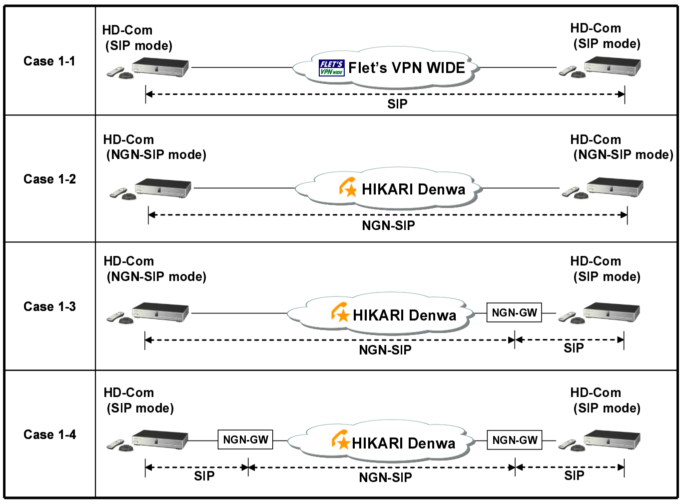

Figure 3: Connectivity tests between SIP and NGN-SIP clients (STEP1).

In the experiments, we confirm the messages of signaling protocols during a conference session. We also measure and analyze the messages related with video and voice during a HDTV conference for over 30 minutes.

4.2.1 Connectivity of SIP Client with NGN-SIP Client (STEP1)

At first, we try to connect HD-COMs to each other with SIP and NGN-SIP mode. Figure 3 shows the test pattern of this connection. When HD-COM runs in SIP-Mode, HD-COM connects to HIKARI-Denwa through Crossway as a NGN-GW(PCGW).

[Case 1-1]
Caller HD-COM(SIP-Mode) calls to callee HD-COM(SIP-Mod) with IP address.

[Case 1-2]
Caller HD-COM(NGN-SIP) calls to callee HD-COM(NGN-SIP) with the 0AB-J telephone number.

[Case 1-3]
Caller HD-COM(NGN-SIP) calls to the opposite Crossway with the 0AB-J telephone number. In this case, the called Crossway with the 0AB-J telephone number calls the destination HD-COM(SIP) with the extended number which is associated with the 0AB-J number in advance.

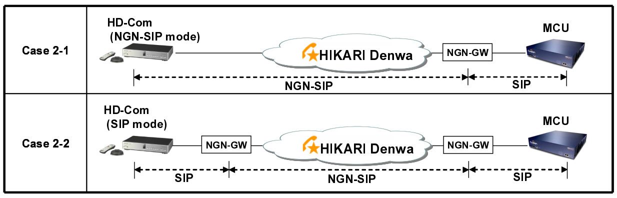

Figure 4: Connectivity test of SIP/NGN-SIP client with MCU (STEP2).

[Case 1-4]
Caller HD-COM(SIP) calls to the opposite Crossway with the 0AB-J telephone number. In this case, the called Crossway with the 0AB-J telephone number calls the destination HD-COM(SIP) with the extended number associated with the 0AB-J number in advance. The caller HD-COM corresponds to an extension client of the Crossway.

The results from those four cases show that the interconnection of HD-COM with SIP/NGN-SIP modes does not cause any problems from the point of signaling control protocol level and picture transfer protocol level. The results also prove that the interconnection between HD-COMs actually is very practical. It is clear that the Crossway can translate SIP of HD-COM into NGN-SIP and vice versa.

4.2.2 Connectivity of SIP/NGN-SIP client with MCU (STEP2)

In the STEP2, HD-COM in SIP/NGN-SIP mode connects to MCU. Figure 4 shows the test pattern of this connection. This experiment confirms that Crossway can translate the vendor original SIP implementations, and also confirms the connectivity of Crossway with various SIP clients in codec level.

[Case 2-1]
Caller HD-COM(NGN-SIP) calls to the MCU. Specifically, HD-COM(NGN-SIP) calls to the opposite Crossway with the 0AB-J telephone number, and the Crossway calls the MCU with the extended telephone number which is associated with the 0AB-J number in advance. In the case 2-1 and 2-2, we confirm the video pictures, which are fed back through the MCU, on the caller HD-COM.

The experimental results show that the interconnection of HD-COM works correctly from the point of Signaling Control Protocol level. However we also confirmed that image noise in Fig. 5 was shown, sometime after a session is established.

[Case 2-2]
Caller HD-COM(SIP) calls to the MCU. Specifically, the Caller HD-COM(SIP) dials a 0AB-J telephone number to connect opposite Crossway, and the called Crossway calls the MCU using the extended telephone number associated with the 0AB-J number in advance.

These results show the interconnection between HD-COM and MCU works correctly from Signaling Control Protocol level, and image noise does not confirmed at all.

Figure 5: Image noise on the caller HD-COM

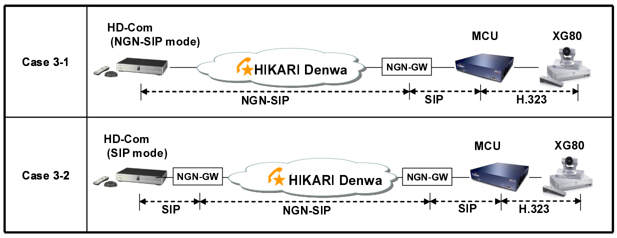

Figure 6: Connectivity tests of SIP/NGN-SIP client with H.323 client through MCU (STEP3)

4.2.3 Connectivity of SIP/NGN-SIP client with H.323 client through MCU (STEP3)

In STEP3, HD-COM connects to H.323 client XG80 through MCU. Figure 6 shows the test pattern of this connection. Here HD-COM and XG80 connect to the MCU respectively, according to appointment information of meeting on the MCU.

[Case 3-1]
The caller HD-COM(NGN-SIP) dials a 0AB-J telephone number to connect to MCU beyond the HIKARI Denwa network. The XG80 dials an extended telephone number to connect to MCU beyond a VPN.

The experimental results show that the message connection between HD-COM and XG80 through MCU works correctly from the point of Signaling Control Protocol level. However we also confirmed image noise such as caused in case 2-1, sometime after a session is established.

[Case 3-2]
The caller HD-COM(SIP) dials a 0AB-J telephone number to connect to MCU beyond the HIKARI Denwa network. The XG80 connects to MCU with the same fashion of case 3-1.

The experimental results show that the message connection between HD-COM and XG80 through MCU works correctly from the point of Signaling Control Protocol level. In addition, image noise such as case 3-1 does not occur at all.

4.2.4 Discussions about the occurrence of image noise

In the test cases 2-1 and 2-2, image noise is appeared sometime after a conference session is established. Hence, we captured the messages transmitted between HD-COM and MCU with wireshark [20], and analyze these. As a result, it is clarified that the transmitted messages which HD-COM requests

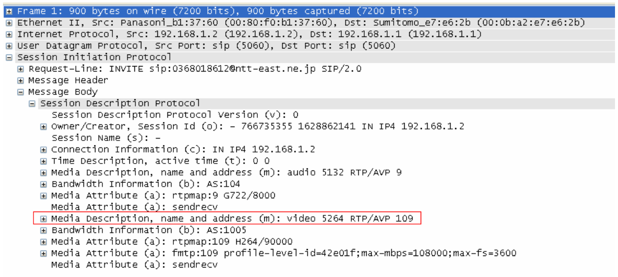

Figure 7: Initial INVITE messages transmitted from caller HD-COM (NGN-SIP mode).

an opposite equipment to redraw its video image, does not arrive at MCU.

HD-COM requests the destination clients to redraw video pictures with RTP/AVP [25]. In fact, HD-COM transmits the RTCP messages to notify the destination clients that a video image has changed significantly. However, even though the Crossway received the messages from HD-COM, the Crossway could not forward the messages to MCU. Figure 7 shows the Initial INVITE message of SIP, which is transmitted from HD-COM. In this figure, Media Description is described as ”video 5264 RTP/AVP 109” in a part of Session Description Protocol(SDP). Although the Crossway supports only RTCP-Based Feedback (RTP/AVPF) [26], it does not support the RTP/AVP.

These results revealed that it is necessary for HD-COM to support RTCP-Based Feedback (RTP/AVPF) or for the Crossway to support RTP/AVP. We are now discussing which of two methods is more suitable to solve the picture noise problem.

4.2.5 The Effects of Reduction of CO_2 Emissions

This subsection evaluates the effect of utilization of HDTV conference systems with CISHDTV from the view point of the reduction of CO_2 emissions. As an evaluation example in the real world, we held “Training workshop of city worker”. The workshop was held with thirty members of Kurihara city office, and twenty-one members from Kannari branch office. In addition, two members from Hatsudai (Tokyo) also participated in the workshop as lecturers.

Table 4 shows the evaluation model and its assumptions. If all of the members gathers in a same conference room at Kurihara City office, twenty-one people from Kannari and two lecturers from Hatsudai have to visit Kurihara City office by automobile, subway and bullet train.

On the other hand, in the experiments, the members participated in the workshop with HDTV conference systems only needed to gather from their own offices. Figure 8 shows an overview of the workshop with HDTV conference systems. The XG80 (H.323 clients) in Hatsudai is connected to the MCU provided by CISHDTV beyond VPN. The HD-COMs (in NGN-SIP mode) in Kurihara and Kannari are connected to the MCU beyond NGN(HIKARI Denwa). Since the system in Hatsudai differs from the other systems, at least the lecturers have to go to Kurihara-city, if the CISHDTV is not

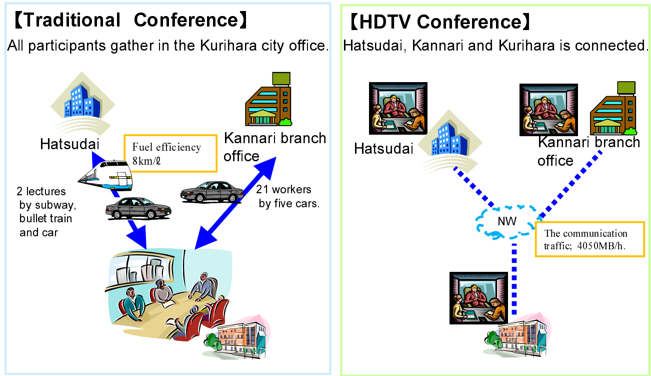

Figure 8: A training workshop for officers at the Kurihara-city with HDTV conference services.

Table 4: Evaluation model and its assumptions

	Traditional Conference	HDTV Conference
Common Conditions	[Participants] Kurihara:30, Kannari:21, Hatsudai:2, [Meeting Time] 90 min	
Evaluation Model	All participants go to the meeting room in Kurihara city office.	Interconnect Kurihara, Kannari and Hatsudai.
Assumptions	[Traveling by Train] -Participants from Hatsudai travel back and forth between Hatsudai and Kurikoma-Kogen station. [Traveling by Automobile] -Participants from Kannari travel between Kannari-SogoSisyo to Kurihara city office by six cars. -Participants from Hatsudai travel between Kurikoma-Kogen station to Kurihara city office by a car. -Automobile mileage: 11.2Km/L	[ICT System] -Conference on 90 minutes -Scheduled 72 hours/year -The distance from Kurihara to Kannari: 12km -Flet’s VPN Wide -Communication Traffic: 8GB/h

provided.

The reduction effect of CO_2 emissions are evaluated with *Kankyo Shiro* [28]. Kankyo Shiro is an evaluation system to measure environmental impacts. It measures how ICT services over networks can reduce the amount of CO_2 emissions quantitatively. In addition, it is fully compliant with the standardized guideline of Life Cycle Assessment Society of Japan Forum [29] under Ministry of Economy, Trade and Industry. Kankyo Shiro considers about every life cycle stage of ICT services, through its production, use and disposal. This system automatically displays the amount of CO_2 emissions by the entries concerned about ICT System, Soft-

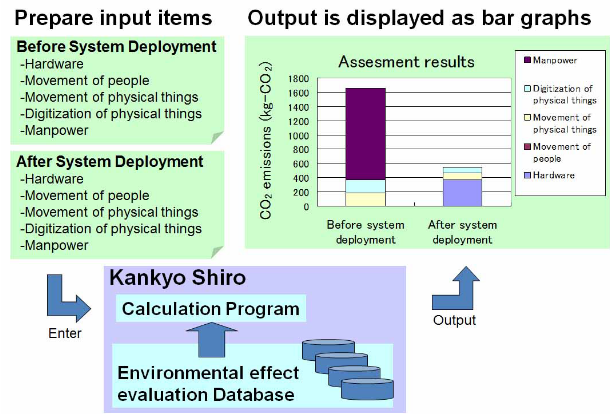

Figure 9: Flow of assessment by Kankyo Shiro.

ware, Movement of People, Movement of Goods, Computerization, Transportation Efficiency and Behavior of people. It calculates the environmental load of the two cases, where ICT systems are introduced or not, and shows the effects of the case with ICT service compared with traditional method. A flow of assessment by Kankyo Shiro is shown in Fig. 9.

Figure 10 shows the reduction effect of CO_2 emissions in this experiment. From the result of the experimentation, it is calculated the amount of reduction of CO_2 emissions is about 93.7kg-CO_2. This is roughly equal to the mount of seven day's CO_2 emissions of average household [30]. As shown in Fig. 10, the reduction rate achieves about 80%, this is because the amount of CO_2 emissions caused by traffic movement exceeded that of by ICT systems.

Figure 11 shows the factors of CO_2 emissions in this experiment. The movement of the lecturers by train has occupied about 58% of total CO_2 emissions in the traditional conferences. In reality, train service is independent of the lecturers' action. However, Kankyo-Shiro takes account of the CO_2 emissions as a potential for reduction. Kankyo-Shiro calculates CO_2 emissions with the basic data, which is defined as a unit amount in which a person moves 1 kilometer by train. This is because that Kankyo-Shiro is based on a premise, that development and spread of IT technology will make people not to take trains and then reduce train services. Even if the movements by train do not take into account, we can see that the reduction of CO_2 emissions achieves about 40%.

In the experiments, the 21 officers of Kannari made a round trip to the Kurihara city office by five cars. The distance from Kannari to Kurihara is about 12 kilometers. From this condition, Kankyo Shiro calculates that the amount of CO_2 produced by the movement of car is about 40kg-CO_2. On the other hand, Kankyo Shiro also calculates that 17kg-CO_2 will be produced by the 21 officers' movement by train, if public railroad service is available between Kurihara and Kannari. Therefore, reduction effect of CO_2 emissions by HDTV conference system is more effective especially in the clustered-type city such as Kurihara, compared with metropolis with convenient public transportations.

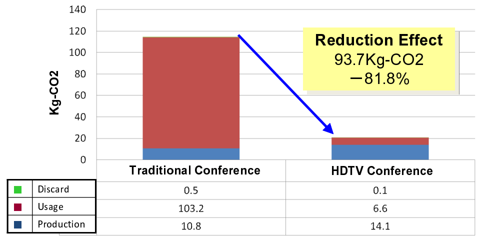

Figure 10: Reduction effect of CO_2 emissions.

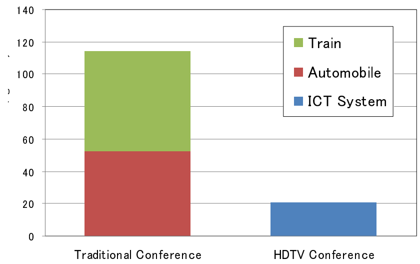

Figure 11: The factors of CO_2 emissions.

5 Conclusions

This paper proposed a cloud-type interconnection service for heterogeneous HDTV clients, named CISHDTV, for the purpose of reduction of CO_2 emissions. Demonstration experiments in Kurihara-city show a service feasibility of CISHDTV. However, it still remains some problems, in which the messages instructing opposite-side client to refresh a picture could not reach to the opposite-side client, when the HD-COM client operates under the NGN-SIP mode. This causes a picture noise severely in the destination client. Now we are analyzing for the difference of implementation in detail, and discussing the proposed service in Multimedia SWG meeting of TTC [31] toward its standardization.

In addition, demonstration evaluations in Kurihara-city shows the effectiveness of proposed CISHDTV, especially it can achieve more than 80% reduction in CO_2 emissions. With a popularization of the CISHDTV, more companies or municipalities will be connected mutually through their existing HDTV conference systems. As a result, it will come to have a great effect on the reduction of CO_2 emissions.

In the near future, we expect that many organizations especially located around local city will utilize HDTV conference systems with CISHDTV.

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Tsutomu Inaba is currently a system engineer of NTT EAST-Miyagi. He is mainly in charge of business-academia collaboration projects. His research interests include P2P network computing and its applications, green computing and fault-tolerant network. He received the B.E. Degree in Mechanical Engineering, the M.S. and Ph.D. Degrees in Information Sciences from Tohoku University in 1993, 1995 and 2010, respectively. He is a member of the IPSJ.

Hideyuki Takahashi is an assistant professor of Research Institute of Electrical Communication of Tohoku University, Japan. He received his doctoral degree in Information Sciences from Tohoku University in 2008. His research interests include ubiquitous computing, green computing and agent-based computing. He is a member of IEICE and IPSJ.

Naoki Nakamura is a lecturer at Graduate School of Medicine, Tohoku University. He received his Ph.D. degree in Information Sciences from Tohoku University, Japan, 2008. His research interest includes wireless networking, distributed algorithms, network performance evaluation, and network management. He is a member of IPSJ.

Norio Shiratori ,born in 1946, is currently an Emeritus Professor and Visiting Professor at the RIEC, Tohoku University and the GITS, Waseda University, Japan. He is a fellow of the IEEE, the IPSJ and the IEICE. He was the president of the IPSJ (2009-2011) and the Chair of the IEEE Sendai Section (2010-2011). He has received "IPSJ Contribution Award" in 2008, "IEICE Contribution Award" in 2011 and "Science and Technology Award (Research Division)" by MEXT (Ministry of Education, Culture, Sports, Science and Technology-Japan) in 2009 and many others.