

## The New IJ Studio TOKYO's Bridge to the Future

### 3.1 Introduction

While IJ is known as an ISP, we have actually been in the video delivery business since the 1990s. Over the past few years, we have been providing large-scale content distribution services like the IJ MediaSphere Service, and we have been expanding our services to meet the increasingly diverse needs of customers. Online video delivery has increased since 2020 brought major changes in the social landscape, and many companies now deliver video in line with that trend. IJ also streams its own financial results presentations and other events to an external audience, and we have received high praise for video and audio quality, which has an impact on corporate branding, and customers have told us they would like to achieve the same. When streaming earnings announcements, we make full use of the knowledge and experience of onsite staff to achieve a stable, high-quality stream. We have cameras and switchers (devices for switching video signals) installed temporarily in the conference room, and these are operated by members of our PR team and multiple other teams. But because the events were recorded in an ordinary conference room, we often had to deal with noise from outside, sudden accidents, and the like. IJ also streams Japan's largest classical music festival, the Spring Festival in Tokyo, every spring, and has offered a paid live stream of the event since 2021. In 2021, we set up a temporary streaming center at the Tokyo Bunka Kaikan, a concert hall in Ueno, which received video from multiple venues and streamed it out. Quite apart from the streaming, this setup involved a lot of effort in terms of transporting equipment to and building the streaming center. So in 2022, we built a streaming center in the IJ lidabashi office, from where we controlled remote IP cameras located in the Tokyo Bunka Kaikan hall. Under this remote production streaming setup, video from the venues was transmitted to the lidabashi sub-control room and streamed from there.

Even so, we had to go through the process of building a streaming center in both 2021 and 2022, and various tasks had to be dealt with, like finding a location and procuring equipment. In view of growing demand (from both inside and outside of IJ) for video delivery, and to enable us to meet the needs of as many customers as possible, we started to look at the prospect of building a permanent streaming center and a permanent studio capable of stably delivering high-quality video.

And so it was that in October 2022, IJ Studio TOKYO came to life in lidabashi. But just having a permanent studio does not guarantee high-quality video streaming. Building a stable video production and streaming environment and getting it up and running takes a lot of time and effort. It involves long-term aging and verification testing, and it takes teamwork and operators with skill and experience.

As few of our staff at IJ had any knowledge of video production, we had to start from scratch when it came to training operators, learning how to handle equipment and wind cables, and determining what level of video and audio quality was required.

In FY2022, we were focused on recording and delivering video internally, trying to learn about the equipment and devices and how to use them, building a system of operations, and so forth. But we would have been complacent to stop at this internal setup. We hope to turn this into a commercial service next fiscal year or beyond, and while we build our studio, we are also working to improve our studio operations by talking to people outside of the company and seeking feedback from within. To this end, we are engaged in dialogue with people both internal and external to IJ and increasingly collaborating with external partners.

We also wanted to take on the video industry challenges discussed in this article. Thinking about what sort of studio IJ should create and how it would be unique to IJ, we designed it to be capable of handling remote production based on IT and IP and to be capable of live video streaming using mobile communication lines.

Below, we discuss the benefits and challenges in using IP in modern video production and take a look at the IJ Studio TOKYO facilities.

### 3.2 Overview of IJ Studio TOKYO Facilities

Here, we discuss the IJ Studio TOKYO facilities.

As Figure 1 shows, IJ Studio TOKYO houses a studio (Photo 1) and six rooms. The rooms are interconnected via a 10Gbps or 1Gbps IP network. The advantage of using IP for the studio system is that you can connect to the studio sub-control room (Photo 2) via a single optical fiber cable. For example, you can easily turn a conference room on



Photo 1: Studio



Photo 2: Studio Sub-control Room

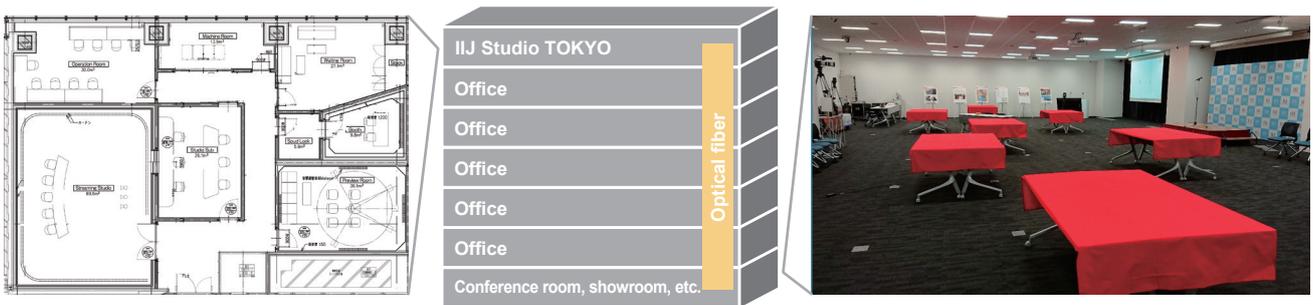


Figure 1: Studio Layout and Network Configuration

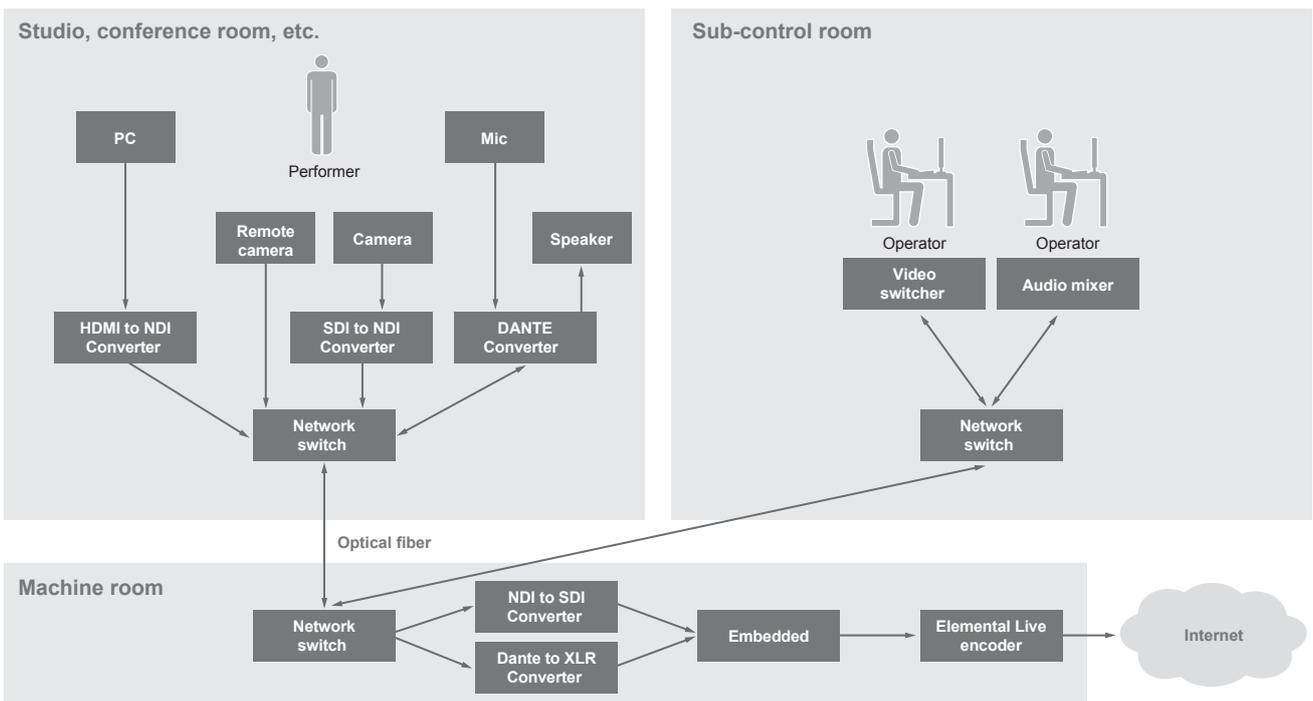


Figure 2: Example Configuration  
 \*Figure assumes only IP is used. SDI can also be used in combination with IP.

another floor into a temporary studio by installing a camera in there. You also have the flexibility to set up a shoot and venue according to your objectives, which includes factors such as the scale of the shoot and whether an audience will be present. Adding in the elements of remote production makes it possible to centrally manage multiple camera angles and color adjustments, which require a lot of time to set up, from within the studio sub-control room, and this helps to reduce the number of onsite cameramen and operators and lighten the workload.

#### ■ Studio

##### ■ Cameras

A total of six cameras are used for filming in the studio (two Sony professional camcorders and four Panasonic remote cameras), so the video produced can use multiple camera angles. The basic concept is to use the remote cameras as the main sources, which helps address camera operator shortages as well. The studio also has white walls and black curtains, as well as a green screen/mat setup to facilitate chroma-key compositing, making it possible to handle a variety of situations to suit users' needs. Lighting is of course indispensable in any shoot, and this is connected via Bluetooth, allowing luminance and color temperature to be controlled from an iPad.

##### ■ Microphones

For stability purposes and to prevent crosstalk, we use Type A radio microphones, which require a license. We use a combination of pin and handheld microphones depending on the objectives of the shoot. An omnidirectional condenser microphone is also installed on the ceiling to allow for any problems, so sound and voice can be recorded reliably when in the studio.

##### ■ Studio Sub-control Room

##### ■ Switchers

In the studio sub-control room, we use the NewTek TriCaster2 Elite as an IP switcher. It can take eight SDI inputs and 32 NDI inputs. So by cutting down on cabling, we have a greater degree of freedom when it comes to where

we set up devices that transmit video sources and how many of them we have.

By using virtual sets, one key feature of software switchers, we can also add a sense of movement to a scene using a single camera, opening up a broader scope of video production possibilities. We also have a Panasonic switcher to use as a sub-switcher, making it possible to perform multiple operations simultaneously, with the main switcher used for the studio shoot and the sub-switcher used for remote production.

##### ■ Digital Mixer

We use Dante for the studio's audio protocols. Using Dante devices makes it easy to change routing configurations via a PC app with Dante Controller or a digital audio mixer, so the required sound source can be routed to the required location quickly without having to fiddle with the physical cabling.

##### ■ Machine Room

We have cut down on unnecessary cabling by consolidating all video signals in the machine room. Video can be efficiently routed to the room or device where it is needed. To make it easy to record live from external venues, we also have receivers for LiveU compact video transmission units in place, which we envision using for events like the Spring Festival. We also have an Elemental Live (encoder for Internet streaming) installed, which can be used for streaming from the studio and video input from external venues. And the communications environment takes advantage of IJ's strengths, with a dedicated 10Gbps Internet line connected directly to the IJ backbone.

##### ■ Recording Booth

IJ Studio TOKYO has a dedicated audio recording booth, which makes it possible to add narration to video being recorded in the studio or pre-record the moderator's voice for a webinar, for example. In order to provide an optimal environment for audio recording, the floor and walls are designed to reduce echo and reverberation. We have also taken care with the shape of the room and the positioning

of sound-absorbing materials, and replaced the existing air conditioner with a dedicated duct, as a result of which you really notice the change in sound quality the moment you enter the room.

### ■ Preview Room

Productions can be previewed on a 100-inch screen with 7.1.4ch Dolby Atmos compatible sound equipment. The room can also be used as a performer greenroom or a location for shooting interviews and the like.

### ■ Greenroom

This is a place to relax before a performance, with a view overlooking the Kagurazaka district. The room also has a dressing table, changing curtains, a large storage space,

and a refrigerator. This room, too, can be used to shoot interviews, discussions, and the like. The space is suitable for shooting still photos as well as video.

### ■ Operations Room

The operations room provides a work place for studio operations, such as storing and testing studio equipment, and editing recorded media. For large-scale streaming events, such as the Spring Festival, multiple streams need to be transmitted and monitored simultaneously. We have two sets of equipment in the sub-control room and two in the operations room, allowing up to four simultaneous streams. Large monitors are therefore installed in this room to display streaming status.



Photo 3: Recording Booth



Photo 5: Greenroom



Photo 4: Preview Room



Photo 6: Operations Room

### 3.3 Why IP? Video Industry Challenges and the Benefits of IP

The mainstream approach in the video industry has long been to produce videos using baseband signals (composite signals, SDI signals, etc.), and this baseband switcher (electronic circuit design) has been used for live video production for over 50 years without change. Back when analog circuit switchers were in use, it would take several hours after the power was turned on for the signals to stabilize and the video levels to stop changing. Decades later, the advent of digital switchers made it possible to have things operating stably as soon as the equipment was powered on. Now with increasingly high video resolutions such as 8K entering the mix, we are starting to come up against the limits of bandwidth and cable length for the 12G coaxial cables (SDI cables) that connect to the switchers.

In the IP space, meanwhile, bandwidth has increased dramatically, going from 10G to 25G and then to 100G, so a gap has opened up in terms of the pace of evolution. Live video production is thus now, after several decades, entering an era of change.

With conventional SDI, you can only transmit in one direction, either in or out, whereas with IP video transmission, you can send and receive multiple videos over a single cable. Compression technology also makes video readily transmissible, providing design flexibility with limited resources. As scale increases, so too does the impact on system building in terms of factors such as routing switchers (a device that distributes video among devices) and number of cables.

Compressed video is already used in the area of video post-production. Since 2000 or so, post-production has been transitioning from linear editing (baseband editing) to PC-based non-linear editing (file-based editing), with tools such as Avid Media Composer and Apple Final Cut Pro, and non-linear editing is now well established in this space. Yet In the area of live video production, reliability has not really been established nor has expertise been built up, so the reality is that compressed video and IP video are not a major part of live video production. The following factors explain why IP and PC tools are not widely used in live video production.



Photo 7: Coaxial Cable



Photo 8: Optical Cable

- **Disadvantages and challenges in an IP studio, including NDI**
  - Lack of IT engineers
  - Unlike with SDI, simply connecting is not enough to enable signal transfers, systems need to be configured
  - Lack of experience when it comes to stability concerns, monitoring complexity, etc.
  - Lack of familiar methodologies or mature lineup of cabling, peripheral equipment, etc.
  - Lack of information

At IJ, our video experts and our IP experts are working together to address the above issues with the aim of providing a stable and user-friendly environment.

A number of protocols are typically used in live video production. In our studio, we adopted NDI (Network Device Interface), which combines the best parts of compression and IP technologies. In the next section, we explain the features and advantages of NDI.

### 3.4 Advantages of NDI (Network Device Interface)

NDI supports 8-bit up to 12-bit signals. Its support for an alpha channel (transparency in addition to RGB) makes it flexible enough for compositing work, and it works very well with non-linear editing machines, allowing smooth and easy handover to post-production workflows. With a view to deploying it in remote production and the like, we see NDI as offering strong future potential, versatility, and cost performance. NDI also works seamlessly with a variety of devices and OSs, and it can be used on Teams apps and smartphones, making it highly versatile. The protocol allows for unobstructed communications between devices in broadcast settings all the way down to ordinary user applications, and so we believed it would be the perfect protocol for experiencing the convenience that IP offers. This is why we adopted it as the main protocol for IJ Studio TOKYO.

	SDI	SMPTE 2022	SMPTE_2110	NDI
Compression	x	x	o	o NDI Codec(DCT)/NDIHX
Alpha channel	x	x	o	o
HD(1080/59.94i) Data Rate	>1.5 Gbit/s	>1.5 Gbit/s	>1.5 Gbit/s	>100 Mbit/s
UHD(2160/60p) Data Rate	>12 Gbit/s	>12 Gbit/s	>12 Gbit/s	>400 Mbit/s

Table 1: Comparison of SDI and IP Video

Even when people appear remotely via Zoom or a smartphone camera in TV productions, current practice is to convert the IP video to SDI, but it would likely be more efficient to produce programs using the unconverted IP. Producing video based mainly on IP is no easy task, however. Overhauling the baseband expertise, methodology, stability, and operations people have cultivated over many decades will require time, persistence, and the understanding of everyone involved.

In my previous job, I spent nearly a decade working to help people transition from linear editing to file-based editing and to make that change stick (demonstrations, system building, and aftermarket service), so I can see that the shift to IP in live video production is no easy task.

### 3.5 Video Production in the Future

Looking ahead, I think production environments will be built in the cloud, and that it will be possible to handle live video production without SDI and other specialized interfaces. But

instead of everything being done in the cloud, my sense is that parts of the process that it is more beneficial to handle in the cloud will be brought in and managed centrally, and that there will be increasingly smooth integration with post-production environments as well. The NDI protocol works well in low-CPU, 1G network cloud environments and makes it possible to pass video around for internal processing in a convenient manner at low cost.

At IIJ Studio TOKYO, we first set up an IP-based production environment that is close to what a local environment offers, and we have started working on IT-driven live video production efforts that match the working environment, which also gives us an opportunity to experience stability and latency issues that can also cause bottlenecks in a cloud environment. At IIJ's Shiroi Data Center Campus, too, we have opened a research facility (Shiroi Wireless Campus) that provides an opportunity to experience the image quality and amount of latency that occurs with 4K NDI transmitted over local 5G.

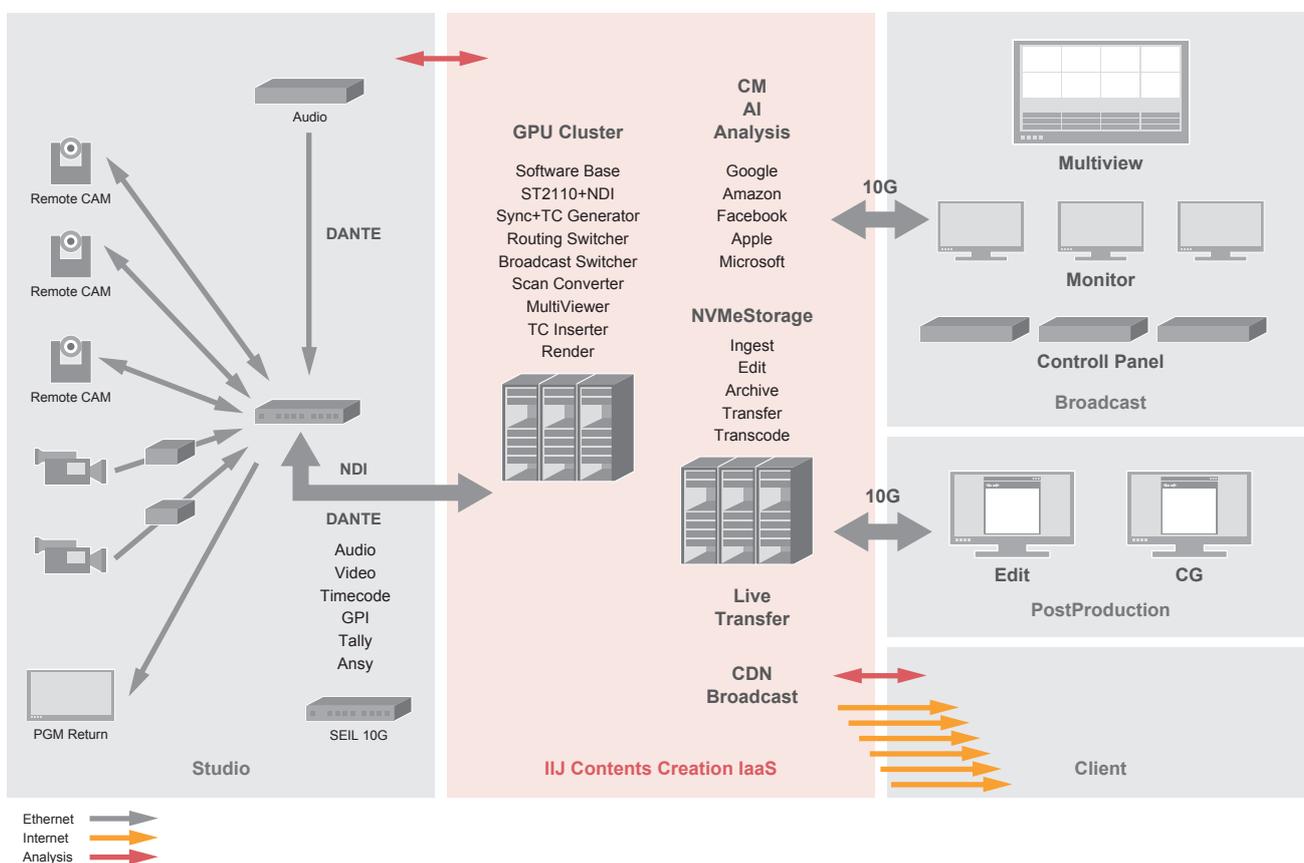


Figure 3: Conceptual Illustration of Future IT Broadcast Station

### 3.6 Past Accomplishments and Initiatives

#### ■ 2019 Accomplishments

We participated in multiple proof-of-concept projects in ST 2110 uncompressed remote production for broadcasters. Manufacturers brought their broadcasting equipment into the studio and we checked the video produced while working through the standards and monitoring communications status, and we were able to identify and share a lot of issues and information.



Photo 9: Shiroi Wireless Campus  
4K NDI Image Quality and Low Latency with Local 5G

#### ■ 2020 Accomplishments

We built a 4K NDI transport demo facility that uses local 5G at Shiroi Data Center Campus, and we made the facility available so that people can experience the features listed below for themselves. This is something we recommend experiencing for people dealing with environments in which remote cameras are frequently moved, such as stadiums and factories, and for people dealing with security issues.



Photo 10: Panasonic PTZ Remote Controller  
and Remote Camera

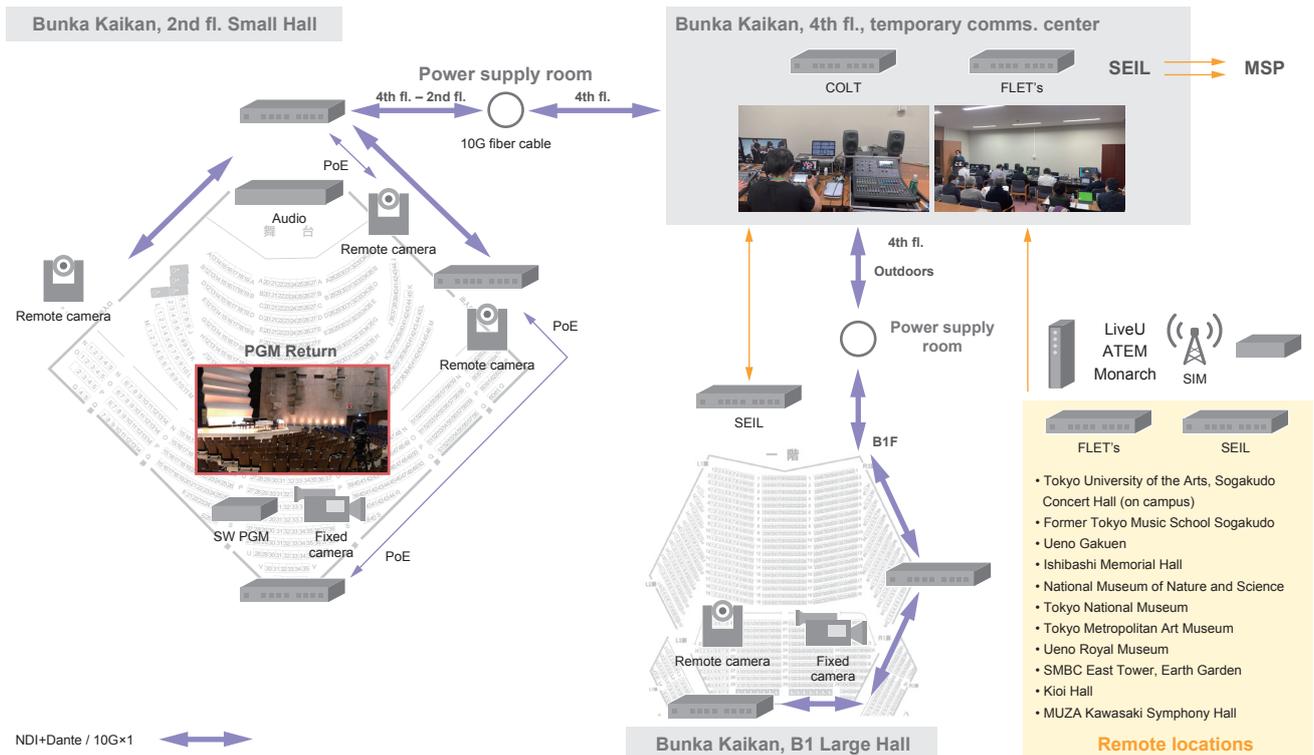


Figure 4: Configuration of Network at Bunka Kaikan

- Bi-directional network offering low latency and high image quality
- Stable communications quality due to use of licensed frequency bands
- Security and lower latency compared with Wi-Fi

### ■ 2021 Accomplishments

At the 2021 Spring Festival, we built a temporary sub-control room that used NDI inside the Bunka Kaikan, one of the performance venues, and set up remote production equipment to stream the performances. The venue and the sub-control room were connected solely via a LAN cable, and we set up our infrastructure so that the video, audio, and tally (“on-air”) signals from the three remote cameras in the venue could be transported via a single cable. To achieve the same cabling with ordinary baseband, you need to run a dedicated cable to each device, which makes the process more laborious and prone to connection errors, but IP makes it easy to reduce connection errors and lighten the workload. The network and camera equipment were also stable, and we determined the NDI image quality, response speed, and the like to be suitable for use in an actual

production environment, so this was IJ’s first real-world NDI deployment. But because we were not covering every single venue across the entire event period, we had to lay and remove our power supply and network cabling for each performance we covered. We also had to shut down the server equipment pretty much every day, and so our first time streaming the event impressed upon us the need for a permanent sub-control room to reduce the work involved and facilitate more stable operations.

### ■ 2022 Accomplishments

For the 2022 Spring Festival, we simultaneously streamed remote productions from four venues using SRT/H.265. This differs from NDI in that latency is high, so we set up two SRT connection modes in advance: a camera adjustment mode that provides good responsiveness but allows frame dropping and an event performance mode with a larger buffer size to facilitate stable transport. We switched modes right before the start of the performances. We set it up so that video from the venues was transported from the event in Ueno to the encoder in lidabashi with a delay of five seconds, and we were able to produce a stable video stream this way.



Photo 11: PTZ Remote Camera



Photo 12: SEIL Router Used to Build L3VPN (left) and PTZ Remote Camera (right)

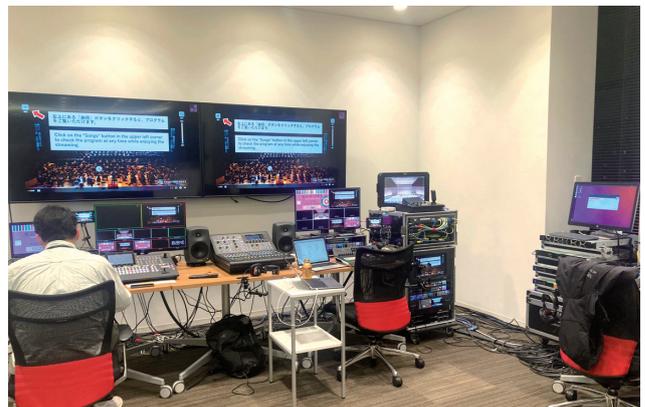


Photo 13: Temporary Sub-control Room

### 3.7 Difficulties and Solutions when Building IJ Studio TOKYO

Our various trials and tribulations have made us recognize the need for and utility in having a permanent studio, and we thus decided to build one. Right after we put the studio into operation, we experienced equipment behaviors such as the TriCaster crashing. We also needed to learn the quirks of each product and how to do everything, including running updates, changing settings, and changing connection methods, but it is all up and running and very stable now. We also made fine-grained adjustments to settings to make efficient use of the entire network's bandwidth—we set part of the NDI network to use multicasting, for instance. For maintainability and fault tolerance purposes, we keep a full backup of the PC-based TriCaster boot image, and we regularly perform backups in the event of major system updates or system changes to enable a swift recovery if anything goes awry. The internally created TriCaster session data is also synced with the file server and constantly backed up, and we have standardized and documented our system so that if the TriCaster were ever to fail to boot at some point, we can immediately restore our system by replacing the main TriCaster unit. Procedural manuals and troubleshooting information are particularly important, and we are constantly adding to our knowledge base in this regard using a range of internal tools.

### 3.8 Final Thoughts

Can we really achieve our dream for the studio? It's one thing to look at cutting-edge technology and muse about whether something is or isn't possible from a technical standpoint, but it's also crucial to get those technologies working properly in real-world operations. Our professional studio operators have dedicated themselves to their craft for 20 or 30 years, so they work with real speed. Unwieldy and unresponsive systems thus tend to be shot down pretty quickly, so it will be important for us to figure out what level of production our system is capable of handling and what sort of projects will play to the system's characteristics as we work out what direction to take going forward.

IJ Studio TOKYO—IJ's IP studio—has only just started up, and we are learning the basics of video production while taking cutting-edge technologies on board, working to enhance the potential and stability of IP in the video production space, and testing methods of managing and monitoring systems, and the like as we continue to innovate. We already have talented operators joining IJ and coming in on secondment from IJ Engineering, and we are gathering information from external sources and working with consultants, so a community of people aligned with the goals of the studio is starting to form and things are going in a very positive direction.

Looking ahead, IJ will continue to engage in projects that help create a world in which people and networks can connect across all sorts of industries, including the video industry.



**Atsushi Sumita**

Video Delivery Business Section, xSP System Services Department, Network Division, IJ  
Mr. Sumita previously worked as a sales engineer at a video trading company, which involved deploying and supporting non-linear editing systems for post-production and broadcasting stations. He joined IJ in July 2019. He participated in ST 2110 remote production proof-of-concept and other projects, and he is involved in the basic design and operation of video production systems used in Olympics-related streaming and, currently, the system used to stream the Spring Festival in Tokyo.



The "3.2 Overview of IJ Studio TOKYO Facilities" section was written by:

**Ryota Imanishi**

Video Delivery Business Section, xSP System Services Department, Network Division, IJ  
In 2015, Mr. Imanishi joined IJ Engineering and became part of IJ's video delivery business. His work includes the operation and maintenance of CDN services and the recording and streaming of events.