Live-Streaming the Spring Festival in Tokyo —Our Report

2.1 Introduction

The Spring Festival in Tokyo is one of Japan's largest classical music festivals, held once a year at music halls, museums, and other venues around Ueno. Originally the Tokyo Opera Nomori, which began in 2005, the festival in its current format has been adding color to Ueno's spring scene since 2009. The 2019 event was huge, featuring 208 performances across all venues, but most of the performances were canceled in 2020 when COVID-19 hit, leaving only 14 performances that year.

In 2021, the festival went ahead under restrictions to prevent the spread of COVID-19—a maximum attendance of 5,000 or a 50% venue capacity limit—so to make up for the limitations on physical attendance, we live-streamed all 60 performances held across the 14 venues.

In 2022, as in 2021, we live-streamed almost all of the 56 performances across 14 venues. With over 10 venues being streamed and some performance or other taking place every day over the festival's month-or-so running time, on some days we streamed as many as four performances simultaneously. To stream multiple performances at a time, in 2021 we carted a whole lot of equipment to the Tokyo Bunka Kaikan, one of the venues, and set up a temporary streaming center to record and broadcast the events. This year, however, we established our streaming center at IIJ's headquarters in Iidabashi and greatly increased the level of operations performed remotely via FLET'S and mobile connectivity in an attempt to reduce streaming costs, including those associated with personnel resources.

This report takes you behind the live-streaming scenes by explaining our process for deciding on system configurations and the IP technology we used, along with some added color on the trials and tribulations of making everything work.

2.2 Live-Streaming Specifications and Solutions

In 2022, the music festival organizers asked us if we could offer an increased range of payment options while keeping ticket prices reasonable to boost live-stream viewership. We added in-app smartphone (iOS/Android) payment support to make it easier to buy tickets. And we had to do a full review of costs to ensure ticket prices would be reasonable. Our goal with the live-streaming specifications was to keep a lid on costs everywhere we could, including how we deployed equipment and staff and how we configured our systems, while not impairing the user experience.

■ Consideration 1: Minimizing equipment

Up until 2021, we brought several cameras to each venue so we could switch camera angles according to what was happening in the performance, but our uniform approach in 2022 was to install a single 4K camera in the back row of each venue to capture the entire scene. This made it possible to greatly reduce the amount of equipment brought into the venues. On the other hand, it meant that the viewer would also be seeing a full-angle image of the performance. So to make up for the video feed not being switched to focus on the highlights of each performance, we incorporated zoom and pan features into the video player to give viewers control over the viewport. Also, although the song list is posted on the player page, it is not visible in fullscreen mode, so we added a feature to the player to let viewers check the song list while in fullscreen mode as well.

■ Consideration 2: On-site staff deployments

Since the performance venues change daily and are public facilities, we are not able to set and leave our broadcast equipment within the venues for the whole duration of the festival. Hence, we had to set things up before the start of every performance, and time was very tight at times

depending on what time performances were scheduled to start on the day in question. Laying cables within the venue was particularly challenging. Stability is important when transmitting video, so we were using wired connections, and this meant laying cables 100m long in large venues, which required several staff to work together. To reduce the workload for on-site staff, tasks such as focusing the camera, adjusting brightness, and performing audio level and LR tests were accomplished remotely rather than by staff at the venue.

Consideration 3: Remote production

Up until 2021, we set our streaming center up at the Tokyo Bunka Kaikan in Ueno, from where we performed the work involved in transmitting the video to viewers, which included recording, video feed switching, and subtitling, and we had to bring a huge amount of equipment to Ueno to enable us to stream four performances at once. Setting the streaming center up at IIJ's headquarters in Iidabashi in 2022 obviated the need for people to travel, transport equipment, and build and operate a separate center. Staff responsible for feed switching no longer needed to travel to Ueno, which reduced not only the costs but also the workload on staff. To prevent problems arising with the remote setup, we decided on how staff would communicate with each other, what the procedures would be for installing and checking equipment, and so on before the festival, and we set rules on updating our operating procedures as needed and swiftly communicating these changes to staff. These efforts are what made the remote production setup work.

Based on these three considerations, we decided on the following specifications: the event would only be live streamed with no archives kept, video would be at most

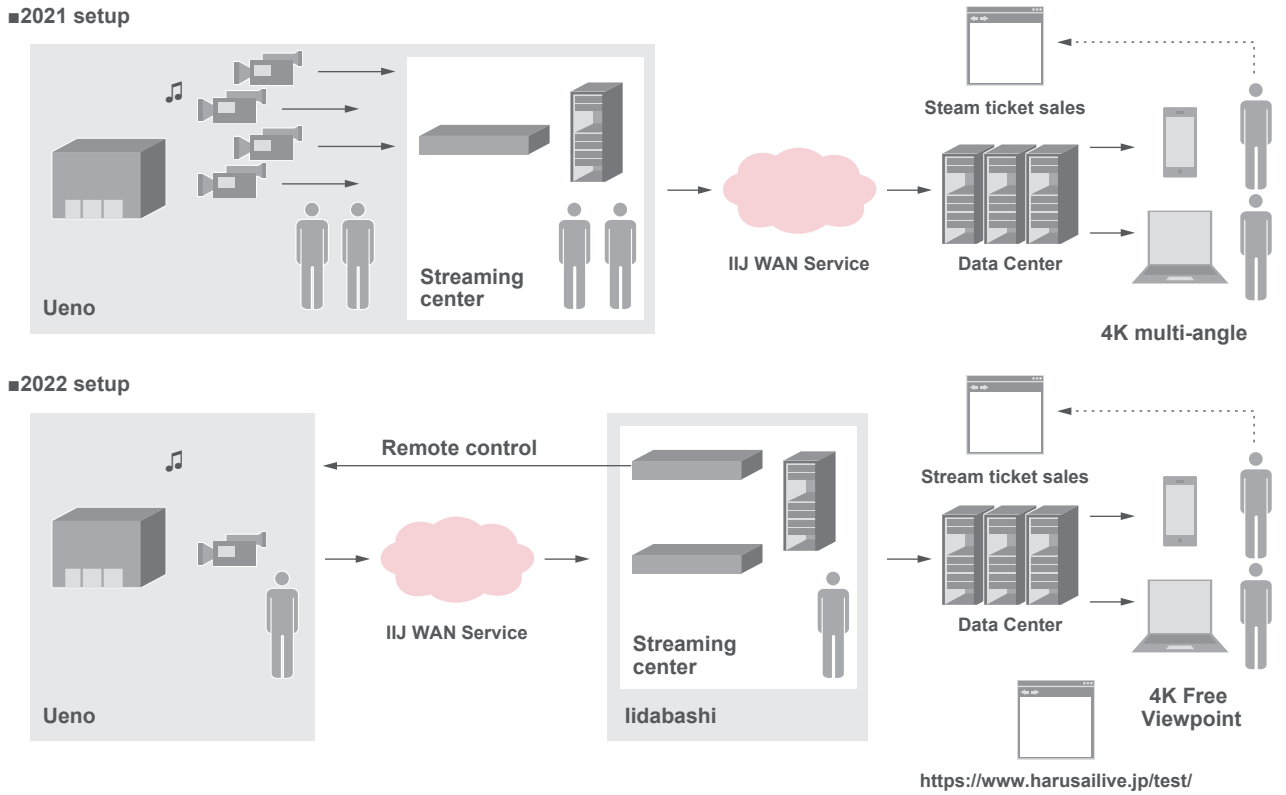

Figure 1: Live-Streaming System Configuration Comparison (2021 & 2022)

4K (with some 2K feeds), and sound would be recorded at AAC 256kbps. In 2021, streaming tickets cost ¥1,500–2,500 (tax inclusive, same below), while in 2022 we set a relatively affordable price of around ¥1,100 per performance (with some available for ¥730).

2.3 Live-Streaming System Configuration

We now describe how we set up the live-streaming system.

■ Cameras

We used Panasonic's AW-UE100K 4K integrated cameras. We selected this model because its size would be unobtrusive at the venues and because it supported remote PTZ (pan, tilt, and zoom). The AW-RP60G controller equipped with a PTZ joystick allowed us to move the camera through the horizontal and vertical planes as well as control zoom in/out, image brightness, and so forth easily from a remote location (IIJ headquarters). This let the on-site staff concentrate on the physical installation of the cameras, cables, and so on, thus reducing the on-site staffing requirement.

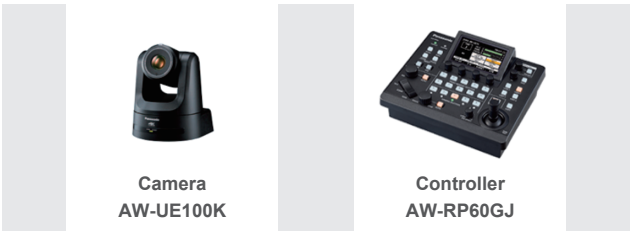

Figure 2: Camera and Controller

■ Transmitting video from Ueno to IIJ headquarters

For the main 4K transmission circuit, we used the IIJ Multi Product Controller Service (https://www.iij.ad.jp/en/biz/mpc/), which enables centralized management and integrated operation of networked devices, and built a Layer 3 VPN using IPv6 loopback on the FLET'S Hikari Next service. The high-performance IIJ router SEIL/X4, which we used as the VPN adapter, retrieves its own configuration data from its management server when powered on and wired up, so there is no need to have engineers on site to configure and check the device. And because the status of all devices is available at glance on the router's control panel, it is very useful in situations, such as the festival, when there are multiple devices to manage.

When we measured network bandwidth ahead of the performances, there were differences depending on the

Tripod and camera placed at back of venue

1. Set up tripod and camera at venue
2. Check camera level/tilt remotely and ask venue staff to adjust tripod
3. Use controller to remotely adjust view angle and brightness
4. Send L and R audio signals from venue and check remotely for left/right stereo alignment

Figure 3: Equipment Setup Procedure at Venue

Figure 4: Transmitting Video from Ueno to IIJ

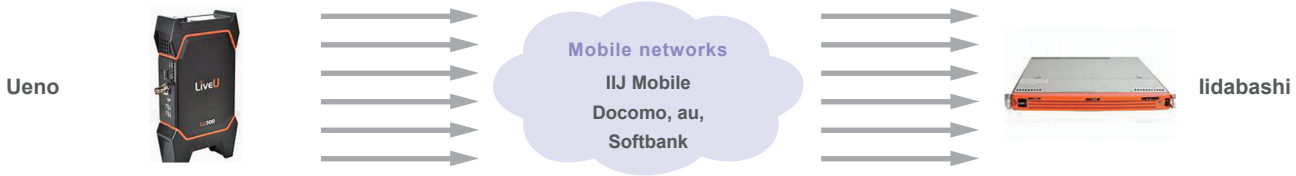

Figure 5: Illustration of LiveU Backup Connection

time of day, but we were getting around 200Mbps over the VPN tunnel, which is sufficient bandwidth for effectively transmitting video.

We used LiveU (https://www.liveu.tv/ja) video transmission devices as a backup and virtually bundled together multiple mobile carriers' connections, over which we transmitted video in HD. The LiveU system allows multiple SIMs to be installed to enable the transmission of more video data over multiple mobile connections, and is even used by broadcasters for live coverage. We used LTE contracts for the SIMs because 5G was not yet available at the venues.

Reception was poor at some venues, and some of them jammed mobile signals during the performances, so we needed to know the quirks of each individual venue to determine where to install the LiveU units. Some trial and error was involved in selecting installation spots, but we were generally able to transmit in HD without issue at bit rates of around 10–15Mbps.

■ Transmission protocols

Our video resolution and frame rate was 4K at 30p. Uncompressed, this would take as much as 6Gbps, so we compressed it to around 30Mbps using H.265 and transmitted it to IIJ headquarters using the SRT protocol.

SRT stands for Secure Reliable Transport and is a video transport protocol published by HaiVision in 2014 to facilitate the transmission of video via the Internet. A range of vendors have adopted it since it was open-sourced in 2017, and the SRT Alliance had over 500 members as of June 2022; IIJ is also a member (https://www.srttalliance.org/). SRT is based on UDP, and while maintaining low latency, it also provides more packet recovery features than TCP, and supports encryption using AES. As one of the leading protocols for transmitting video over broadband services and the like where bandwidth is not guaranteed, it can be expected to be adopted on an increasing number of devices going forward.

■ Transmitting and buffering

Our connection had an effective bandwidth of 200 Mbps, so we figured we would be able to transmit using SRT at around 30Mbps without any problems, but when we actually tried it out, the system was generating annoying little noises every few minutes. The error counter did not rise when this happened, so we were unable to identify the cause, but we were able to resolve it by setting a larger buffer size on the receiving device.

A larger buffer increases the broadcast delay, but this was not a problem because the content we were dealing with was concerts, so strictly real-time coverage was not really a major imperative. When live-streaming sports and other such events, however, low latency is a must, so the settings need to be adjusted according to the characteristics of the connection being used.

■ Subtitles

The operas were not performed in Japanese. Lohengrin is sung in German and Turandot in Italian, so in the case of large concert halls, Japanese translations appeared

Figure 6: Player with Subtitle Support

on displays on both sides of the stage. Although there were no such in-venue subtitles for songs performed at art galleries and museums, we had to include subtitles for users watching via stream. In 2021, we hardcoded the subtitles into the video, but in 2022, we provided subtitles using the setup shown in Figure 7. This meant that users were able to easily turn subtitles on and off during the performances.

To display the subtitles at the right time, the operator needs to keep the subtitling system in time with the song. But the engineers alone cannot handle the timing. To deal with this issue, music festival staff who properly understood the content helped our engineers to display the right subtitles at the right time. We built a system to insert the subtitles into the video data in the form of ID3 metadata in real time in accordance with the instructions issued, and we set our operations up so that we could control this subtitling system remotely in response to instructions from staff positioned at the side of the stage. These timing instructions are issued in real time, but the video is transmitted with a few seconds' delay, so our subtitling system includes an appropriate delay to ensure the text appears at the right time.

■ Streaming center at IIJ headquarters

We were in charge of coordinating the video feeds of the performances coming in from the venues in Ueno, inserting on-screen text before the performance, during intermission, and at the end, and transcoding the video into a format viewable by end users and streaming it out. As the photo shows, we had displays as well as switchers and other equipment lined up in our workspace to enable us to process up to four performances simultaneously. We used a network monitoring tool (Zabbix) to visualize network communications and bandwidth (video bitrate), letting us easily determine venue status and see the status of our communications systems at a glance, and this turned out to be an important means of telling what was happening from a remote location.

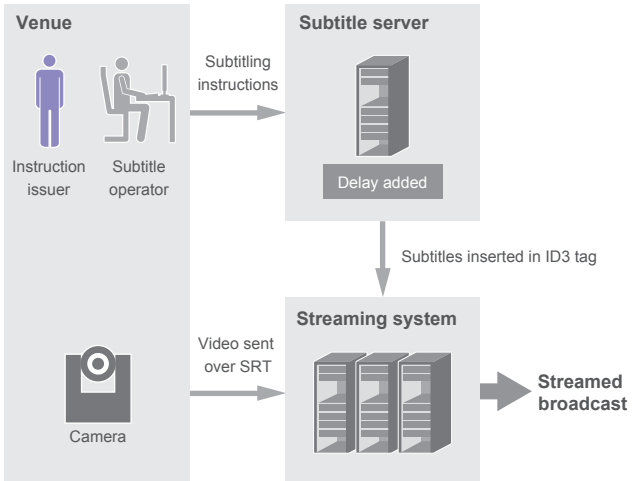

Figure 7: Subtitling System Diagram

Figure 8: Streaming Center at IIJ Headquarters

Communication tools

Communication among remotely located team members is key to making remote production work. It is common to use an intercom system at live events, but on this occasion, we used Slack (chat room tool) and set up a channel for each venue. Although this created the extra work of typing text messages, it also let us check on progress at other venues at a glance and made it easy to go back through the timeline and follow our workflow history, so it provided excellent visibility. It also proved to be very useful in enabling the festival organizers to share certain details with us, such as information on encores, which is often sorted out on the day of the performance. That said, we did note individual differences in terms of when team members posted and how granular the information they provided was. This was a reminder that with any tool, we need to make sure everyone is fully aware of why we are using the tool and what the communication rules are.

2.4 Conclusion

Preparations for the Spring Festival in Tokyo 2023 are already underway, and we have started selecting and testing new equipment to push remote production even further. In light of the results and lessons learned this year, we will be working to provide an even better streaming experience ahead.

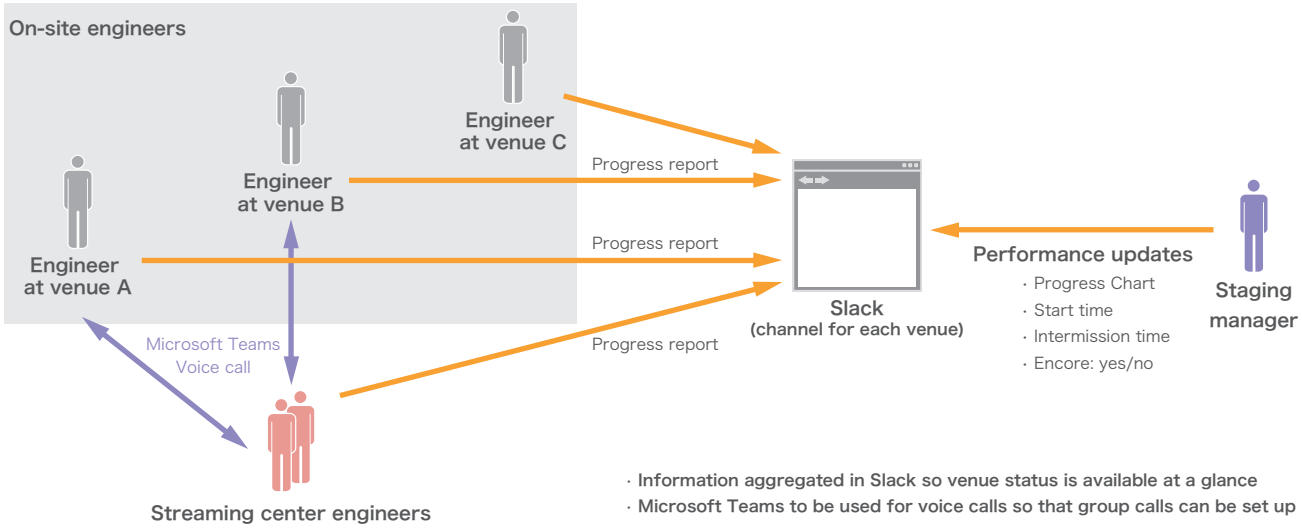

Figure 9: How We Communicated Depending on the Situation

Hiro Okada

xSP System Services, Network Division, IIJ

Intrigued by the Internet, Mr. Okada joined IIJ in April 2000. After working in sales, he went on to work in business customer connection services. Since 2015, he has worked in streaming/broadcast-related business. He is involved in starting up paid streaming platforms, studios, etc.

Fumitaka Watanabe

Streaming Businesses Section, xSP System Services, Network Division, IIJ

Having previously worked in the digitization and development of broadcasting services, from the launch of BS digital broadcast channels through to advanced BS broadcasting, Mr. Watanabe currently focuses on developing and proposing solutions for increasingly diverse video streaming/broadcasting services, including simulcasting and VOD/live-streaming.