Services/Systems Provided over the Games Data Network [I]: Functional-Area Networks and Wi-Fi for the Games Stakeholders

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Abstract

This article describes an overview of the Games management systems that the Functional Areas of the Organising Committee used over the Games Data Network. It also describes some of the difficulties preparing and operating such event the Organising Committee faced in terms of systems and services other than communication service.

Keywords: FA system/network, Communication service, Wi-Fi connection service

1. Logical Separation of Services and Networks

As already mentioned in another chapter, the Games Data Network was divided into three categories: the network for the system for distributing competition results (CPN), the network for back-office operation used by the Organising Committee (BON), and other networks (OTN). The systems and services used by each functional area (FA) were mainly provided by the last network, OTN. This article describes those systems and services provided by OTN.

The total number of information devices connected simultaneously to the Games Data Network through these Functional Area (FA) systems and services were 120,000 devices during the Olympic Games and 64,000 devices during the Paralympic Games (Figure 1).

In addition to the systems for athlete information, competition records, and judgment results handled by the CPN, there were many other systems/services directly related to the operation of the Games: for example, the system for press agencies distributing the results of these events and moments of events such as the opening and closing ceremonies, the system to manage athlete medical information, the system for power monitoring, the ticket sales and management system, the CATV service transmitting competition images to the related staff members in real time, and the Internet service for stakeholders authenticated by the accreditation cards for accessing the venues.

These systems required network to have not only high reliability, but also adequate bandwidth stability, access controls, and security measures to prevent from cyberattacks. Furthermore, in some cases, FA required flexibly responding to changes occurred in these requirements. It was not practical to build separate networks to meet these requirements individually, especially from a cost point of view. Therefore, the Games Data Network for the Olympic and Paralympic Games Tokyo 2020 (hereinafter referred to as "Tokyo 2020 Games") was constructed using VRF function in the network devices (routers and L3 switches), a function that logically separated multiple networks by maintaining multiple independent routing tables on the same physical devices. This allowed to superimpose virtual

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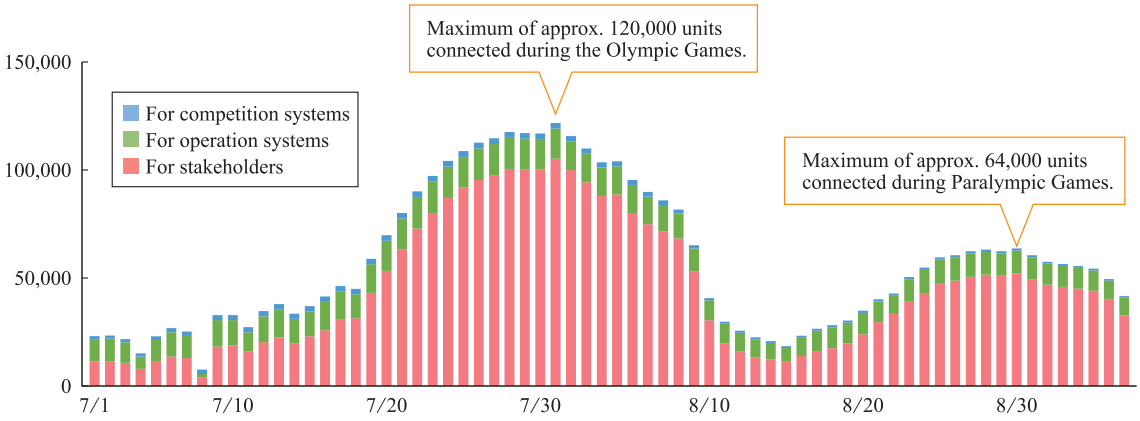

Figure 1　Number of Terminals Connected to the Games Data Network

networks with different requirements from each system, onto the Games Data Network, while keeping equipment and telecom service costs low.

The major networks and services superimposed on the Games Data Network for the Tokyo 2020 Games are shown in Table 1.

2. Major Networks Provided to FA Systems, etc.

This section describes the major virtual networks provided to the FAs and other organization's systems. Hereinafter referred to as FA networks.

2.1 Security Network

The security network (hereinafter referred to as CCTV network/Closed Camera TV) is mainly a network for security information systems such as surveillance cameras. In the past Games, security network was designed and constructed separately from the Games Data Network, but for Tokyo 2020 Games, the Organising Committee decided to construct over the Games Data Network for cost and efficiency reasons.

The security network was a network that connected and transmitted images from surveillance cameras from 43 competition venues as well as from 53 non-competition venues, including the Main Press Centre (MPC)/International Broadcast Centre (IBC), athletes' village, bus and fleet depots, etc., to the Games Security Coordination Centre (GSCC), serving as the Games security command center. The network eventually accommodated approximately 8,000 surveillance cameras, including existing legacy cameras, as well as 4,000 sensors, 28 public road cameras, and 1,500 PCs for monitoring (approximately 150 at the GSCC and 1,100 at the Venue Security Coordination Centre (VSCC) and 250 installed at related organizations) (Figure 2).

Because of the scale of the network as well as the close relationship between the operational requirements and the system, a task team was established at a very early stage of planning with members from the Security Bureau, Panasonic System Solutions Japan (PSSJ), the Technology Bureau, and NTT East so that the team could closely coordinate the requirements and design of the network in details.

Three main design issues described below were discussed in the task team. First issue was selection of multicast methods for sending images. There were two types of multicast methods: Any-Source Multicast (ASM), which did not require source information to be recognized, and Static-Source Multicast (SSM), which recognized source information and assigned addresses statically. The ASM method was employed for Tokyo 2020 Games because of cost and burden required on the system. Second issue was the network configuration. In normal operations, the VSCC at each venue monitored the corresponding venue, so video images were necessary to first collect and send to the VSCC. However, since GSCC took command and function as a backup in emergency situations, the video images also needed simultaneously distributed to GSCC from each venue as well. To achieve this requirement efficiently, the network was designed with a star configuration, placing GSCC at the top and connecting to each venue.

The third issue was the bandwidth design of Wide Area Network, WAN, which needed to consider instantaneous burst characteristics of the cameras to be installed. The WAN bandwidth was then designed based on the number of screens simultaneously need to monitor at GSCC. In addition, the selection and design of

Table 1 Major Services and Systems Superimposed on the Games Data Network

Type	Service System	VRF name and configuration	Overview
OIN	Competition System (CPN)	OIN	Network used to send competition data and results to overseas data centres, etc.
	Operation and business system (BON)		Business network used by the organising committee staff.
OTN	FA network (Note : FA stands for "Functional Area". Each department within the organising committee that performs each functional area necessary for the operation of the Games		
	Security network	CCTV	A network service surveillance camera and recording devices are connected. Images from the surveillance cameras are send with multicast to the GSCC, monitoring centre, and the venue.
	Internet access network for FA	FA-INTERNET	A network for connecting systems and terminals used by FAs to the Internet.
	For payment terminals Internet	FA-VISA	Payment network used by various businesses.
	VPN for MED-FA	FA-MED	VPN for medical systems (electronic medical records, radiology, pharmacy, and clinical data systems).
	VPN for NRG-FA	FA-NRG-UPS	VPN for UPS (Uninterruptible Power Supply) monitoring system.
		FA-NRG-EMS	VPN for EMS (Energy Management System).
		FA-NRG-IBC	VPN network service for monitoring power control systems installed in IBCs.
	VPN for LAN-FA	FA-LAN	VPN used by the system that remotely (from MPC) translates athlete interviews and press conferences held at each venue.
	VPN for SPP-FA	FA-SPP	VPN connected by sports presentation systems (systems that record and distribute digest images of competitions).
	VPN for TEC-FA	FA-TEC	VPN connected to the temperature monitoring system at the VDC (Venue Data Centre : a data centre within the venue where systems that handle competition data are installed).
	Network for OMEGA	OMEGA	VPN service for OMEGA to connect to the Internet at the venue.
	Network for IOC staff	IOC-LAN	Network used by the IOC for IOC offices in the Olympic Family Hotel.
	Telecommunication services		
	For Games officials Internet	INTERNET	Internet service used by Games officials at competition venues, related facilities, and on buses. Multiple services are provided by changing SSIDs and authentication methods depending on the location and users (athletes, volunteers, stakeholders, etc.).
	VPN for the press (Press Plus)	By 10 News Agencies	VPN service for major news agencies (10 companies) to connect between MPC and Venues. Logically separate networks by VRF setting to each agency. (Other than the 10 major agencies, they used the Internet for stakeholders.)
	Inter-Venue CATV	CATV	A service that multicasts competition videos from each venue aggregated at the IBC to other venues. Commercial channels are also distributed to some venues.
	In-Venue CATV	CATV-MGMT	A service that distributes competition video in real-time basis within the venue where the competition is held.
	Fixed-line/FMC	TEL	IP fixed-line telephone service, Extension integrated with commercial extension cell phone service.
	Video conferencing system	GLOBAL-IP	A network service for connecting videoconferencing systems for conference. Global IP is paid out to the conference terminal and videoconferencing system is connected over the Internet.
	For GLOBAL-IP Internet		Internet service that allows direct connection to the Internet with a global IP without network address translation at the Internet Gateway.
	VLAN Access (VPN between/within a Venue)	—※	VPN service to connect between Venues (L3VPN/L2VPN) upon request of the Games stakeholders. VPN service to connect terminals within a Venue upon request of Games officials.

※ Logically separate the networks by setting VRF each time an L3VPN application is received.

the equipment installed in the Venue was made to sufficiently handle the traffic flow feeds to the video monitoring terminals (multiple 8-split screens) and feeds to the recording devices (single screen) at the same time.

Moreover, the network also accommodated other traffic form that of the surveillance camera images, such as traffic from the security guard management system

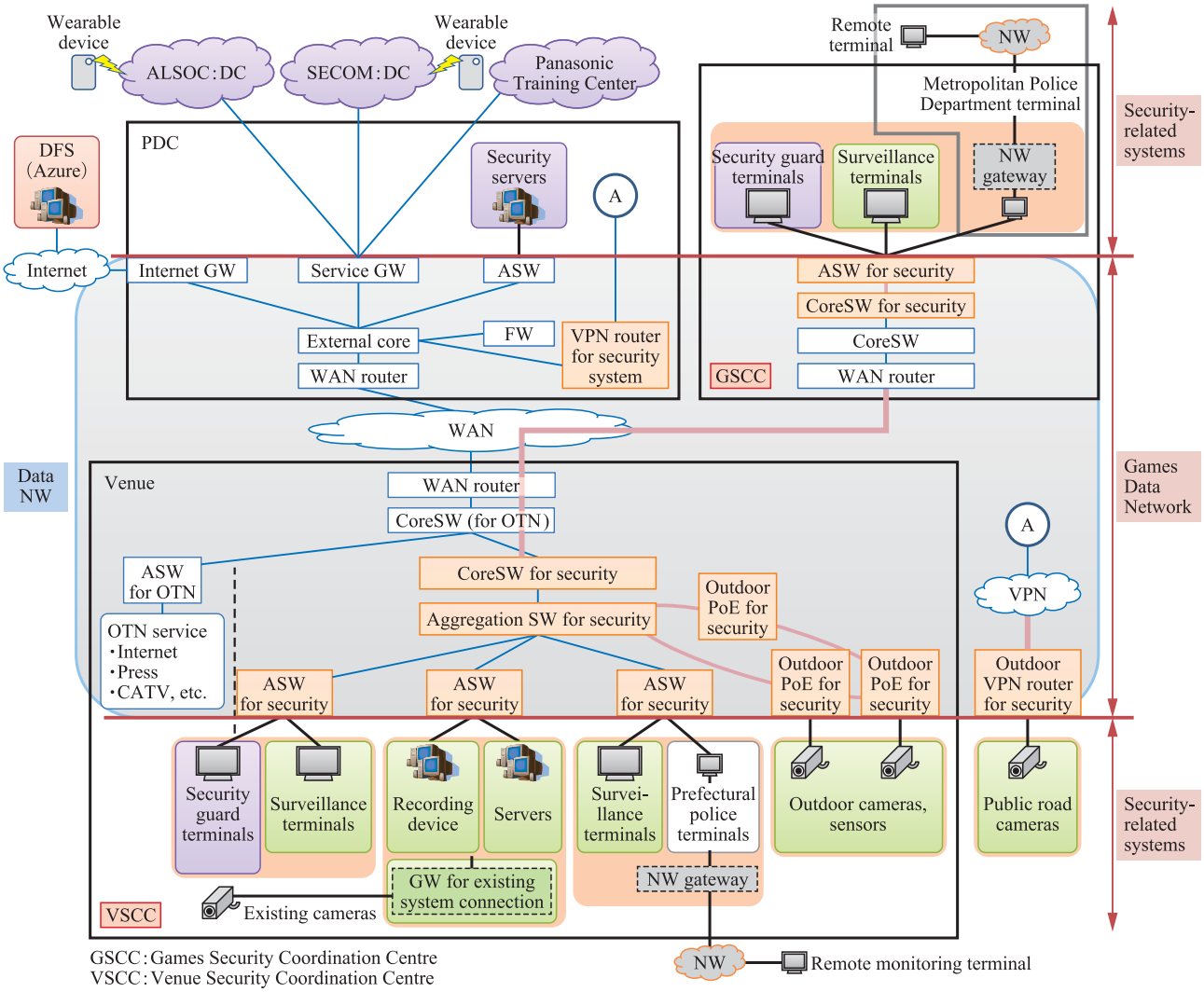

Figure 2　Overview of Security (CCTV) Network

that managed incidents and reported from security guards at the venue via wearable devices, and traffic from the system that obtained SNS analysis information by connecting to hosting servers on the Internet.

Since many of the security cameras were installed outdoors due to their characteristics, a verification test was conducted for one month in August 2020 after the postponement of the Games was announced. The test was to confirm that the components such as the PoE-SW and its power supply, network equipment that connected to the cameras, were installed in the small box and was able to operate properly even under the scorching sun in the summer.

2.2　Other FA Networks

This section outlines the "FA networks" used in Tokyo 2020 Games operation superimposed on the Games Data Network other from CCTV. The other FA networks were required to operate various systems such as MED-FA, the medical department that handled the electronic medical records of athletes and NRG-FA which monitored the electric power used for lighting and equipment at the venues.

The preparation of CCTV was started early by the SEC-FA (Security Bureau) and the task team had been established in 2018 to clarify requirement. However, planning of systems and network requirements i.e. functions and number of equipment connected to the network, used by many other FAs delayed, because it only covered certain part of the Games operation, where less priority or overall operation had not been fixed. There was a concern that since these systems of FA were considered critical for the Games operation, it was obvious that various requests would be concentrated at

the last minutes. Therefore, the network team decided to launch a working group in May 2019 to gather requirements beforehand from the FAs. Even so, it took about six months to complete all the hearings on system requirements, and if the Games was held as scheduled, less than six months remained to design, configure, and implement physical network based on those requirements.

Since physically constructing networks for each FA system was time-consuming and costly, the Organising Committee decided to logically superimpose those networks over the Games Data Network as much as possible. On top of this, the requirements of each FA were considered individually. The network was divided into two types : "Internet access network for FA" which can be shared by multiple FAs, and "VPN dedicated to (each) FA" which were customized for each system (CCTV is one of this type).

The "Internet access network for FA" is a virtual network that is suitable for connecting to specific Server or Cloud service through the Internet. This network is further divided into two types : a type user needs to log-in or a type that the network can be used by just connecting devices.

On the other hand, the medical system and the power monitoring system must avoid any information leakage and unauthorized access, and network needed to be separated from other FAs in the Organising Committee. Therefore, the requirement for "VPN dedicated to (each) FA" was not be connected to the Internet and constructed in a closed network (VLAN) through separate VPN. The network that met the requirements of each FA was made using closed L3-VPN as a basis and superimposed them on the OTN.

In the process of designing and preparing for the installation, the postponement of the Games was announced. Some of the requirements were changed after the postponement, such as the change of medical system requirements by coronavirus disease (COVID-19) countermeasures. Table 2 summarizes the networks provided to FAs and their systems.

Table 2 Two Types of Internet Connections and FA/Systems Used

Internet connection for FA system (FAs using the system and their system outline)	
TKT-FA	Ticket System
FNB-FA	Ordering System/Employee Attendance Management System
LIC-FA	POS terminal of official stores
SPT-FA	Weather Information Centre (WIC)
TEC-FA	Radio Monitoring System
RES-FA	Info System (Match Result Information System)
Internet connection for payment terminal (FA to be used)	
FIN-FA, LIC-FA, MPS-FA, PRC-FA, PRS-FA, TKT-FA, SPT/INS-FA, VIL-FA, FNB-FA	

3. Wi-Fi Connection Services for Stakeholders

3.1 Overview of Wi-Fi Connections Provided for Stakeholders

The communication services, other than the FA network, that TEC provided over the OTN will be described in detail later, however, in this section provides overview of Wi-Fi connections provided for stakeholders.

Rather than being an independent service, Wi-Fi connectivity was defined as a function that allowed devices to connect to various systems and the Internet. Due to this concept, Tokyo 2020 Games, as a result, provided 14 different SSID Wi-Fi connections according to the difference of requirements and the end user groups.

One of the main reasons to place different name SSID was to simplify the process of trouble shooting when issue occurred. For SSIDs that were used by general stakeholders, not Organising Committee staff members, the Organising Committee used Japanese names that were globally well known, such as "Sakura2020" and "Kabuki2020" to SSIDs to make it easier to search as well as feel "Japan" to athletes and stakeholders from overseas.

Table 3 lists the SSID names for Wi-Fi connectivity provided by each service superimposed on the Games Data Network.

In addition, Table 4 shows the statistics of unique connections (per day) to the Games Data Network via Wi-Fi services. The actual usage differs slightly due to the different users, but the maximum number of connections can be seen in the first half of the Olympic period (July).

It should also be noted that Wi-Fi connectivity itself is a technology that has been around for a long time. Because of this reason, even the systems that preferred to use wired connectivity in the past Games are changing. Wi-Fi is started to be used as a default or as an additional function, and the importance of this function is coming larger.

Table 3 Wi-Fi Accommodated by the Games Data Network

Type	Service System	SSID Name	Users, etc.
OIN	Games Operation and Business System (BON)	TOKYO2020-TLS	For Organising Committee staff PCs
		Kimono2020	For Organising Committee staff smartphone
OTN	Internet for convention officials	Omotenashi2020	For guests at the Organising Committee's headquarters
		Sakura2020	For accreditation holders (athletes and officials, stakeholders)
		Onigiri2020	For volunteers
		Sushi2020	For Guests
		Wasabi2020	For Bus Depot
		Katana2020	For Athletes' Village Residence Building
		T2020_Official_Hospitality	For VIP Spectators
		OBS	For OBS
		OBS Plus	For OBS (with terminal authentication)
	VPN for Press (Press Plus)	Kabuki2020	For Press
	Internet for FA system	Samurai2020	Dedicated to FAs of the Organising Committee
	Network for IOC Staff	IOC	For IOC

Table 4 Number of Terminals Used (Identified by MAC Address)

SSID Name	Average per day	Standard deviation	Maximum number (date)
TOKYO2020-TLS	3,751.6	779.4	4,958 (7/26)
Kimono2020	4,160.6	1,000.6	5,659 (7/26)
Samurai2020	56.2	50.8	226 (7/23)
Onigiri2020	1,561.3	812.2	2,738 (7/25)
Omotenashi2020 (-2)	1,700.6	351.4	2,120 (7/30)
Sakura2020 (-2)	23,514.5	15,189.5	47,170 (7/28)
Sushi2020	1,888.5	546.0	2,539 (8/26)
Wasabi2020	924.4	246.5	1,200 (8/7)
Katana2020 (-2)	14,081.4	9,401.0	29,311 (7/29)
Kabuki2020	89.2	76.7	232 (7/24)
IOC	266.5	68.0	367 (7/23)
OBS	1,524.7	793.8	2,669 (7/28)
OBS Plus	1.2	0.4	2 —
T2020_Official_Hospitality	＊Planned but not used		

3.2 Trouble Cases of Wi-Fi Connections and Its Troubleshooting : Instability of Wi-Fi for the Press

Prior to the opening ceremony of the Olympic Games on July 23, 2021, Wi-Fi for press in the MPC, the National Stadium, and other locations had difficulty connecting to Wi-Fi Access Points (APs). There were several causes : many press staff members brought terminals and connected to the Wi-Fi made speed not high enough ; the Wi-Fi devices (router) brought into the venue had interreference with the Wi-Fi frequency the Organising Committee provided ; there were some locations where the signal strength was not strong to access. On the other hand, the wired ports installed at each press seat were only used about 30% of what had been installed. The resolution of troubles was driven by a lot of joint work between IOC, Tokyo 2020 and NTT with deployment of in depth reviews of Wi-Fi services to different centres and tribunes in specific sites, along with specialists from NTT. As a result, the following measures had been implemented and troubles resolved in about one week:

① Switched the Wi-Fi AP channel and signal strength from automatic to manual settings and optimized them according to the environment they

were installed (184 APs in total).

② Relocated Wi-Fi Aps, at the press tribune and media centre at each venue, to higher and more visible locations, and installed additional 43 APs in areas where the number of press agency exceeded from the original plan.

③ Since the wired cable connection had been sufficiently installed to each seat, USB-LAN conversion adapters were quickly procured and distributed to the press, encouraging them to used wired connections.

In addition, the wireless team monitored the use of prohibited frequency bands in the venue and asked to stop using those devices when they were founded.

The main reason for this situation is thought to be the dramatic increase of using wireless LANs compared to the past Games.

Initially, primary requirement was wired connection because stability was the priority. Therefore, wired port had been installed at each press tribune seat, while Wi-Fi connection was considered as a secondary purpose. However, the number of press users using Wi-Fi outnumbered those using wired connections in Tokyo 2020 Games. This is maybe due to the increase in the number of notebook PCs without LAN ports.

In addition, from a marketing perspective, the Olympic venues were designed to be "clean venues", which meant that communication devices were not allowed to be installed where visible such as spectator seats and seats around the press tribunes for television viewing. Therefore, APs were initially installed under the seats or hidden in the walls, with the top boards and walls covering them. This is thought to be another cause of instability of Wi-Fi connection. We should emphasize that one lesson for the future Organising Committee will be, the high density Wi-Fi solutions for MPC, Venue Media Centres and tribunes to meet the operational needs of media should be studied on a priority basis in advance.

4. Summary and Discussion for the Next Article

This article introduced the major systems and services superimposed on the Games Data Network, as well as described about the Wi-Fi connections used to connect to FA systems.

The equipment for the FA systems installed over the OTN was managed and operated by the end users, including FAs. Although certain guidelines were provided and system reviews were made beforehand, there were limitations in managing overall operation. For example, if the preparation and test were not sufficiently conducted beforehand, issue such as designed usage were found different from actual usage in the early stages of implementation. In such cases, the network also needed to diagnose its connection along with the analysis of the system. The case of Wi-Fi issue for the press, although it was not an FA system but access to the internet, is an example of a trouble that occurred due to the difference between usage assumption and its actual usage.

Providing network to FAs gave the technology teams an opportunity to recognize the difficulty of governance, assigning and sharing responsibilities with inside and outside the Organising Committee. The next section will discuss the major "communication services" in detail.

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