Enhancement of Mobile Communication Environment for Spectators

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Abstract

With the increase in the number of cell phone users and the spread of information provision services via smartphones, we had concerns about cell phone congestion and slow communication speeds in and around venues during the Tokyo 2020 Olympic and Paralympic Games. We promoted two measures to improve the mobile communication environment to reduce those concerns. One is the deployment and enhancement of mobile communication networks by mobile network operators, and the other is the development of the Wi-Fi communication environment by facility owners themselves. This article summarizes the activities for these two measures, especially the efforts for the permanent facilities and the result.

Keywords : Cellular phone, Mobile communication, 5G, Wi-Fi for spectators, Legacy

1. Introduction

The importance of high-speed data communications on mobile devices like smartphones has increased with each Olympic and Paralympic Games and those communications have evolved to be an essential infrastructure for spectators and the Games stakeholders. For example, it has become commonplace for spectators to share (upload) videos and images of their experience through SNS applications, not just view (download) video replays and other moving images.

However, so far in Japan, cell phones often cannot make a connection in a venue of a large-scale competition or event, while mobile device use is increasing year by year. Therefore, we saw it should be critical to improve the communication environment where we can use mobile phones and mobile devices comfortably in and around the Games venues for the Olympic and Paralympic Games Tokyo 2020 (hereafter, Tokyo 2020 Games).

Although the Tokyo 2020 Games were eventually held with almost no spectators, the Organising Committee initially had expected 8 million spectators and needed to provide a comfortable mobile communication environment for potential users like 200,000 volunteers and other people involved in the Games. We planned to deploy and enhance cell phone and Wi-Fi communication facilities in the spectator seating areas and concourses at the venues by asking mobile network operators and venue facility owners to obtain their understanding and cooperation as shown in Figure 1. And the communication environment, especially for cell phones, has become an essential infrastructure for Tokyo 2020 Games and also society as a whole. Therefore, we believed that it is crucial to keep providing comfortable facilities by developing a communications infrastructure not only during the Games but also after the Games, and it will ultimately lead to an increase in the attractiveness of each competition venue. Based on this idea, the project targeted the spectator areas of 43 competition venues, the Athletes Village, and some areas of the International Broadcast Centre (IBC) Main Press Centre (MPC) (Table 1).

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As it turned out, there were almost no opportunities to use mobile communication facilities at spectator areas in the Tokyo 2020 Games due to the policy of non-spectator for the Games. On the other hand, permanent facilities for legacy use after the Games have generally been developed as planned, and some test use before the Games has been conducted. The following is a brief history and status of the fulfillment.

To deploy base stations such as antennas and devices and to secure the conditions for the installation (space, power supply, etc.), we request cooperation in the implementation as follows:

Mobile Network Operators	Install and operate their base stations
Facility Owners	Secure and provide the conditions for the installation of permanent base stations
Tokyo 2020 Organising Committee	Secure and provide the conditions for the installation of temporary base stations

(Cost sharing shall be decided after consultation on a case-by-case basis.)

Figure 1 Request for Cooperation to the Mobile Network Operators and Facility Owners　The Organising Committee requested cooperation in the development and enhancement of cell phone and Wi-Fi communication facilities after coordinating the roles of each party.

Table 1 Target Areas for Cell Phone and Wi-Fi Facilities Deployment and Enhancement

	Competition venues	Athletes Village, IBC/MPC
Public cell phone	Spectator area	Residential and business areas
Wi-Fi for spectators	Spectator Area	Only for related stakeholders

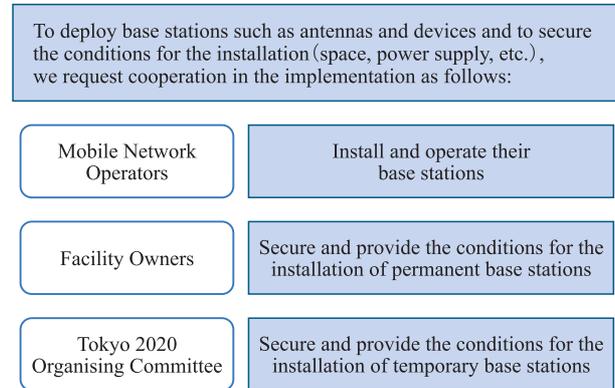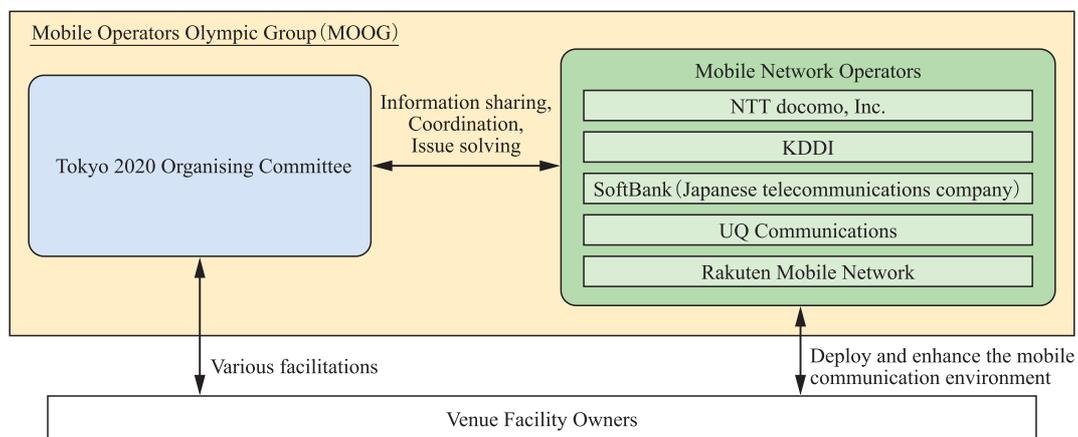## 2. Cell Phone Network Development

2.1 Mobile Operators Olympic Group and Guidelines

In July 2016, the Organising Committee established the Mobile Operators Olympic Group (MOOG) with four mobile network operators (NTT docomo, KDDI, SoftBank, and UQ Communications) to develop the cell phone communication environment for the Games. After that, Rakuten Mobile Inc. joined MOOG in 2018 (Figure 2).

Based on repeated discussions with these mobile network operators that provided communication services using their communication facilities, we released the "Guidelines for the Improvement of the Mobile Phone Communication Environment for the Tokyo 2020 Olympic and Paralympic Games" (hereafter, Guidelines) on November 8, 2017. In the Guidelines, the following points were discussed and agreed upon:

In the cell phone communication environment in and around the venues,

- 20% of users will need to be connected even if they make voice calls concurrently.
- 100% of data communication will need to be connected, and users can comfortably enjoy some content like video except during times of congestion.

* This framework does not restrict usual business or direct access between the facility owners and the mobile network operators.

Figure 2 Structure of the Mobile Operators Olympic Group (MOOG)　The Organising Committee and mobile network operators launched MOOG in 2016 to promote the development plan for the cell phone communication environment.

To achieve these goals, each mobile network operator needed to take measures for the "dead zone" and the "congestion". They considered installing antennas in some areas for spectators where signal reception was too poor to connect cell phones to reduce the number of dead zones, and also considered installing additional antennas in areas where many spectators would use their mobile devices simultaneously to avoid unavailability even if congestions had occurred. Inevitably, MOOG's subsequent activities shifted to the steady implementation of such installation and expansion at the target venues.

2.2 Activities and Achievements for the Installation

When the mobile network operators installed communication facilities, it was necessary to lease space for base station equipment and antennas from the facility owners and receive power supply. They had to coordinate with the department in charge of the venue development of the Organising Committee in the case of temporary facilities, and with the facility owners of the venues such as stadiums in the case of permanent facilities. These activities started in full swing in 2018.

The Organising Committee requested the owners of each facility to understand and cooperate with additional facilities for the Games and compiled plans for the development of facilities by mobile network operators. In reality, the conditions of the facilities in the venue were not uniform, the development plans varied by venue and mobile network operator, and we have nearly 50 venues, so we asked each mobile network operator to carry out its specific coordination.

From the viewpoint of a venue owner, coordination with multiple mobile network operators was needed almost simultaneously, resulting in enormous workloads to deal with those. For this reason, the mobile network operators participating in MOOG consulted with each other and appointed a represented managing company for each venue. That company was to lead negotiation and coordination with the venue, which was a sort of divisional cooperation.

Negotiations with the venues, however, required more stakeholders and more time than usual, as it was necessary to coordinate with the venue owners, the facility management company, and the venue construction company managers and contractors on the Organising Committee side. Therefore, we had to rush through construction from spring 2020 to just before the Games for almost all venues. The one-year postponement had

Table 2 Status of 5G Service Area Deployment

Time	Spectator area	Route to the venue
Summer 2020	All competition venues except Izu MTB course	Several venues
Summer 2021	All venues	About half venues

created some leeway in terms of the construction period, even though the actual construction could not begin.

Moreover, we had to consider measures against coronavirus disease 2019 (COVID-19) infection to start the construction in 2021, resulting in another round of adjustments.

Nevertheless, the mobile network operators recognized the necessity and goal of adding permanent mobile communication facilities at each venue and followed the Guidelines. In the end, about 4,700 antennas were installed/added as legacy facilities in total, accounting for more than 90% of the initial development plan (including temporary facilities), and they are still in operation after the Games.

2.3 Fifth-Generation Mobile Communication System (5G)

5G commercial services started in some areas in Japan in March 2020. Regarding the competition venues for the Tokyo 2020 Games, priority was given to the development of spectator seating areas. As of summer 2020, 5G was available in the spectator seating areas of all competition venues except one. The postponement of the Games by one year resulted in the expansion of 5G coverage in urban areas, which also covered some routes to the venue without a specific measurement (Table 2). However, there were almost no spectators during the Games time, and the use of 5G had to be limited.

Please refer to 4-3 of these special issue for more information on the innovation project using the public 5G network. And please refer to 2-5 of these special issue for the local 5G demonstration (conducted at the National Stadium) that was for the ground area not sufficiently covered by the public 5G network because it mainly covered the spectator seating area.

3. Spectator Wi-Fi

3.1 Requests to the Venue Facilities

As of two to three years before the Games, nearly 70% of all competition venues had little or no existing Wi-Fi

environment that spectators could use freely. The only venues that earlier had Wi-Fi for spectators were some stadiums used for professional sports teams, some event venues, and the New National Stadium, which had plans to introduce Wi-Fi for spectators in preparation for the Games.

In the past Games, the Organising Committee had no experience in providing Wi-Fi for spectators and relied on mobile network operators' Wi-Fi facility development plans. Regarding the Tokyo 2020 Games, however, the Organising Committee believed that Wi-Fi for spectators in permanent facilities and locations needed be implemented and used as a legacy by the venue facility owners or mobile network operators, so the Organising Committee decided to take the initiative and encourage their cooperation of those. Because we knew that there were high expectations for Japan's mobile communications environment domestically and internationally, and the opportunities for its use in future events would be increasing more and more.

The Organising Committee positioned "hospitality" through the "integrated development and utilization of Wi-Fi for spectators" as an innovation measure for the Tokyo 2020 Games and has set a policy to make it a legacy after the Games as a significant infrastructure for a tourism-oriented nation.

Starting with the briefing session for the related local governments in October 2017, we repeatedly asked to cooperate on "the development of Wi-Fi for spectators by each facility owner as a legacy". Most of the new development of Wi-Fi for spectators that followed those efforts were at venues related to the Tokyo Metropolitan Government (TMG), which was the target of measures based on the Tokyo Data Highway basic strategy (August 2019, https://www.digitalservice.metro.tokyo.lg.jp/tokyodatahighway/index.html) (Table 3).

3.2 Wi-Fi Installation Plans and Achievements at Tokyo-related Venues

Except for a few venues, we began the full-scale

Table 3 List of Venues/Status of Wi-Fi for Spectators before the Tokyo 2020 Games

No	Venue	Existing facilities	Facilities newly installed for the Games	No	Venue	Existing facilities	Facilities newly installed for the Games
1	Tokyo Stadium	—	Permanent	20	Olympic Stadium	Existing	—
2	Tokyo Metropolitan Gymnasium	—	Permanent	21	Ibaraki Kashima Stadium	Existing	—
3	Ariake Gymnastics Centre	—	Temporary	22	Sapporo Dome	Existing	—
4	Ariake Tennis Park	—	Permanent and temporary	23	Saitama Stadium	Existing	—
				24	Makuhari Messe Hall A	Existing	—
5	Oi Hockey Stadium	—	Permanent and temporary	25	Makuhari Messe Hall B	Existing	—
				26	Makuhari Messe Hall C	Existing	—
6	Sea Forest Waterway	—	Permanent and temporary	27	Sapporo Odori Park	Existing	—
7	Tokyo Aquatics Centre	—	Permanent and temporary	28	Enoshima Yacht Harbour	Existing	—
				29	Izu Velodrome	Existing	—
8	Tatsumi Water Polo Centre	—	Permanent and temporary	30	Miyagi Stadium	Existing	—
				31	International Stadium Yokohama	Existing	—
9	Musashinonomori Park	—	Temporary	32	Yokohama Baseball Stadium	Existing	—
10	Ariake Urban Sports Park	—	Temporary	33	Yoyogi National Stadium	—	—
11	Odaiba Marine Park	—	Temporary	34	Nippon Budokan	Existing	—
12	Shiokaze Park	—	Temporary	35	Kokugikan Arena	—	—
13	Aomi Urban Sports Park	—	Temporary	36	Equestrian Park	—	—
14	Sea Forest Cross-Country Course	—	Temporary	37	Tsurigasaki Surfing Beach	—	—
15	Kasai Canoe Slalom Centre	—	Permanent and temporary	38	Saitama Super Arena	—	—
				39	Asaka Shooting Range	—	—
16	Yumenoshima Park Archery Field	—	Permanent and temporary	40	Kasumigaseki Country Club	—	—
				41	Izu MTB Course	—	—
17	Ariake Arena	—	Permanent	42	Fuji International Speedway	—	—
18	Tokyo International Forum	Existing	—	43	Fukushima Azuma Baseball Stadium	—	—
19	Musashino Forest Sport Plaza	—	Permanent and temporary				

development studies in the fall of 2019, so the cooperation of existing operators at each venue and telecom partners in charge of telecommunications construction work for the Games was essential to complete the development in less than one year before the Games. The Organising Committee agreed with TMG that the Organising Committee would oversee procurement and construction. Since the Wi-Fi installation works were needed to be carried out at the same time as the construction of the overlay facilities at the venues due to limited schedules, those involved in managing the work had a tremendously hard time coordinating and cooperating.

We designed that each Wi-Fi access point would cover approximately 100 seats and provide an Internet connection environment of at least 1 Mbit/s at a simultaneous connection rate of 30%, assuming the throughput to enable video viewing. In the case of installing temporary Wi-Fi facilities, we considered installing those Wi-Fi access points on temporary fences and prefabricated roofs so that to have as little impact as possible on the permanent facilities (i.e., to avoid the need for repairs after removing temporary ones).

After a one-year postponement, we proceeded with construction coordination to install the Wi-Fi facility in time for the Tokyo 2020 Games held in 2021. However, deciding on the non-spectator policy shortly before the Games, the facility was eventually used only by a portion of the Olympic family and supporting athletes.

As permanent facilities, a total of more than 1,000 access points were installed at 11 of the 19 venues owned by TMG (1-19 in Table 3) and provided the public wireless LAN service "Tokyo Free Wi-Fi" (https://www.wifi-tokyo.jp/en/), and other services.

3.3 Usage of the Newly Installed and Expanded Wi-Fi before the Games

Of the stadiums that were installed Wi-Fi for spectators in preparation for the Tokyo 2020 Games, only the Tokyo Stadium and the National Stadium had actual usage records before the Games.

The Tokyo Stadium was the main venue for the 2019 Rugby World Cup (RWC2019) and the competition venue for the Tokyo 2020 Games, so the stadium had begun preparing for Wi-Fi in time for the RWC2019, ahead of the activities described in 3.2. The Organising Committee was in charge of managing the construction of the Wi-Fi facilities at this Tokyo Stadium as well since the main target was to use it at the Tokyo 2020 Games.

Since the implementation in the Tokyo Stadium was decided approximately six months before RWC2019, we did not have enough time to design and introduce those Wi-Fi facilities for spectators. So, we adopted an expansion contract with the existing Wi-Fi facility provider for the construction work to overcome the time restriction. Then, we encountered issues such as slow display and screen transitions of the captive portal screen during the initial phase of operation but improved subsequently by dividing the VLAN of access points and revising those of accommodations. At the Tokyo Stadium, the Wi-Fi service for spectators was provided at all RWC2019 matches from the opening match on September 20, 2019, to November 1, 2019, and used by more than 10,000 spectators during those matches.

The National Stadium has one of the world's highest density Wi-Fi environment with one access point per 70 seats in the spectator area, which was available from the National Stadium opening event on December 21, 2019. There is a total of 1,300 access points installed for the whole area including the concourse and stores.

4. Conclusion

Under the policy of promoting the development of a mobile communication environment, we could see added cell phone communication facilities to all competition venues and newly deployed Wi-Fi for spectators at major TMG-owned venues. Together with some of those professional sports teams that already had Wi-Fi for spectators, we planned to provide a comfortable mobile communications environment for many spectators. However, it is regrettable that I cannot describe the actual performance of these facilities here because it was seldom used in practice due to the policy of a non-spectator for the Games.

In the meanwhile, we can regard it as an achievement of the Tokyo 2020 Games that we enhanced legacy facilities to a certain level and demonstrated an advanced project model in which companies normally compete cooperated for the improvement of legacy facilities as MOOG.

In the area of Wi-Fi, while promoting the development of Wi-Fi for spectators, I should also note that the Organising Committee had to work in the opposite direction of expansion and installation. That was, shutting down existing Wi-Fi access points temporarily in the venue or changing their frequencies to avoid channel interference with Wi-Fi for competition meas-

urement or the Games management by the stakeholders in those stadiums.

Although the positions and usages of Wi-Fi communications would be changing with the arrival of the 5G era, it will take a reasonable amount of time for replaced completely with 5G because there is assumed to remain a specific demand for offloading mobile data communications. We believe that these efforts in preparation for the Tokyo 2020 Games are part of the foundation that will support a turning point in the mobile communications environment in Japan.

We expect that new next-generation technologies will spread to the telecommunications infrastructure through these world-class events in the future. When collaborative efforts among mobile network operators through a framework such as MOOG can accelerate the development of such technologies and lead to further enhancement of the mobile communications environment in Japan. I believe this can be called as one of the "legacies" of the Tokyo 2020 Games.

Please refer to 2-12 of these special issue for more information on the policies for the use of the 2.4 GHz and 5 GHz bands for Wi-Fi use during the Games, as well as some activities by the Organising Committee to protect the Wi-Fi frequencies used by the Games like monitoring and stopping unauthorized use.

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