

Digital Technology to Support Next-Generation Stadiums/Arenas

● Masaru Watanabe ● Hideki Koyama ● Yuichi Terui ● Kazuhiro Nagase
● Kiyoshi Kawano

The Japanese Government aims to grow the sports market to 15 trillion yen by 2025, leveraging a series of international sporting events to be held in Japan from 2019 onwards. Stadiums/arenas that can host international sporting events are expected to facilitate sustainable growth of local economies while benefiting from the growth potential of the sports industry. Against this backdrop, Fujitsu has developed a stadium/arena solution, which helps to satisfy various requirements for international competitions and reduce management costs, as well as a spectator experience service platform that enhances the value of spectating experiences. Providing these services to stadiums/arenas, Fujitsu will boost the sports industry as well as revitalize local communities. This paper describes these digital technologies that Fujitsu offers to realize next-generation stadiums/arenas. It also presents an experiment of the next-generation live viewing system developed jointly with B.LEAGUE (the Japan Professional Basketball League) in anticipation of that realization.

1. Introduction

Major sporting events will be held in Japan around the year 2020. For example, the Rugby World Cup is scheduled to take place in 12 Japanese cities in 2019. All of these events are expected to draw international tourists to Japan, not only to the metropolitan Tokyo area but also to remote regional areas. The Japanese Government formed the Japan Revitalization Strategy 2016 (cabinet decision passed on June 2, 2016), which designated “making sports into a growth industry” as part of the 10 Strategic Public-Private Joint Projects, setting out to achieve growth in the sports market from 5.5 trillion yen in 2012 to 15 trillion by 2025.¹⁾ Furthermore, the Strategy of Investment for the Future 2017 (cabinet decision passed on June 9, 2017) identifies a specific target of opening 20 new stadiums/arenas by 2025.²⁾ In this paper, the term “stadiums/arenas” refers to those facilities with capacities in the thousands to tens of thousands of people, that cater to commercial events, and whose main purpose is to host sports/athletic games.

Stadiums/arenas that serve these purposes are expected to facilitate sustainable growth of local economies while benefiting from the growth potential

of the sports industry.

Japan has long placed an emphasis on the educational aspects of sports, failing to recognize its growth potential as an industry. Many sports facilities have therefore been developed purely for the benefit of those who play or compete, and not much attention is paid to the viewpoint that the stadiums/arenas of today should offer spaces where people—sports spectators and members of local communities alike—gather and enjoy themselves. The sports industry has the potential in the future to stimulate local economies across different sectors, such as retailing, construction, travel, and broadcasting. Here, stadiums/arenas are considered to be an important element. Thus, they are expected to turn themselves from being a cost center into a profit center, and being a symbol of local communities, they boost the local economy and realize sustainable growth.

Against this backdrop, Fujitsu offers a stadium/arena solution and a spectator experience service platform to promote the sports industry and contribute to revitalizing local communities. The stadium/arena solution helps to satisfy various requirements for international competitions and reduce management costs.

The spectator experience service platform enhances the value of spectating experiences, and by doing so it increases customer engagement, leading to enhanced profits.

This paper describes these digital technologies that Fujitsu offers to realize next-generation stadiums/arenas.

2. Digital technology for stadium/arena solution

For stadiums/arenas, the life cycle cost includes not only the initial investment cost but also a significant amount of management costs in the form of facility operation and maintenance. This necessitates well-considered planning from the early stages of the facility development project to take these costs into account. When the construction of facility is planned with a specific major events in mind, it is essential to conceive the plan for the facility's use after the event (legacy plan). Fujitsu leverages its systematic digital technology, which we have developed in various areas, for flexible operation and enhanced efficiency in management and maintenance to offer the stadium/arena solution, which contributes to a reduction in management costs.

This section describes some of the technologies used for this solution.

2.1 Information & communication infrastructure

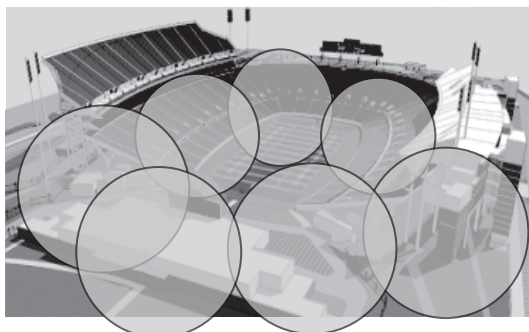
Enhancing the efficiency of operation and management through ICT requires network infrastructure,

such as IP-PBX to handle circuit switches for Internet Protocol (IP) telephones, Ethernet LAN, wide area network (WAN), and high-density Wi-Fi, and information security. Previously, stadiums/arenas did not actively pursue the development of information and communication infrastructure. As time passed, even ascertaining detailed information on the use of installed communication cables was difficult. It thus became increasingly difficult to add temporary communication networks every time major events were held, and the cost of installing new communication systems increased. In the future, designs must consider the importance of communication infrastructure from early on in the facility development. Also, the provision of free Wi-Fi and smartphone-based services for spectators will be indispensable to maximize user satisfaction.

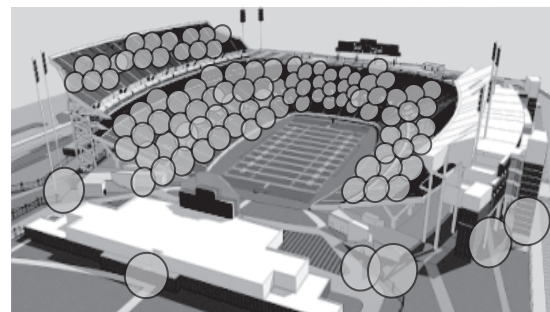
To address this network-related challenge, Fujitsu offers high-density Wi-Fi to secure sufficient capacity to accommodate terminal devices (**Figure 1**). As seen in Figure 1(a), conventional high-power access points (AP) generate mutual interference if they are placed too close to one another. The number of APs is therefore limited, inevitably limiting coverage capacity. Due to this reason, some areas may be left outside the network range. We therefore use many less-powerful APs to avoid interference and secure sufficient capacity, as depicted in Figure 1(b). In this way, the area coverage of the radio signal can also be easily extended.

2.2 Facility infrastructure

The stadium/arena solution offers facility infrastructure, which is a group of systems for safe



(a) Conventional Wi-Fi coverage



(b) High-density Wi-Fi coverage

Figure 1
Comparison of conventional and high-density Wi-Fi.

management/operation of the physical structure. With these systems, it is possible to economize on the utility costs and streamline services, leading to efficient facility operation and management. The facility infrastructure comprises FUJITSU Security Solution facility general management system Futuric to manage electric power, lighting, and air conditioning; systems for physical security including visual surveillance, access control, and access gates; and a system to manage car parking space efficiently. Fujitsu developed these systems for offices and commercial facilities. They are now optimized and further developed for stadiums/arenas.

Today, facilities that accommodate many people, such as stadiums/arenas, can be easily targeted by terrorist attacks. Thus, it is also important to prepare against such attacks. Considering the large-scale events that will be held in the future, facilities must meet strict security requirements. Furthermore, stadiums/arenas cannot afford to not have such systems as large display screens to project games and information, digital signage, and scoreboards. Fujitsu can also offer these backed by its strong expertise.

2.3 Systems for assisting operation and maintenance

Operating stadiums/arenas requires as many as several hundreds of staff members, including maintenance engineers and event operators. IoT-enabled systems using wristbands for sensing vital signs and smartphones can enable facilities to manage personnel in order to grasp work, environments, and physical loads. This allows the facilities to ensure safety, planning efficient staff distribution and so on, allowing them to reduce the overall costs of operation/maintenance (Figure 2).

2.4 Universal design

It is important that stadiums/arenas allow everyone to come together and enjoy the excitement of sports regardless of disabilities or nationalities.

An example is *Ontenna*,³⁾ a small hearing aid that can be clipped onto the hair like a hair pin. It transmits vibrations and light to convey sounds. As illustrated in Figure 3, *Ontenna* detects the ambient sounds as sound pressure levels ranging between 30 and 90 dB and converts it into 256-level signals. The device attached to the hair controls the vibration and light emissions according to these signals, allowing the wearer to virtually experience the sensation of a sound's rhythms, its patterns, and its volume.

For foreign visitors, support will be provided through systems such as a hands-free voice recognition interpreting device, multi-lingual audio guides, multi-lingual cloud service using videophones, and so on.

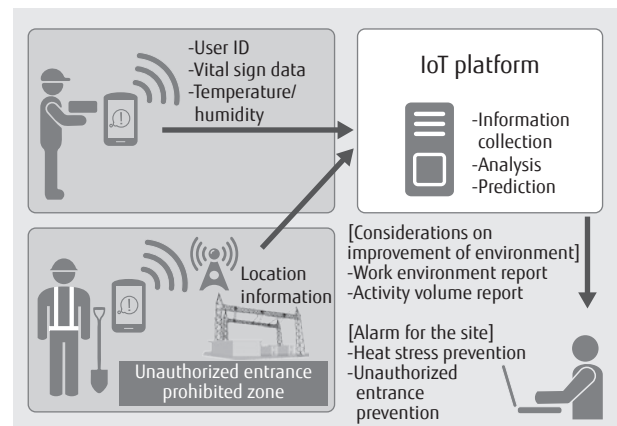


Figure 2 Systems for assisting operation and maintenance.



Figure 3 *Ontenna* overview.

2.5 Disaster prevention system

One of the most important functions of stadiums/arenas is to serve as an evacuation area in disaster situations. Fujitsu offers various emergency systems that can be deployed in emergencies, such as a disaster prevention system, an emergency reserve management system, a safety communication system, and an evacuation guidance system.

3. Digital technology that supports the spectator experience service platform

In order to sustainably grow stadium/arena operational management, it is necessary to maximize the spectators' experiences (customer experience) in watching sports. To make spectator experiences more valuable, Fujitsu offers the spectator experience service platform. The core technologies include free viewpoint video generation technology, a live viewing system, and a place-based services platform. These technologies enable Fujitsu to realize new styles of watching sports, enhancing the entertainment value of sports.

The following sections describe the live viewing system.

3.1 Outline of live viewing system

It is commonplace that professional sports leagues adopt the home-and-away match style. There are local fans who wish to watch their favorite team's away games at their home arena. Fujitsu live viewing system makes it possible to bring the away game to the screens at the home arena with very realistic

rendering in real time, driving up event revenues and enlivening local fan communities. The engagement of excited supporters in the live viewing venue can then be broadcast back to a big screen at the away arena, reciprocating the live updates (through communication by reporters) and developing a sense of unity between the venues. This can be realized by FUJITSU Network Real-Time Video Transmission Gear IP-HE950 Series,⁴⁾ which allows the inexpensive transmission of large-size data in real time via IP networks (Figure 4).

To render video as if it is unfolding in front of the audience's very eyes, the data to be transmitted should be ultra-high-definition 4K/8K video with multi-channel stereo audio captured by numerous microphones. As the visual and audio data are transmitted by different transmitting equipment and through different IP networks, the image and audio channels are unsynchronized at the live viewing end. To address this issue, we have introduced a system to synchronize the video and audio. The video and audio data sent to the live viewing venue are delay-adjusted so that the lag is reduced to as little as a few tens of milliseconds. Meanwhile, high-speed transmission that conveys information without delay is crucial for developing the effect of unity between the venues. By realizing the interactive arrangements with only a 0.3-second delay, the system can give participants the impression that they are at the same venue.

The system collects the sounds in the venues coming from the match and the audiences and controls the sound, lighting, and vibration in the live viewing venue. This effect will be able to induce emotional

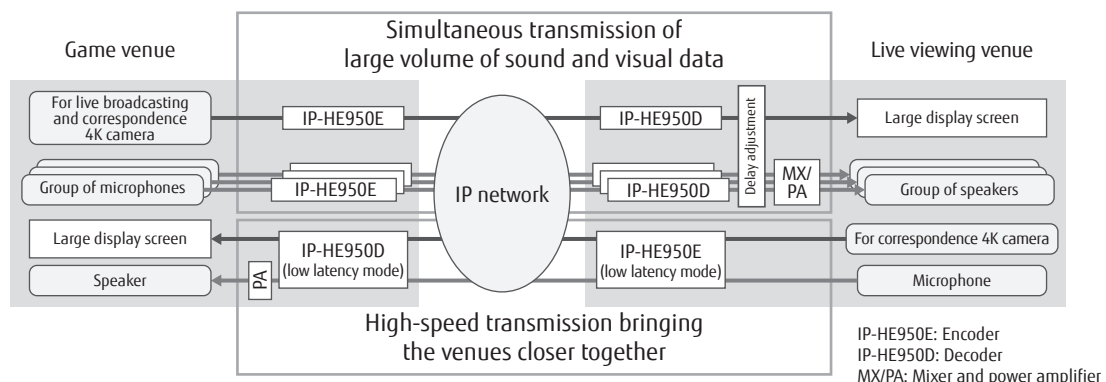


Figure 4
Video transmission system that recreates realistic excitement of real venue.

excitement in the audiences, as the system conveys not only the realistic ambiance of the game field but also the dynamic movements of the players no less effectively than the spectators in the real venue can feel. The technology employed to make this amplified emotional experience possible is Sound Intelligence, a sound-base technology co-created with Yamaha Corporation.

Figure 5 illustrates how Sound Intelligence can be deployed in the live viewing system. The video and audio data transmitted from the game venue are analyzed by AI using a database (DB) for arrangements based on experience and learning. The AI then automatically executes effective staging according to the game progress. Specific ideas for this effect include the inducement of realistic game video by playing realistic sounds with effective accentuation, insertion of graphic effects onto the large screen, and automation of special effect equipment (moving light projectors, laser show projectors, CO₂ smoke machines, etc.). This is equivalent to the semi-automation of a highly technical DJ performance, and it realizes enhanced spectator experience in live viewing without incurring a high cost.

3.2 Empirical trial of live viewing service with B.LEAGUE

This section describes a specific initiative involving the live viewing service that we worked on with the Japan Professional Basketball League (B.LEAGUE).

Like many other sports associations, B.LEAGUE relies on sponsorships and revenues from ticket sales and the commercialization of licensing rights for its finances. An increase in spectators directly boosts ticket

sales and possibly the revenues from merchandise and catering services. Furthermore, increased popularity will enhance its advertising value and consequently attract more advertisement offers from sponsors.

Adopting the home-and-away style league matches, B.LEAGUE games often see more fans for the home team and fewer for the away team at the game venue. Given this situation, we are considering the possibility to develop a new public viewing service (hereafter, PV service) to be offered to the fans of the away team designed to enhance their levels of satisfaction and the clubs' profits. Previously, a PV service would typically offer live broadcast of the game for those fans who could not watch it in the stadium.

Fujitsu's remote spectating environment "live viewing service" (hereafter, LV service) aims to connect those fans at remote venues throughout Japan to the game venue by means of ICT and realize "a realistic, exciting game experience no less than the game venue" and "a shared sense of unity with the players and other fans." The service aims to contribute to the "pursuit of entertainment value" that B.LEAGUE strives for. As the service is likely to increase the number of spectators at away venues as well as game venues, we intend to launch this service as a new source of revenue starting in the 2018–19 season. We conducted a trial of this service on January 14, 2018 as the Next-Generation Live Viewing "B.LIVE in Tokyo" (hereafter, the B.LIVE) for the B.LEAGUE All-Star Game that took place in Kumamoto. The details are as follows.

The All-Star Game was organized in Kumamoto this year with the intention to give support to the local communities recovering from the Kumamoto

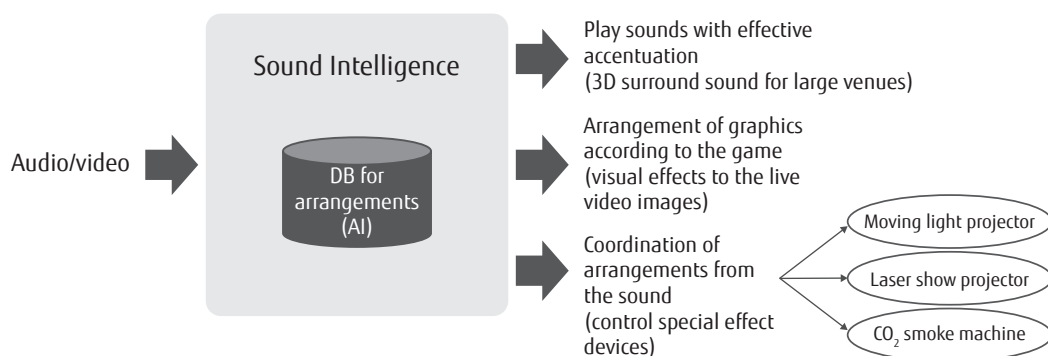


Figure 5
Leveraging Sound Intelligence in live viewing system.

earthquakes in April 2016. The B.LIVE event was organized so that the game venue (Kumamoto Prefectural Gymnasium) and B.LIVE venue (Yebisu The Garden Hall in Shibuya City, Tokyo) were connected with a high-speed network to enjoy the game in real time. Using the aforementioned live viewing system, the game was projected onto a large display screen in clear, ultra-high-definition 4K streaming with surround sound and lighting effects to recreate the ambiance of the game venue, including the players' dribbling, steps, and squeaks of their shoes, and so on, inducing a highly realistic, exciting atmosphere. Furthermore, we put spaces on both sides of the screen to install mock baskets and vibration actuators (motorized devices), staging the movements in the game with vibration in the floor so that audiences could experience the game dynamically. The 4K video, lighting, sound, and vibration were coordinated in such a way that the excitement and dynamism of the game was recreated in the B.LIVE venue very effectively.

Feedback from the audiences in the B.LIVE included "it was the best ever, I really enjoyed the basketball game in a setting different from the arena" and "it felt so real and I enjoyed the experience of a new style of spectating sports."⁵⁾

This initiative proved to be a success to meet sports fans' desires through leveraging ICT and showcasing the excitement of next-generation stadiums/arenas in Fujitsu's vision. Our future tasks include reviewing the costs based on the results of this trial and further enhancing the fans' satisfaction and B.LEAGUE's profitability. We will also aim to expand the project to other sports and modes of entertainment.

4. Conclusion

This paper described solutions for stadiums/arenas based on the digital technologies offered by Fujitsu.

Fujitsu has provided these solutions to stadiums and arenas that hold large-scale sporting events. However, there are about 20,000 sporting venues throughout Japan that are not big enough to be considered stadiums/arenas. Most of them are educational facilities, which means that their user fees and operating rates are low. Therefore, they cannot afford to invest in their facilities. We are currently developing a solution together with the technologies described

in this paper so that small-scale sporting facilities can also benefit from them. This solution would help turn a local sports facility into a base for local communities and a trigger for stimulating the local economy, and has the possibility to be used for new business opportunities other than sports.

Fujitsu continues to aspire to bring about the story to create a "better, more prosperous future" with diverse stakeholders by means of contributions and support to local communities through sports. By doing so, Fujitsu aims to contribute to the sports industry and local communities that are about to take a step toward major change.

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Masaru Watanabe

Fujitsu Ltd.

Mr. Watanabe is currently engaged in sports digital platform project.



Hideki Koyama

Fujitsu Ltd.

Mr. Koyama is currently engaged in sports business planning and business promotion in the basketball market.



Yuichi Terui

Fujitsu Ltd.

Mr. Terui is currently engaged in planning of the spectator experience service platform.



Kazuhiro Nagase

Fujitsu Ltd.

Mr. Nagase is currently engaged in planning of the stadium/arena solution.



Kiyoshi Kawano

Fujitsu Ltd.

Mr. Kawano is currently engaged in stadium/arena solution programs.