System Platform for the Tokyo 2020 Games

KAWASE Takeshi OGURA Mikio

Abstract

The System Platform considered "naturally in operation" was built and operated under the pressure of "absolutely unstoppable" even at the Olympic and Paralympic Games Tokyo 2020. For the Olympic and Paralympic Games Tokyo 2020, we made maximum use of cloud services, built a private cloud that clears the high system requirements unique to the Olympic and Paralympic Games, implemented a common platform that connects to the cloud, and operated the Games in a hybrid cloud environment. The System Platform for cyber security was also thoroughly implemented, and zero incidents affecting the operation of the Games were recorded. This article reviews the System Platform of the Olympic and Paralympic Games Tokyo 2020 and discusses its prospects.

Keywords : System platform, Private cloud, Common platform design, Platform security

1. Introduction

The Olympic and Paralympic Games Tokyo 2020 (hereinafter referred to as "Tokyo 2020") were postponed for one year for the first time in history due to the spread of coronavirus disease 2019 (COVID-19) ended successfully with the Information System of the games operating smoothly without any interruption during the entire duration of the Tokyo 2020 Games. The System Platform, which consists of servers and storage that operates the information system, also contributed to the success of the Games by achieving stable operation without a single incident affecting the games' operation.

This article reviews the challenges and solutions to the System Platform specific to the Tokyo 2020 Games and discusses the legacy of the Games.

KAWASE Takeshi
Technology Services Bureau, The Tokyo Organising Committee of the Olympic and Paralympic Games
E-mail kawase.takeshi@fujitsu.com
OGURA Mikio
Technology Services Bureau, The Tokyo Organising Committee of the Olympic and Paralympic Games
E-mail ogu@fujitsu.com
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2. Overview of the System Platform

The information system was built for the Olympic and Paralympic Games operation by establishing a Primary Data Centre (hereinafter the PDC) and a Secondary Data Centre (hereinafter the SDC) for disaster measures in the host city for each Games. In addition, a Venue Data Centre (hereinafter the "VDC") and an On Venue Result (hereinafter the "OVR") were installed at each competition venue to deploy systems for the Games' measurement and distribution. The competition was operated under a design that allows operations to continue even in the unlikely event of network problems between venues.

The System Platform for past Olympic and Paralympic Games was on-premise until the Rio 2016 Games, which was changed to a cloud environment owned by a global partner from Pyeongchang 2018 Games (Figure 1).

The cloud environment runs the "Games Information System and Games Management System", "Office Suite", "Integrated Data Platform", etc., and provides functions to each venue via the PDC/SDC.

The Tokyo 2020 Games, while following the basic layout of the System Platform of previous Olympic and Paralympic Games, accelerated the shift to the cloud and

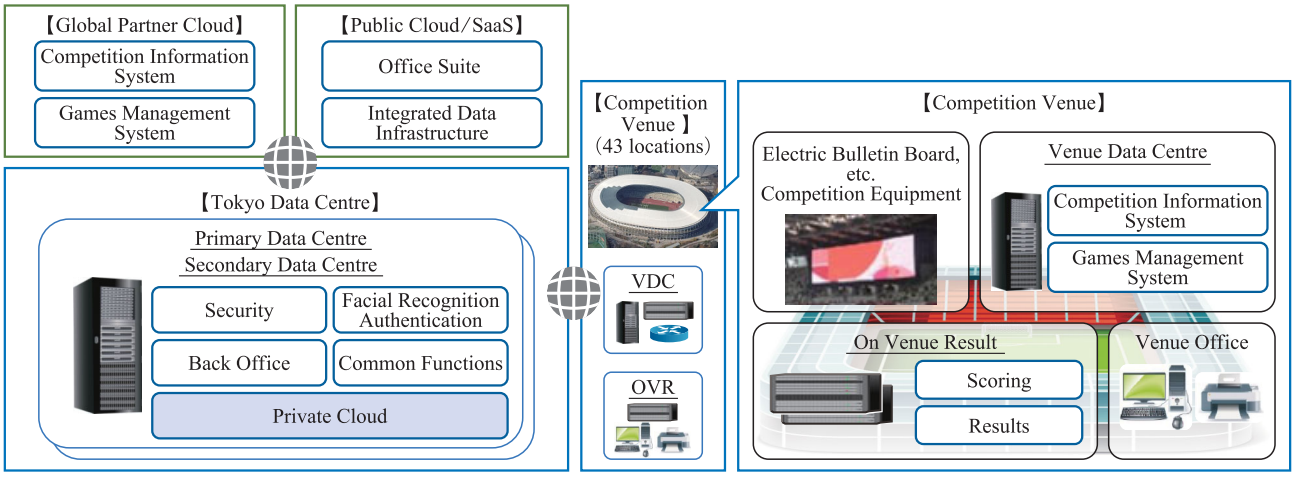

Figure 1　Overall View of the System Platform　The System Platform consists of the main Primary Data Centre, Secondary Data Centre for disaster measures, Venue Data Centre and On Venue Result for each stadium, and a hybrid cloud system using external clouds.（©2021-International Olympic Committee-All Rights Reserved）

established a System Platform based on the following two basic policies.

・ Basic Policy ①:

Public cloud computing and existing systems of partners and suppliers should be used to the possible extent in the construction and operation of short-term use systems.

・ Basic Policy ②:

Functions that cannot be handled by the existing system and mechanisms for inter-system linkage should be built independently in a private cloud environment.

Based on the above policies, the Olympic and Paralympic Games' system was operated in a "Hybrid Cloud Environment" that maximizes operational flexibility and cost advantages. The authors believe this System Platform utilized the most cloud technology compared to previous Olympic and Paralympic Games, contributing to flexible application development/operation and a back-office automation environment.

3. Requirements for the System Platform

3.1 Scalability and Reliability

The following three points can be cited as characteristics of the Information System for the Olympic and Paralympic Games.

（1） In a situation where business requirements take longer than expected to be finalized, which often happens to organizations that are being built in a short period, server virtualization capabilities are needed that can provide server resources in an on-premise environment promptly when required.

（2） Performance and stability are required based on the assumption that hundreds of thousands of users will be accessing the system intensively in a short period immediately before and during the Olympic and Paralympic Games. In other words, a cloud environment that can withstand high loads is required.

（3） Because mission-critical systems must be operated such that they can never shut down during the short Games period, reliability and redundancy are required to ensure that operations can continue even in the event of a data centre disaster or serious problems.

Building the system using cloud services such as IaaS is recommended to meet the above requirements. However, servers must be installed on-premise at each competition venue to meet the requirements of millisecond response time for competition measurement and immediate distribution of results. It was also necessary to set up a PDC/SDC to consolidate these servers and connect them to each cloud, thereby establishing a System Platform.

Therefore, it was essential to build a private cloud as the System Platform for the Tokyo 2020 Games that satisfies the following requirements.

① Have a server virtualization function that can provide a server promptly when needed.
② Provide an environment that ensures reliability by ensuring hardware and virtual server redundancy.
③ Has expandability and ease of expansion for the increase in the number of resources and data for the duration of the Olympic and Paralympic Games and reduces costs by improving the efficiency of infrastructure construction and operation.
④ Continues the Olympic and Paralympic Games operations even during a disaster.

3.2 Standardization and Platformization of Common Functions

The Information System for the Olympic and Paralympic Games will be constructed as an international multi-vendor system, including the core system for Olympic Games and Paralympic Games operations provided by the global partners. Although 66 business applications were finally introduced at the Tokyo 2020 Games, each business department and partner company studied the system individually, giving rise to concerns that the system development project would become isolated and siloed, resulting in insufficient data integration between systems and unnecessarily high costs.

Therefore, Tokyo 2020 designed an enterprise architecture based on a rough analysis of business requirements in the initial study phase, standardizing data and technology systems, and creating a common platform. In addition, since many business applications were provided agilely using the public cloud environment, it was necessary to design a hub function to connect the on-premise and cloud environments.

3.3 Thorough Security Measures

Cyber security measures have been an issue that has attracted worldwide attention at the Tokyo 2020 Games, as cyber security attacks have caused security incidents that have affected the operation of the Olympic and Paralympic Games in the past.

Therefore, to prevent security incidents from occurring at the Tokyo 2020 Games, it was essential to establish a highly robust System Platform, and we focused on comprehensiveness when considering security measures.

A hybrid architecture was adopted for the Common Platform of Security Functions, which included not only the cloud environment of global partners but also major cloud services used in the back-office environment.

4. System Platform Design

4.1 Physical Design of the Private Cloud Environment

For easy construction of a private cloud environment that meets the requirements described in 3.1, a vertically integrated virtualization and cloud computing

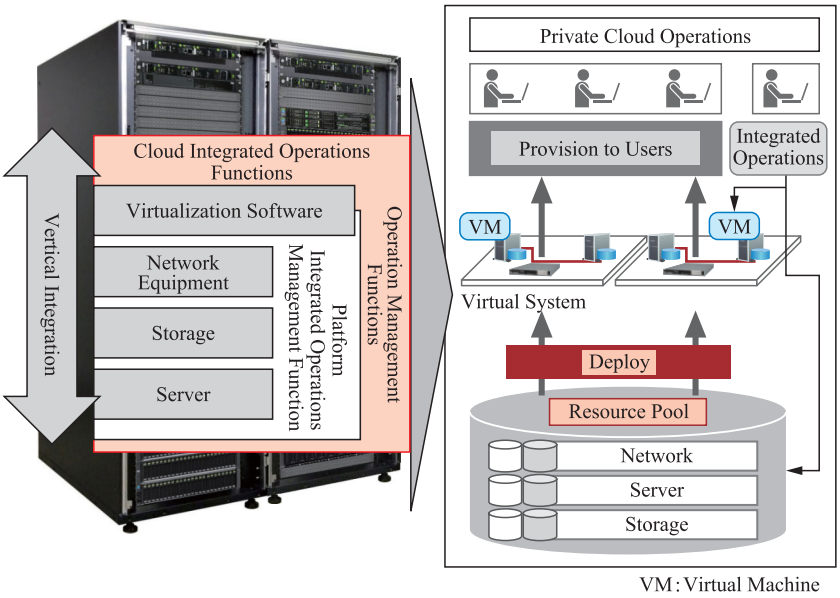

Figure 2 PRIMEFLEX for Cloud Vertically integrated virtualized cloud platform.
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system, "FUJITSU Integrated System PRIMEFLEX for Cloud (PRIMEFLEX)", which employs globally proven virtualization technology and can be expanded as needed, was adopted as the PDC. PRIMEFLEX is a vertically integrated virtualization and cloud computing platform that can be expanded as needed (Figure 2).

The introduction of PRIMEFLEX enabled the configuration of a system with high mutual compatibility by unifying OS types, versions, security levels, and centralized monitoring of hardware failures and resource thresholds to centralize operation and management. By enabling the flexible provision of virtual servers following the timing of business application introduction and gradually expanding the resource pool toward the production of the Games period, the scale of the private cloud was kept to the minimum necessary to reduce introduction costs and minimize maintenance and operation costs to establish the System Platform. This has also enabled the company to establish a System Platform with minimal maintenance and operation costs.

In addition, to prepare for the risk of data centre collapse or system shutdown in the event of a disaster, a sub-site SDC was set up so that it could be switched over in the incident of a disaster. The System Platform environment was designed to be at its minimum and was constructed and operated cost-effectively.

4.2 Design of Common Functions of System Platform

The design of common functions of the System Platform targeted the ① Authentication Platform, which is required for each application, ② Data Linkage Platform, which is required for coordination among applications, and ③ Integrated Database Platform, which consolidates the information of each application. To integrate with on-premise systems, we built ① and ② on a private cloud and ③ on a public cloud (Figure 3).

① Authentication Platform

The Authentication Platform was implemented through a hybrid cloud environment, providing authentication functions for Single Sign-on (SSO) and Multi-factor Authentication for staff and stakeholder business systems.

- Single Sign-on Function:

Provides SSO authentication for each application using SAML, Open ID Connect, and proxy authentication.

- Multi-factor Authentication Function:

In addition to integrated Windows authentication and ID/password authentication, we provide multi-factor authentication functions such as one-time passwords to strengthen the security of each application.

② Data Linkage Platform

Provided a platform for real-time data integration and batch data integration between various environments (PDC/SDC, systems provided by Games partners, and cloud services).

- High-speed Data Linkage Function:

Provided data (CSV, XML, etc.) linkage function

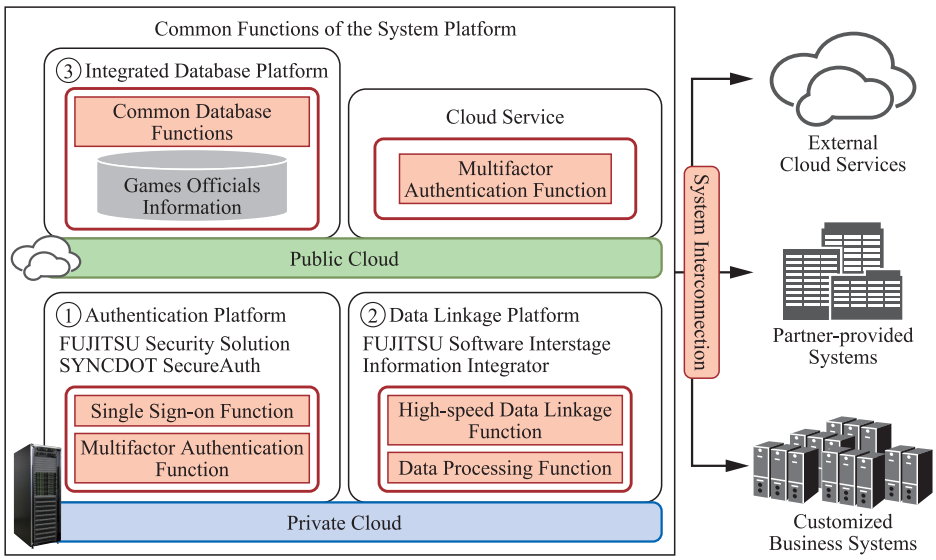

Figure 3 Design of Common Functions The system's authentication function, data linkage function, and integrated database function are commonized.

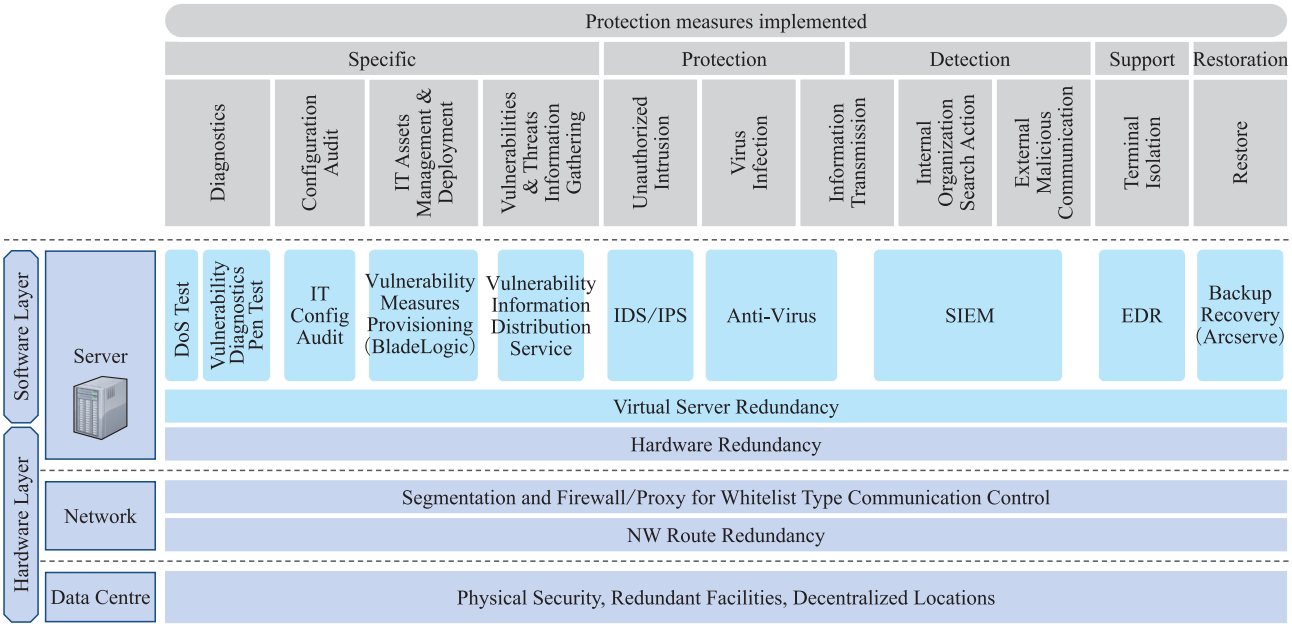

Figure 4 Multi-layer Security Defense Mechanism for Security Measures of Private Cloud Functions for security measures are deployed comprehensively to identify, prevent, detect, respond to, and recover from attacks to ensure robustness.

between systems, including external systems, via cloud computing and the Internet.

・ Data Processing Functions:

Provided data processing functions such as format conversion, merging, filtering, and fixed value setting are provided for data linkage.

③ Integrated Database Platform

Information commonly required by each application, such as persons involved in the Tokyo 2020 Games, was aggregated and compiled into a database, which could be used with the API.

By providing common functions, we could reduce the development period for each application and significantly contribute to the reduction of development costs.

In addition, the centralized management of accounts and other information made management and operation more efficient, facilitated tracking in the event of security incidents, and enabled the smooth operation of the Games system.

4.3 Design of Security Measures

The main policy of the security measures that were comprehensively implemented is described below (Figure 4).

4.3.1 Detecting the Occurrence of Vulnerabilities and Immediate Application of Countermeasures

To eliminate vulnerabilities, the existence or nonexistence of vulnerabilities was validated every month in the operation system. The System Platform requires a mechanism to quickly and without omission apply measures for detected vulnerabilities to all business applications on all virtual servers, and "BladeLogic", which automates patch application and provisioning, was introduced to achieve operation with a unified security level.

4.3.2 Establishment of the Multi-layered Defense Mechanism

To protect against cyber-attacks, a comprehensive multi-layered defense mechanism was established by deploying various solutions.

In addition to protection from attacks, operations were established to detect and immediately respond to suspicious behavior.

4.3.3 Network-level Communication Control

Servers were defined to be installed in four zones according to their purpose (Table 1). All communications between servers in different segments were controlled by a firewall in the form of a whitelist.

In addition, all operations on the servers must be

Table 1 Zone Division and Definition

Zone	Zone Definition
DMZ	External zone that is open to the Internet
Edge	Zone that requires an external connection to the Internet
Trusted	Default trusted zone
Secure	Most secure and isolated zone

performed via a jump server and remote desktop connections to the jump server. It should require multifactor authentication using an authentication application in addition to IDs and passwords.

Security measures at the network level prevent the intrusion of malicious programs and enhance robustness to minimize damage in the event of an intrusion into the internal network.

4.3.4 Built the Backup and Restore Environment

To ensure smooth restoration in the event of a cyber incident that compromised the system environment, we have installed "Arcserve UDP", which backup critical systems daily and restore them to their pre-attack state. The System Platform environment was designed to ensure the continuity of Games operations by enabling reliable and rapid recovery from cyber attacks.

5. Operation Result at the Tokyo 2020 Games

5.1 Improvement of Operational Maturity

Based on the design of the System Platform described in 4. above, a security countermeasure mechanism was constructed, and thorough audit tests and operational training were conducted to improve the security level of the System Platform before the Games time.

5.1.1 Thorough Auditing/Testing

Security reviews by security specialists during system installation, penetration tests, and security assessments by multiple external organizations were conducted to raise the security level, and attack defense exercises by white-hat hackers were conducted to close vulnerability holes.

In addition, we conducted periodic inventory and audits of accounts with administrative privileges and maintained an environment in which privileged accounts were kept to the minimum necessary to prevent unnecessary accounts from being misused.

Table 2 Configuration of System Platform during the Games Period

Data centre (PDC・SDC)	Competition venue (VDC・OVR)
・Number of installed servers : 35 ・Number of virtual servers : 220 ・Storage capacity : 490 TByte	・Number of installed servers : 140

5.1.2 Thorough Operational Training

We conducted a series of operational drills to verify the operation of the System Platform in the actual operation of the Games through test events, and to deal with simulated incidents through Technology Rehearsal and Table Top Exercise, to familiarize ourselves with system monitoring and operation. In addition, several Disaster Recovery Rehearsals were conducted to recover from system downtime due to PDC damage or cyber incidents. An operational system was established, and operations were mastered so that operations could be immediately restored even in the event of a large-scale failure.

5.2 Achievements during the Olympic and Paralympic Games

The System Platform built for the Tokyo 2020 Games was expanded to the following configuration during the Games (Table 2).

In Rio 2016 Games, 138 Physical Servers and 258 Virtual Servers were operating at the PDC and SDC. In Tokyo 2020, the number of servers and storage space built exclusively for the Games was significantly reduced by shifting to the cloud.

Regarding the common functions of the System Platform, business applications were operated between 12 authentication platforms and 8 data linkage platforms. The integrated database platform was widely used for business applications for the Games officials, such as Tokyo 2020 ICON, a support system for infectious disease control operations. The rapid provision of the server environment through the private cloud and the streamlined application development through the common function design of the System Platform reduced the delivery period of the business applications from two to six months and reduced the cost.

In addition, 62 incidents related to the System Platform were issued during the Games period, but no incidents affected the Games' operations. Implementing multi-layered security measures, thorough audits, and strengthening the System Platform through operational

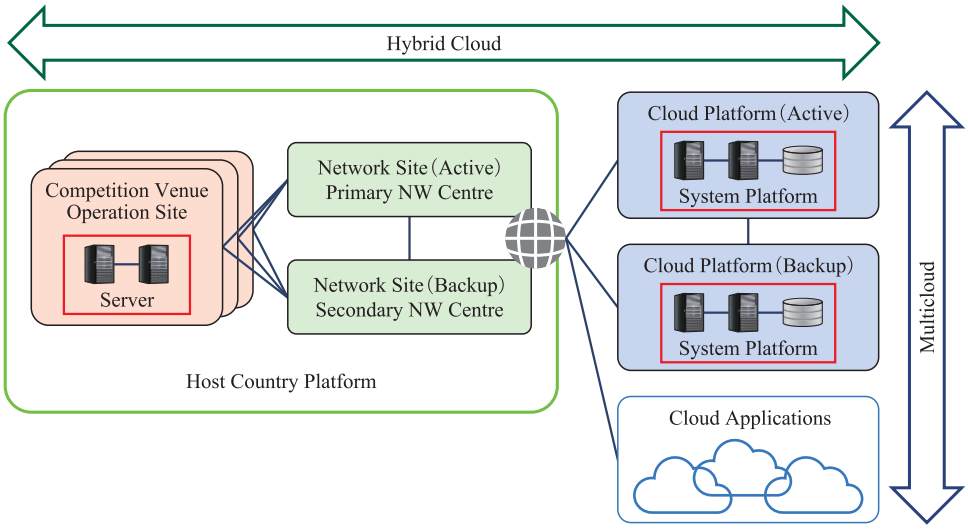

Figure 5 System Platform Using Common Cloud Platform for Each Olympic and Paralympic Games

training contributed to the stable operation of the Games system.

The server, security, network, and application teams worked in unison to set up the platform, and the one-team monitoring and operation prevented threats before they occurred.

6. Future Prospects

The stable operation of the platform, including the System Platform and communication networks introduced in this report, is considered to have primarily contributed to the significantly fewer critical incidents that occurred during the Games time compared to previous Olympic and Paralympic Games. The effectiveness of the hybrid cloud/multi-cloud System Platform was confirmed at the Tokyo 2020 Games, and it is expected that the optimal combination of those will be considered for future Olympic and Paralympic Games.

To meet high response requirements and to ensure contingency in the incident of network problems, it will be necessary to install servers at local venues for Olympic and Paralympic Games operations. However, because of the high level of requirements specific to the Olympic and Paralympic Games, it would be a heavy burden for the organising committees of each host city, which are just starting, to define the requirements and design the system. Therefore, it is preferred that a global partner involved in multiple Games provides a common cloud platform for each Olympic and Paralympic Games that meets the requirements. This will allow each country to use the System Platform that meets the requirements of the Olympic and Paralympic Games simply by setting up a network base that serves as a hub for relaying between each venue or base and the cloud and by having a dedicated line to the common cloud platform (Figure 5).

On the other hand, in considering the reliability and redundancy of the System Platform, attention must be focused on cyber security trends that have become increasingly severe in recent years, as well as operational problems that frequently occur at large-scale cloud service providers. Specifically, instead of "same architecture, different location" redundancy that mainly assumes physical disasters at data centres, "different architecture, different location" redundancy that also assumes contamination of the system environment by severe cyber-attacks should be considered. This may minimize the business impact caused by cyber-attacks and problems in the external business environment.

We want to take this opportunity to thank our partners and suppliers who have contributed to the construction and operation of a stable System Platform throughout the Tokyo 2020 Games.

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KAWASE Takeshi

Graduated from Ritsumeikan University in 2006. He joined Fujitsu Limited in the same year. He was seconded from Fujitsu Limited to the Tokyo 2020 Organising Committee in 2017-04. In 2017-04, he was transferred from Fujitsu Limited to the Tokyo 2020 Organising Committee to take charge of infrastructure construction in the Technology Services Bureau.

OGURA Mikio

Graduated from the University of Electro-Communications in 1996. Joined Fujitsu Limited in the same year. He was transferred from Fujitsu Limited to the Tokyo 2020 Organising Committee in 2015-09 as the Manager of the System Infrastructure Section of the Technology Service Bureau. He was transferred to the Tokyo 2020 Organising Committee from Fujitsu Limited in 2015-09, where he established the system infrastructure for the Tokyo 2020 Games as the head of the System Infrastructure Section of the Technology Services Bureau.