Services/Systems Provided over the Games Data Network [Ⅱ] : Telecom Services Offered by the Organising Committee

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Abstract

This article provides an overview of the main "telecommunication services" provided by the Organising Committee of the Tokyo 2020 Olympic and Paralympic Games using the Games Data Network, their achievements and results. This paper also discusses the problems encountered in the preparation and construction of these services, and provides a viewpoint for providing similar services at future events.

Keywords : Communication service for the Games, Press Plus (Press VLAN services), Local 5G, CATV, FMC service

1. Communication Service

An overview of the Games Data Network, the network for FA systems housed in OCOG Technology Network (OTN), and the widely used basic functionality of Wi-Fi connectivity, are described earlier. In this section, we will continue to introduce the design, construction, and provision of some of the main "communication services" used during the Games time, as described below.

Main communication services

- Internet for the Stakeholders
- Special VLAN service for the press (Press Plus)
- CATV (Community Access Television) service
- IP fixed-line telephone and FMC services
- VLAN for TV conference service
- IOC staff network (used at Olympic Family Hotel)
- VLAN Connect (VPN within and between venues)
- Internet with global IP address, etc.

2. VLAN Service for the Press (Press Plus Service)

2.1 What is the Press Plus Service?

Major press agencies covering the Games send photos taken by photographers at each venue to the Main Press Centre (MPC), where they select the photos and distribute to the media worldwide. The network used to send photos from the venues to the MPC was called "Press Plus," a virtual private network (VPN) service with secure bandwidth provided by the Organising Committee (Figure 1). A total of ten agencies, international press agencies accredited by IOC and official domestic press agencies of the Olympic and Paralympic Games Tokyo 2020 (hereafter referred to as "Tokyo 2020 Games"), used this service.

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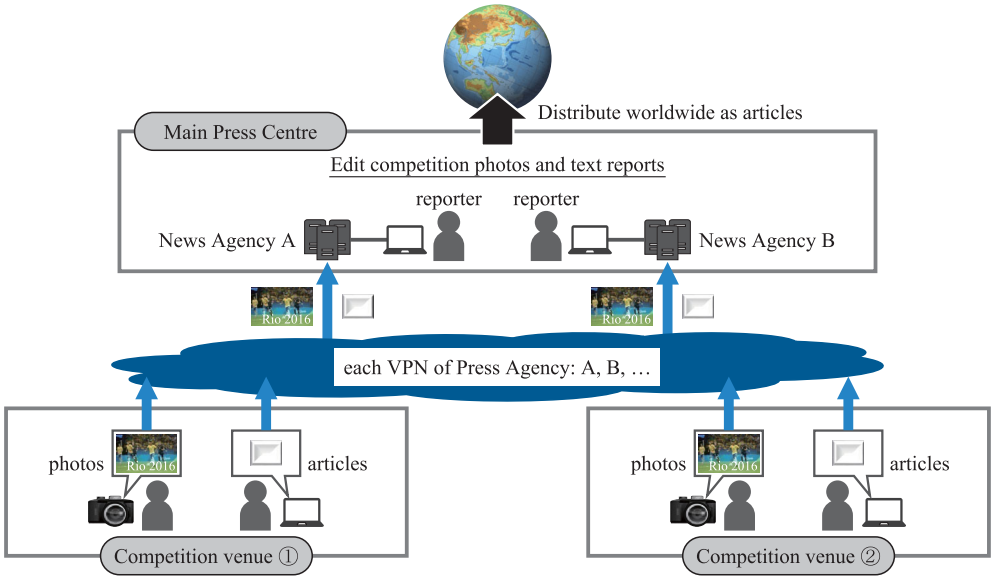

Figure 1　Press Plus Service Image

2.2　Main Service Requirements

In the past Games, a static VLAN (virtual LAN) environment was provided so that the terminals of each press agency at the venue were able to communicate with the terminals installed at their MPC desks. However, because it was static, the location of switches that could be connected to the press VPN and the ports that could be connected with the VPN were limited, and the press agencies needed to travel to those locations and use the specific ports to send data from venues to the MPC.

For greater convenience, a new method of "dynamic VLAN assignment based on MAC address (unique physical address called Media Access Control) authentication" was introduced for the Tokyo 2020 Games, and this service was provided as a "closed L3-VPN" and "Wi-Fi access" specifications. The communication terminals such as cameras had unique MAC addresses assigned, and when a terminal was connected, the MAC address was recognized by the L3 switch, which functioned as a router and a switching hub. By managing and registering which terminals were used by which agencies, the moment a terminal (precisely a wired cable connected to the terminal) was plugged into an open port on an L3 switch at various locations in the venue, it was recognized and authenticated which agency's terminal it was, and was dynamically and securely connected to the VLAN configured by each agency. This was called a "closed L3-VPN" specification.

This closed L3-VPN service was initially considered to need to include the function to connect to the Internet, but since security threats such as unauthorized access are more serious, some press agencies had said that the Internet connection is unnecessary in consideration of security, and the Internet connection is finally excluded from the Press Plus specifications. On the other hand, there was a strong request from press agencies for Wi-Fi connectivity, so it was provided after joint verification by NTT East and Cisco. In addition, for fixed locations, each company was able to statically connect to its own VLAN by connecting to a predetermined cable ports. Specifically, the designated locations such as Photo Position/Press Tribune/Venue Media Centre were connected to Press Plus VLAN via specific wired LAN cables, while the Catwalk/Underwater locations were connected to Press Plus VLAN via specific L2 switch ports.

2.3　Operational Testing and Operation

As this was the first time in the history of the Games that a dynamic allocation function was introduced, this service was tested beforehand with the press agencies three times in June 2018, October 2019, and May 2021 : the first was to confirm "dynamic VLAN allocation based on MAC address authentication", and the second was to confirm registration and overall functionality using the "portal for MAC address registration", and the third was to test the final operation using the actual environment between venues. In June 2021, nine of the press agencies participated in the third test, along with the IOC, the

Organising Committee, Cisco, NEC, and camera manufacturers (Canon, Nikon, and Sony). The service was launched on the same day of the MPC soft opening, July 1 2021.

During the Games time, an engineer dedicated for Press Plus was assigned as a support staff in MPC enable each agency to inquire about the service directly without going through the service desk. Thanks to such careful preparation and organization, there were no network problems or trouble reports. The system also performed well during the opening ceremony and track and field events such as men's and women's 100 m finals, which were reportedly expected to be the most heavily used events during the Games. The total number of devices used during the Olympics was 2,253, and the maximum communication bandwidth to the MPC was 1.8 Gbit/s.

2.4 Local 5G Demonstration

Technological innovation and institutional development of the next-generation communication system, Local 5G (see Figure 2), has been progressing rapidly, including institutional revisions related to the expansion of the frequency band used for Local 5G ; Sub6 of 4.6 to 4.9 GHz and Millimeter wave of 28.3 to 29.1 GHz were newly available in December 2020. In addition, the NSA (Non-Stand Alone) system using Sub6, which will be the mainstream system, became available, and this technology and service were in the phase of expansion at the time of the Games. On the other hand, the expectation on the speed for distributing visual contents in the current media is increasing, and transferring photo data reliably and quickly is significant for the events that draw large attentions such as global sports events.

With this background, a telecommunications service partner, NTT East provided local 5G as one of Press Plus connectivity functions to agencies at Tokyo 2020 Games in order to gain practical knowledge of the use of local 5G for news coverage of large-scale events.

NTT East installed local 5G at the Olympic Stadium. Unlike spectator seating, the stadium field where the Games were held often lacked sufficient cellular coverage, so a local 5G environment was built to cover those spaces. Six media agencies that wished to use the system connected their devices through Local 5G to their Press Plus VLANs. This system enabled photographers from each agency to upload large-volume photo data taken in the field during the opening and closing ceremonies as well as Track and Field competitions in a stable environment in real time. Each company was provided five terminals, and the total transmission volume during the Games was 475 GByte ; assuming that each file was about 10 M, this means that nearly 50,000 high-resolution photos were uploaded. Three antennas were designed and built to cover the field, the photo positions where wired LAN ports were not located, and the competition field. During the competition, there was once a situation in which connection was difficult due to interference between some cells, so the antennas were adjusted and recovered to provide an optimal signal environment during the competition. There were no major complaints from users, and all companies seemed satisfied with the quality of the system. Local 5G is a technology that offers the advantage of high-quality wireless access in an environment where Wi-Fi and public networks are unstable due to interference and congestion, and it can be said that the characteristics of this technology were fully demonstrated at the Games. Some of the press agencies expressed their hope that the system would be used for the FIFA World Cup Qatar 2022 and the next Olympic Games.

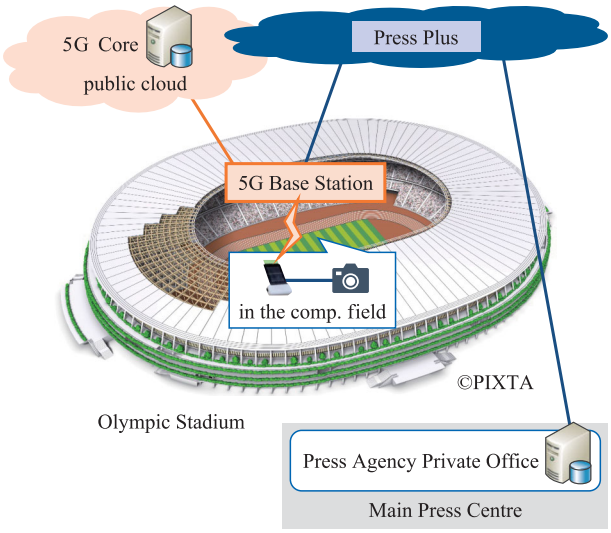

Figure 2 5G Demonstration Image Local 5G is a dedicated 5G network that a company or municipality builds within a certain area or site. A radio station license is required for each case, and this time, a license was obtained at the Olympic Stadium during the Games, and the service was provided to the press in the area that public services or the Organising Committee services were difficult to reach.

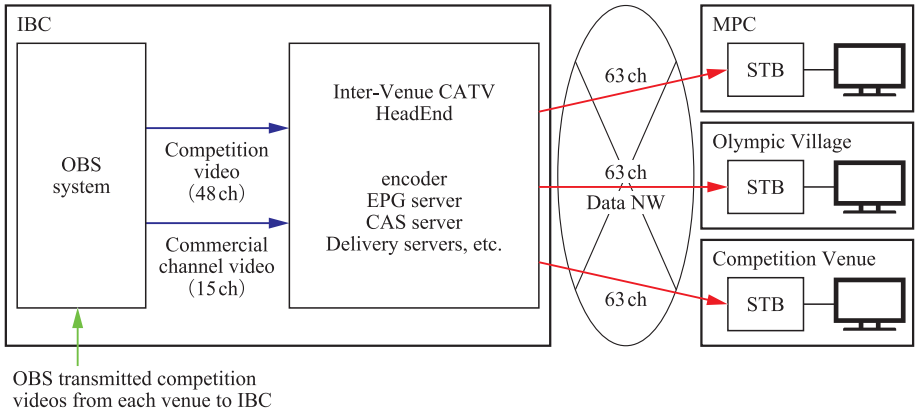

Figure 3 Inter-Venue CATV System Configuration Games video and commercial TV channels provided by the Olympic Broadcasting Services (OBS) system were distributed to 56 venues/locations.

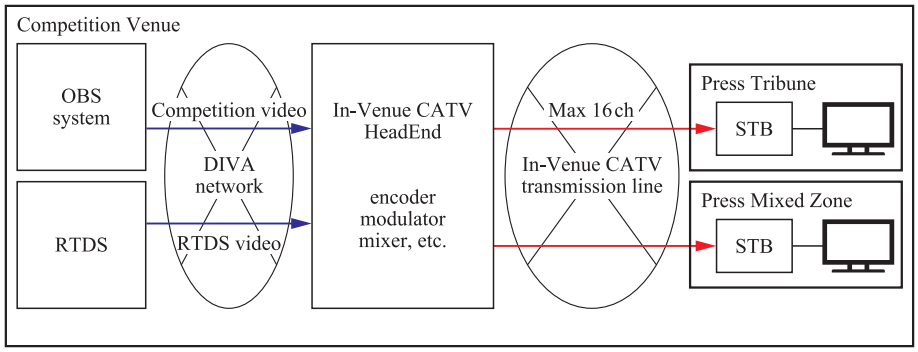

Figure 4 In-Venue CATV System Configuration The figure shows the system in the form of RF signal transmission. In addition, HD-SDI signals from the OBS system and Real Time Data System (RTDS) are transmitted as they are. The competition video and RTDS video were received via DIVA network, a video and audio network within the competition venues, and distributed to the TVs within the venues.

3. CATV Service

3.1 What is CATV?

Community Access Television (CATV) was a video distribution service dedicated to the Games that distributed images of the competitions at each competition venue and commercial TV channels (national TV broadcasts from foreign countries) to MPCs, competition venues, athletes' villages, and other locations. Viewers included stakeholders (IOC, International Sports Federations, Games management staff, etc.), athletes, media representatives, national Olympic committees who had applied for rate cards (a paid menu provided by the Organising Committee).

There were two CATV services: "Inter-Venue CATV" and "In-Venue CATV". The system configurations of the two services are shown in Figures 3 and 4.

The design is based on the following assumptions:

- Proven services and equipment will be used as the basis.
- Sustainability will be realized by utilizing existing facilities and reusing them after the convention.
- Inter-Venue CATV distribution shall be provided as a service embedded on the Games Data Network.
- In-Venue CATV transmits images with low latency.

3.2 Inter-Venue CATV Requirements and Functions

Inter-Venue CATV was a form of multi-channel distribution of competition videos (48 channels) collected at the IBC, commercial TV channels (15 channels), and program list for one week of competition videos. The service was provided from each competition site through the Games Data Network to MPCs, competition venues, athletes' villages, Olympic family hotels, and individual locations where rate cards were

applied for (Figure 5). This was a large-scale, 24-hour IP multicast distribution of 630 Mbit/s (approximately 10 Mbit/s per channel) to approximately 3,500 STBs (Set Top Boxes, video receivers). In superimposing this on OTN of the Games data network, Layer 3 processing equipment was configured to be independent in order to avoid mutual influence with the closed-circuit television (CCTV) security network, which also used IP multicast.

Figure 6 shows the number of Inter-Venue CATV STBs in daily use and the cumulative number of STBs that had started to be used up to that date.

To superimpose and distribute the data over the Games Data Network that extended over a wide area between venues, we used the technology of "Hikari TV" provided by NTT Plala Inc. "Hikari TV" is a multi-channel IP broadcasting service that provides services equivalent to broadcast quality, and conforms to industry standard specifications in Japan, including the standards of Association of Radio Industries and Business in Japan and IPTV Forum Japan. This system had the following processing functions (1) to (4) and satisfied the requirements of Inter-Venue CATV for safe, high-quality video distribution of competition videos (HD-SDI signal) provided by OBS through the Games Data Network.

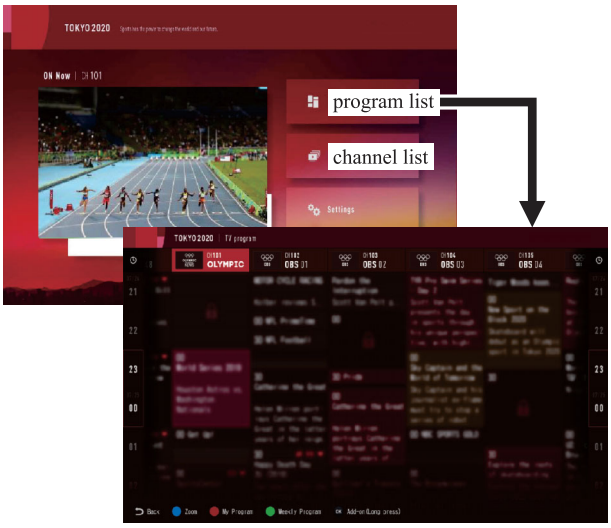

Figure 5 STB Screen Image of Inter-Venue CATV (Home and Program List Pages) (©2021-International Olympic Committee-All Rights Reserved)

① Real-time encoding of SDI signals provided by the program provider
(video format : 1080/59.94i, encoding method : H.264)
② Superimposition of program information
③ Encryption of encoded video and program information, IP packetization, and error correction processing (FEC, Forward Error Correction)
④ IPv6 multicast stream distribution

In addition, the following customizations ⑤ and ⑥ were made to take advantage of these processing functions ① ~ ④ and adapted them to the special environment of the conventions.

⑤ IPv4 compatibility with the Games Data Network protocol (customization of the distribution function

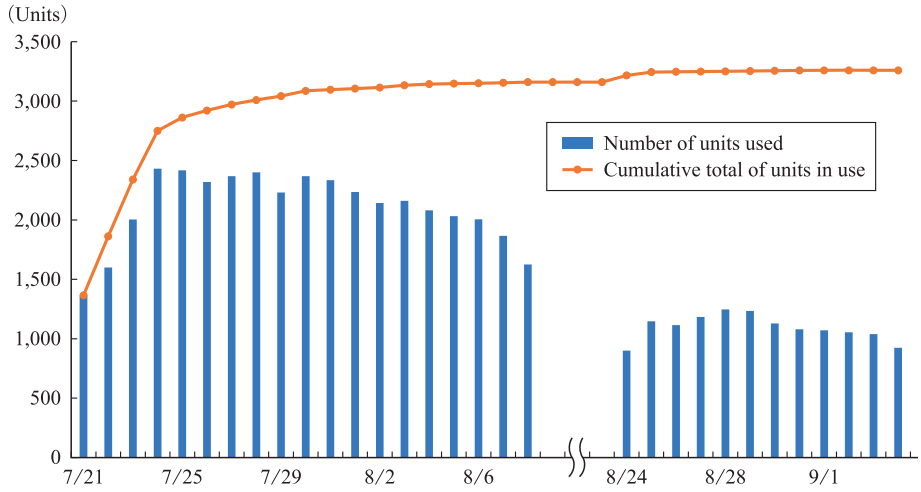

Figure 6 Inter-Venue CATV STB Usage Trends July 21st was the day when the qualifying matches started. The number of STBs in use on a daily basis and the cumulative total of STBs that had been put into use by that time or the Organising Committee services. Almost all the STBs in the planed locations were activated by the end of July.

and STB)

⑥ UI development of STB for conventions

3.3 Problems Discovered When Providing Inter-Venue CATV and Their Solutions

Although the operation of Games Data Network was verified using the verification environment before construction, a major problem occurred during test operation in the athletes' village (where approximately 1,400 STBs were installed) just before the start of operation.

Hikari TV STBs are equipped with many functions that are not used during the Olympic Games, such as the ability to watch programs recorded or broadcast on the STBs with Digital Living Network Alliance (DLNA) compatible recorders, smartphones, and tablets in the home. Therefore, it was necessary to customize the system by deactivating unused functions and the processing affected by such deactivation. This problem was a failure of communication between the STBs and the head end (distribution facility), and was caused by the presence of an unusual number of STBs on the same network.

At startup, the STBs of Hikari TV searched for DLNA-compatible devices (recorders, tablets, etc.) on the network, and the DLNA-compatible devices responded to the search and link up with the STBs. This process was also executed in the athletes' village, and all other STBs responded to one STB's search at startup as a DLNA-enabled device. Because of the large number of STBs that responded, a large number of ARP packets were generated during this process. Because the number of ARP packets exceeded the "incoming ARP packet rate limit" of the ARP Inspection function set in the access switch of the Games Data Network, the access switch automatically set the port connecting the STB that was about to be activated to the errdisable state and started operating to prevent the STB from communicating.

Because there were venues other than the athletes' village where this problem could occur, and because it was just before the start of the Games operations, the problem was handled by blocking DLNA-related communications on the access switch side, where settings could be changed remotely and at once, rather than stopping the relevant functions of the STBs.

In a network environment with a small number of STBs (several dozen), this problem does not occur because the number of ARP packets generated is small. Therefore, the problem did not occur in the verification environment or in most of the venues, delaying the discovery of the problem. When converting an existing commercial service to a special environment, it is necessary to take countermeasures such as conducting sufficient pre-verification in an environment close to the production conditions.

3.4 In-Venue CATV Requirements and Functions

In-Venue CATV was a form of real-time distribution of video images shot by OBS at each competition venue, limited to the competition venue at which the video images were taken, and provided to the press (Press Tribune, etc.), athlete-related rooms (Warm-up Area, etc.), and other locations.

The transmission latency requirement was 300 milli seconds or less, so low latency transmission was achieved by preparing transmission paths for SDI signals provided by OBS as they were, or by converting SDI signals to RF signals. 3,200 terminals were deployed in In-Venue CATV. In some venues, TVs, STBs, and other terminals had to be installed in outdoor spaces (Press Tribune, Press Mixed Zone, etc.), so the following measures were taken.

- Prepared protective cases for STBs and other devices to protect them from rainfall.
- Installation of sunshades to make the TV screen easier to see

However, during the actual event, the heat from the sunlight caused the TV casing to deform, and we had to take measures such as putting the TV monitors under the feet when they were not in use.

4. Fixed Telephone Service and FMC

A fixed-line telephone service centered on IP telephone service was provided for the Olympic and Paralympic Games stakeholders. In addition, extension services between cell phones and IP phones were provided for staff members, and regular analog phones were provided in areas where fax machines and IP networks could not be installed.

4.1 Requirements for Provision

The phone system of the Olympic and Paralympic Games had the characteristic of being used by a large number of stakeholders and staff members just before

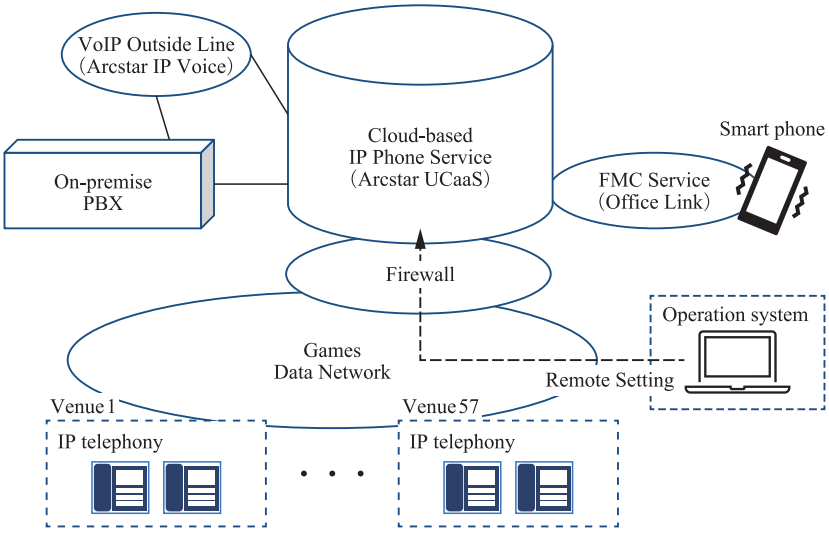

Figure 7　Composition of Landline and FMC (Fixed Mobile Calling Service)

the Games start, after being used by a small number of staff members for a long preparation period. Many staff members moved around without a fixed location, so coordination between fixed and cell phones was also important. In addition, it was difficult to hear the detail requirements in advance, so the key requirements were to complete the delivery in a short period of time and to respond quickly to the frequently changed requests.

4.2 Configuration of the Conference Telephone Environment

The conference call environment consisted of the following services (Figure 7).

(1) Cloud-based IP Phone Service

"Arcstar UCaaS", a cloud-based IP phone service provided by NTT Communications, was used to control approximately 2,600 IP phones and integrate on-premise PBX and cell phone extension services. The service was highly compatible with short-term intensive use because it was able to be used for a monthly fee without assets, it enabled to flexibly respond to fluctuations in demand be easily kitted and configured via a portal, and be configured for several hundred phones per hour.

(2) On-premise PBX

A fixed telephone environment for staff members had been required for five years prior to the Games, and an IP telephone environment for approximately 300 units was continuously provided using a small PBX.

(3) FMC Service

An environment that enabled to connect approximately 15,000 cell phones and fixed-line phones to an internal line was established using NTT DoCoMo's "Office Link" service.

(4) Games Data Network

The terminals of cloud-based IP phones and on-premise PBXs were connected to the LAN for the conference via a PoE switch. The network provided priority control and firewall functions to integrate voice and data.

4.3 Migration in Preparation for the Games

During the preparation period before the Games, cell phones were deployed for staff members, IP fixed-line phones were provided for each department, and an environment was prepared to link extensions using FMC service.

Since the scale and reliability of the existing on-premise PBX were not sufficient, and since the number of phones required increased rapidly only around the Games time and would be drastically reduced in a few months, it was decided to introduce cloud-based IP telephones. The deployment of cloud-based IP telephony began three months prior to the Games, and was quickly deployed at competition venues, media centres, and other locations where reliability was required (Figure 8). The on-premise PBX and mobile extension services used during the preparation period were also linked.

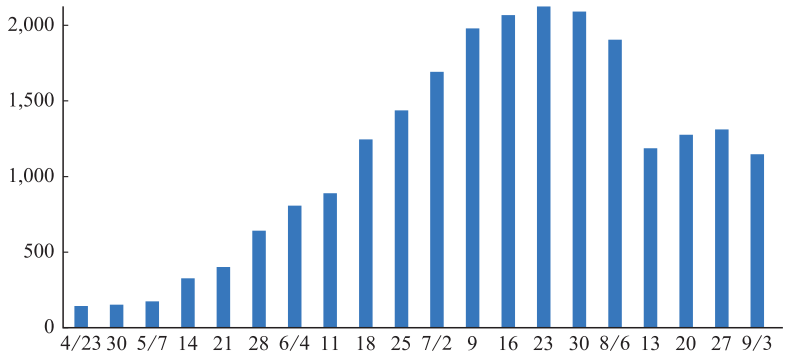

Figure 8　Changes in the Number of Cloud Fixed-line Phones Installed

Table 1　Number of Calls during the Games (Comparison with London 2012 Games)

	London2012 2012.7.27～2012.9.9		Tokyo2020 2021.7.23～2021.9.5	
Outgoing Calls	380k Call	41.1%	268k Call	23.0%
fixed to overseas	47k Call	5.1%	1k Call	0.1%
fixed to Domestic fixed	88k Call	9.5%	16k Call	1.4%
fixed to Domestic Moblie	245k Call	26.5%	11k Call	0.9%
mobile to all outside	—		240k Call	20.6%
Incoming Calls	492k Call	53.1%	289k Call	24.8%
to fixed phone	492k Call	53.1%	52k Call	4.5%
to mobile	—		237k Call	20.3%
Extension Calls	54k Call	5.8%	609k Call	52.2%
fixed to fixed	54k Call	5.8%	18k Call	1.5%
mobile from/to fixed	—		6k Call	0.5%
mobile to mobile	—		585k Call	50.2%
Total	926k Call	100.0%	1166k Call	100.0%

(Note)　In the Tokyo 2020 Games, all staff members were given cell phones (smartphones) as extension terminals. Information on extensions and outgoing calls to and from staff members' cell phones is also necessary to compare incoming and outgoing calls from the Organising Committee's terminals with those from London. So, the figures are listed in this above table. Although extension service was managed by a cloud-based IP service, the extension calls between cell phones and the number of outgoing calls to/from cell phones do not go through the Games Data Network ; i. e., strictly speaking, they do not go through the Games Data Network. (In other words, it is not strictly a closed service in the Games Data Network.)

4.4　Operational Results

Table 1 shows the results of the use of the system during the Games time. (the information for the London 2012 Games is based on interviews with people who had experienced the London 2012 Games in the past.)

The decrease in incoming and outgoing calls to outside lines and the large increase in incoming calls to inside lines could be attributed to the mobile extension service, which was provided to all staff members for the first time at the Tokyo 2020 Games. In terms of cost reduction, in addition to the introduction of this service, migration to a hybrid configuration (FMC service) centered on a cloud PBX was effective when demand increased and reliability was required.

The data also shows that cell phones (with extension functions) were used more than fixed-line phones, but fixed-line phones were used as "a phone that can be used reliably for emergency or official communications" to ensure the reliability required by the Organising Committee, while cell phones were used as "a phone that can be used easily at any time". It is assumed that cell phones were used more frequently in terms of traffic. In addition, it is thought that the use of web conferencing, business chat and other tools on the smartphones distributed to the staff members and stakeholders was more active than in the past Games.

5.　Final Remarks

The communication services described in this section

are the basic services that had been used by the stakeholders and staff members in the past Games for confirming and communicating with the management and for reporting on the competitions, though there were some additions and changes in functions. We are proud that we were able to provide these services without any major problems at this year's event.

The VLANs provided to the press will change according to user requests, like the "dynamic allocation" function of this time, and it is expected that inter-Venue CATV, which does not have strict latency condition, may shift to streaming. In addition, as a communication tool, we have described here mainly the telephone service operated and managed by the Organising Committee. However, it is clear after the postponement of the Games that the use of data communication from smartphones and web conferencing using PCs has increased significantly. At the Tokyo 2020 Games, the Internet services used by the participants were primarily routed through the Organising Committee's data centre, but because it can be the bottleneck, in the future, one option will be to promote the use of the public network with some control on the application/terminal side. In this case, how to respond to such changes in usage/provisioning patterns and resulting changes in traffic while ensuring quality and information security will be an issue for the future.

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