



Fundamentals of Streaming

How to Setup a Virtual Event System

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ABSTRACT

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The goal of this thesis was to present the fundamentals of streaming technology and how streaming technology can be used as a tool. Virtual event technologies in the event production were studied in this thesis. This thesis can be used as a guide on how to produce a virtual event system. The emphasis was on the technical production aspects.

The objective of this thesis was to examine the needed equipment and expertise when preparing for a virtual event broadcast. The phases of technical production and how a portable virtual event setup for small hybrid corporate events is planned were presented in this thesis.

As a result, this thesis can be used as a guide when planning and producing a virtual event. The example setup was efficient and fulfilled the needs of the event it was planned for. The setup can be used as it is to broadcast.

The fundamentals of the technology presented in this thesis can be used in various contexts, such as traditional live music festivals, gaming streams and corporate broadcasts. The wireless technology and local network system applications are being constantly developed and this creates interesting new opportunities to further use and harness the ever-developing streaming broadcasting technology.

Keywords: streaming, webcasting, live event, production, guide

CONTENTS

1	INTRODUCTION	6
2	WHAT IS AN ONLINE EVENT?.....	7
2.1	Traditional on-location and in-person events	7
2.2	Webcasting, streaming and other forms of online events.....	8
2.3	The live event industry and COVID-19.....	10
2.4	Virtual events are here to stay.....	11
2.5	General production of virtual and hybrid events	12
2.6	Technical plots	15
2.7	Technical script of the broadcast.....	17
2.8	Visual layout and sound design of the broadcast.....	19
3	EQUIPMENT	22
3.1	Cameras	22
3.2	Audio equipment.....	26
3.3	Computers and live production systems	30
3.4	Adapters and converters	34
3.5	Streaming software, platforms, and internet connection	39
3.6	Encoder, controllers, switchers, and other supporting tools	41
4	VIRTUAL EVENT TEAM.....	46
5	VIRTUAL EVENT EXAMPLE.....	55
5.1	Portable virtual event setup.....	55
5.2	Challenges of this setup.....	57
5.3	How to improve this setup?.....	58
6	SURVEY FINDINGS	60
7	CONCLUSIONS AND DISCUSSION	71
	REFERENCES	73
	APPENDICES.....	79
	Appendix 1. Thesis survey questions.....	79

ABBREVIATIONS AND TERMS

Dante	Dante is an audio over Ethernet and audio over IP technology that allows lossless audio signal transmitting from source to destination
DDR	Digital Disk Recorder. Media content player within the TriCaster live production system
DSK	Downstream key. Overlaid graphics such as titles
HDMI	High-Definition Multimedia Interface. Consumer-focused video signal transmitting protocol that can carry lossless data for 15 metres
Hybrid event	An event that has a remote event woven into a live event
Lavalier mic	A wired, or a wireless mic attached to the clothes or body of the performer
NDI	Abbreviation of Network Device Interface. It's a video connectivity protocol developed by NewTek
NDI HX Camera App	A program in the NDI application family. Makes a phone device a live video source
NDI Tools	A family of applications for IP-based device connecting
NewTek	A company that develops NDI technology and produces TriCaster live event computer systems
Online event	An event that takes place fully online
OTT	Over-the-top media service. Delivering on-demand content over the internet. Also called streaming but should not be confused with video streaming.
PPT computer	PowerPoint Computer. A media input computer that is used as a media input and showing the slides locally in the studio
SDI	Serial Digital Interface. A video signal transmitting protocol that locks in place and can carry lossless data up to 91 metres

TriCaster	A stand-alone computer system developed by NewTek, that can broadcast, stream and record simultaneously, which also supports multi camera inputs
vMix	A video streaming software mixer that runs on Windows 10. VMix can switch, record and stream media content
Webcasting	An online broadcast that is very similar to a TV production
Webinar	Lectures, conferences, or other seminar events where the slides are the focus. The presenter speaks over the slides

1 INTRODUCTION

Global pandemic created a huge demand for remote event solutions. Webcasting and streaming became undeniably essential due to the global pandemic. Physical events needed to be moved to be online and new events were to exist online only. Some of the events were produced by people that had no previous training or knowledge of virtual events (Chodor & Cyranski 2021, 121).

This thesis studies the basics of streaming and webcasting. The goal of the thesis is to provide basic understanding on how to stream and webcast and give an estimate on how much workforce and equipment is needed. Thesis concentrates on how to broadcast quality video and audio and presents a virtual event setup that can be used for portable multi camera broadcasting.

The fundamentals of streaming technology are presented and how this technology can be used as a tool. This thesis can be used as a guide on how to produce a virtual event. The emphasis is on the technical production aspects.

The objective of this thesis is to examine the needed equipment and expertise when preparing for a virtual event broadcast.

Research methods used in this thesis are empirical research methods and qualitative research methods. This thesis uses empirical research methods by analysing the live event setup that was planned and executed in a corporate webinar in Nokia Kehräsaari on 2.6.2021. Also, a survey for live event professionals was conducted to measure how live event technology was initialized during the global pandemic. The process of producing virtual events was first observed by working in the virtual event projects, keeping record on the acquired knowledge and skills, and finally reporting the findings as a form of this thesis.

2 WHAT IS AN ONLINE EVENT?

2.1 Traditional on-location and in-person events

Events bring people together. Traditional on-location events serve social, cultural, and work-related purposes. Authors of the book “Successful Event Management” Anton Shone, and Bryn Barry suggest that there are four categories of events that serve different purposes:

- Leisure events
- Personal events
- Cultural events
- Organisational events

(Shone & Barry 2010, 5).

Goals of the corporate events are to reinforce relations to the customers, do business and strengthen the company brand (Catani 2017, 19). People have the need to bond, and they want to meet each other in traditional on location meetings. Events can provide meaningful experiences and be socially, economically, or otherwise valuable for the visitors. (Catani 2017, 20-21.)

Events that share knowledge and success such as galas, professional keynotes and seminars are easier to convert into a virtual experience than the events that have the social interaction in their concepts. For example, a gala with keynote speakers does not necessarily need the interaction with the audience to work. (Chodor & Cyranski 2021, 75.)

Events that generate experiences and require social interaction are sometimes tricky to convert into a virtual event. Concerts, sports events, parties, and workshops have the social interaction built in the concept itself and just are not the same in the virtual world. Therefore, social interactions are converted too. Having engagement features such as moderated chat, networking lounges and private chats adds the needed social aspect to the virtual events. (Chodor & Cyranski 2021, 156-157.)

A physical event requires travelling and it can be costly for the companies, the environment and people travelling to the event (Optimizely 2022). Travelling to a physical event can have significantly greater carbon emissions compared to hybrid or fully virtual events. This is relevant especially if attendants and speakers travel from multiple countries to their destination. (Chodor & Cyranski 2021, 81-82.)

The nature of events has changed during the global pandemic. Possibilities of virtual and hybrid events are recognized by organisations (Chodor & Cyranski 2021, 34). People adapted to the new situation by going online. Remote events became the standard and the need for expertise on streaming became crucial. (Chodor & Cyranski 2021, 100.)

2.2 Webcasting, streaming and other forms of online events

An online event broadcast is a form of audio-visual product that is routed to media locations (Optimizely 2022). There are few genres of online events, such as webinars, webcasting, streaming and web conferencing (Chodor & Cyranski 2021, 53-62). A virtual event is a meeting or conference that takes place either partly or fully online. It might have been an event that was originally held as a physical event but then moved to the online environment. To attend an online event the attendant must have a device with internet connection. (Chodor & Cyranski 2021, 33.)

Streaming and webcasting can be done in many ways. To have a broadcast that gives off a professional feel, the broadcast needs to have professional staff that has an adequate amount of audio equipment, cameras, and other gear. (Optimizely 2022.) The needed gear and virtual event team requirements are explained later in chapters 3 and 4.



PICTURE 1. Virtual event requires adequate amount of equipment and staff (Luiza Preda 2020)

If a person wants to have a small and intimate event, for example for their social media followers, the simplest way is to use a mobile phone (Krings 2022). So, everything needed for a simple stream is to use a mobile phone and an app that provides this service, such as Instagram or YouTube (Duhamel 2022).

Usually, a well-made event needs more than just a camera and a mic. That is when technical aspects of virtual events production come into question.

Basic signal flow of broadcast is that the audio-visual signal is sent to the streaming software, then sent to the platform like YouTube and then received by the viewer. Embedding can be done in several ways depending on the broadcasting platform and the destination, but for example YouTube streams and videos can be embedded to websites using HTML-code. (YouTube Help 2022.)

The word streaming also has other meanings than online webcasting. Over-the-top media services, OTT, provide TV series, movies, and other forms of entertainment. Examples of these kinds of OTT service providers are YleArena, HBO Max and Netflix. The entertainment received from these platforms is called streaming. (Endavo media 2022.) Streaming can also mean the gaming streams

where the content creator plays a game. This thesis will not discuss the production process of game-play streaming culture or OTT streaming services in detail, since it is not in the scope of this thesis.

2.3 The live event industry and COVID-19

Without a doubt, COVID-19 has had tragic effects on the live event industry around the globe. According to Weckström's (2020) article, the live event, entertainment, and art industry in Finland has suffered starting from March 2020, when COVID-19 hit. Weckström presents Tilastokeskus's statistics "Palvelualojen liikevaihtokuvaaja 2020", which compares the revenues in the first months of 2019 and 2020. The dramatic drop in the revenue happened due to the corona restrictions, which made working in the art industry impossible. (Weckström 2020.)

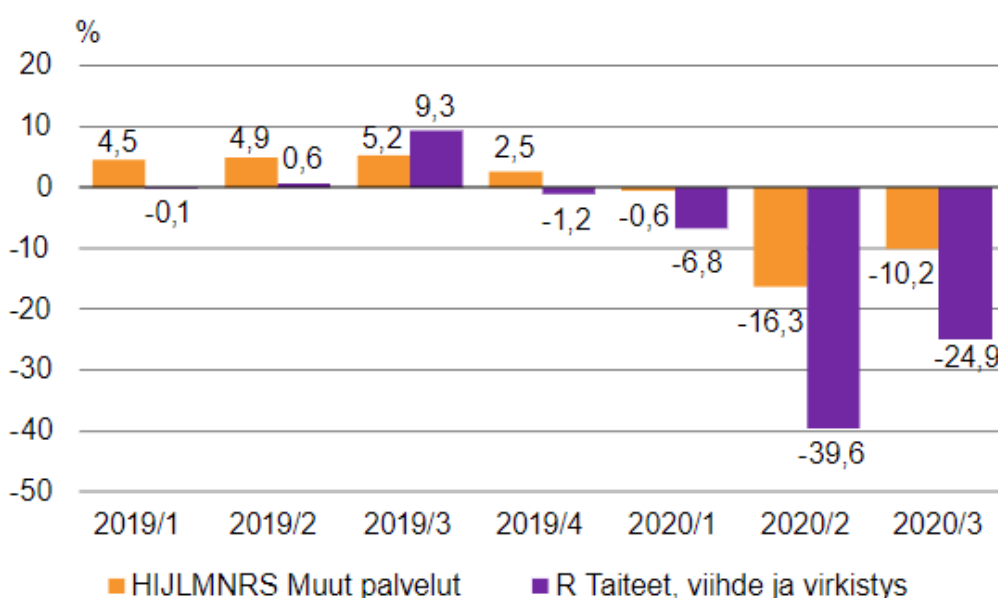


FIGURE 1. First months of 2019 and 2020 is being compared (Tilastokeskus 2020)

The event ticket market dramatically fell in 2020 and there was only a slight recovery for the year of 2021 (The live event industry and COVID-19 2021, 8). The immediate impact of the COVID-19 for the live event industry was that the artists needed to go online. The events took place online and digital media revenue benefited from lockdown. (Digital Media Report 2021, 8.) Virtual events became

the main substitute for the artists and live event industry in general. (The live event industry and COVID-19 2021, 15.)

The live streams and virtual events are expected to stay, even after the on-location and in-person events resume. In-person events are still valued higher than online events, but the hybrid events combine the best of both worlds. (The live event industry and COVID-19 2021, 25.) According to the survey conducted by Bandsintown (2020) states that 80% of the responders would be willing to pay for a live stream to support their favourite artist, 60% plan to continue watching live streams after in-person concerts return and 73% have watched a stream (Bandsintown 2020).

An estimation of the future is that the hybrid events could be a considerable employer for the live event professionals since it can offer the in-person experience for people attending the local venue while the live stream attracts a wider online audience (The live event industry and COVID-19 2021, 35). AR, VR, and other immersive reality events are also one potential segment of industry that combine game industry knowledge with live streaming expertise to create experiences for the customers (The live event industry and COVID-19 2021, 45).

2.4 Virtual events are here to stay

A survey conducted by Content Marketing institute in July 2021 suggests that virtual events, webinars, and online courses were proven to produce best content marketing results (12th annual B2B content marketing, 2022, 21). Virtual events generate sales and increase the audience. Sales and revenues had a 15% increase compared to what the sales and revenues were 12 months prior to July 2021. (12th annual B2B content marketing, 2022, 4.)

Tech companies started providing new business products and services, due to COVID-19. For example, 62% support remote working environments and 47% involve digital events. (TrustRadius 2020.) According to a survey conducted by LinkedIn that studied the impact of COVID-19 in marketing, webinars were the

focus of investments. Webinars had an increased investment of 67%. An online video had a 44% increase in investment as a marketing tool. (LinkedIn 2020.)

In a post-COVID-vaccine business environment, in-person events' budget is expected to grow 52%. Thirty-three percent of the marketers said they'd increase their budget on digital events and 39% said their budget will increase to produce hybrid events. (12th annual B2B content marketing, 2022, 40.)

These increases suggest that virtual events and audio-visual content are here to stay. Audio-visual content, webinars and other forms of virtual events gained their place during the pandemic and those tools are highly likely to be used in the future too. This creates a demand for professional virtual event producers.

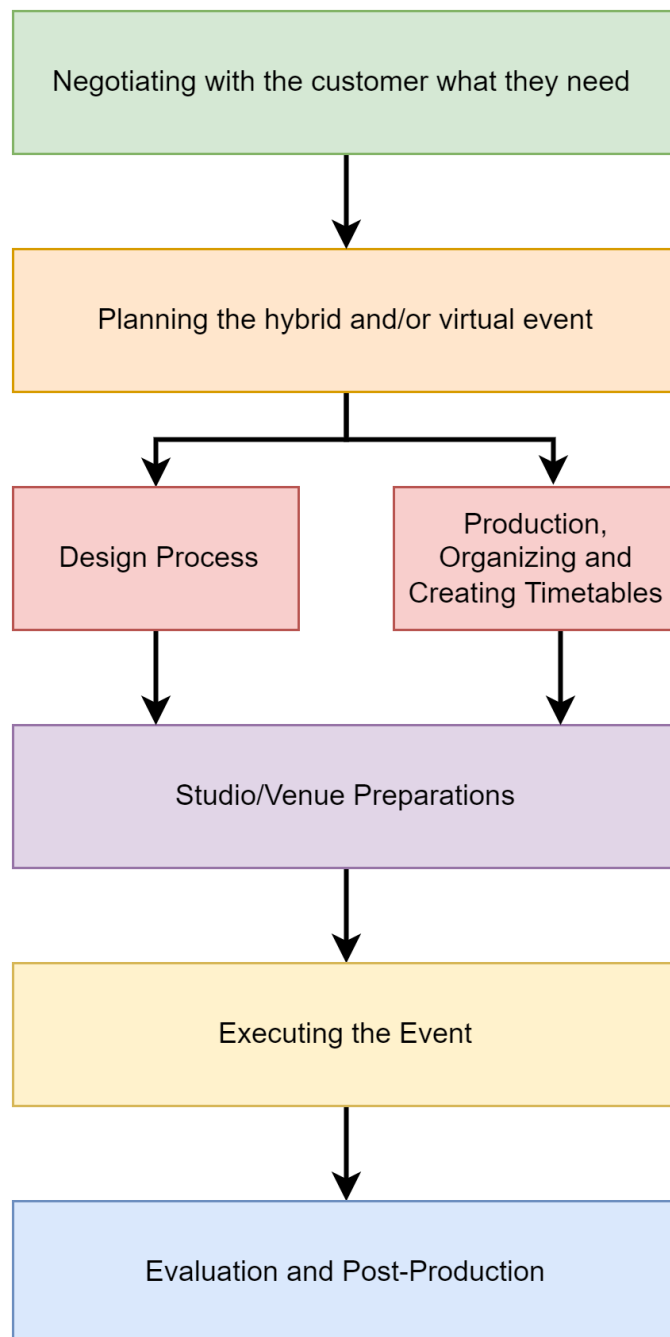
2.5 General production of virtual and hybrid events

When the decision on arranging an event is made, general production and the technical planning can begin. Event marketing experts Helena Vallo and Eija Häyrinen (2014) even suggest that the technical aspects of a professional event should be planned well ahead since the pool of professional audio- video and light technicians in Finland is limited and thus reserving the right people for the event must be done in advance. (Vallo & Häyrinen 2014, 177.)

The form of the event is based on the goals and needs of the customer. The customer might want to have an online seminar where speakers and attendants take part for example from the comfort of their homes, and the starting and ending broadcast takes place in a studio with main keynote speakers. (Chodor & Cyranski 2021, 33.)

According to Catani, the goal of a corporate event is to deepen relations with customers, do business and reinforce the company's brand (Catani, 2017). The goals and needs of the customer determine the size of the event. If the goal is to have a small online seminar inside their company, sometimes one mic, two cameras and some background music routed to a Zoom call is just enough. If the goal

is to get in touch with business partners and get some business done, then having a multi camera production comes into question.



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FIGURE 2. Virtual event production process

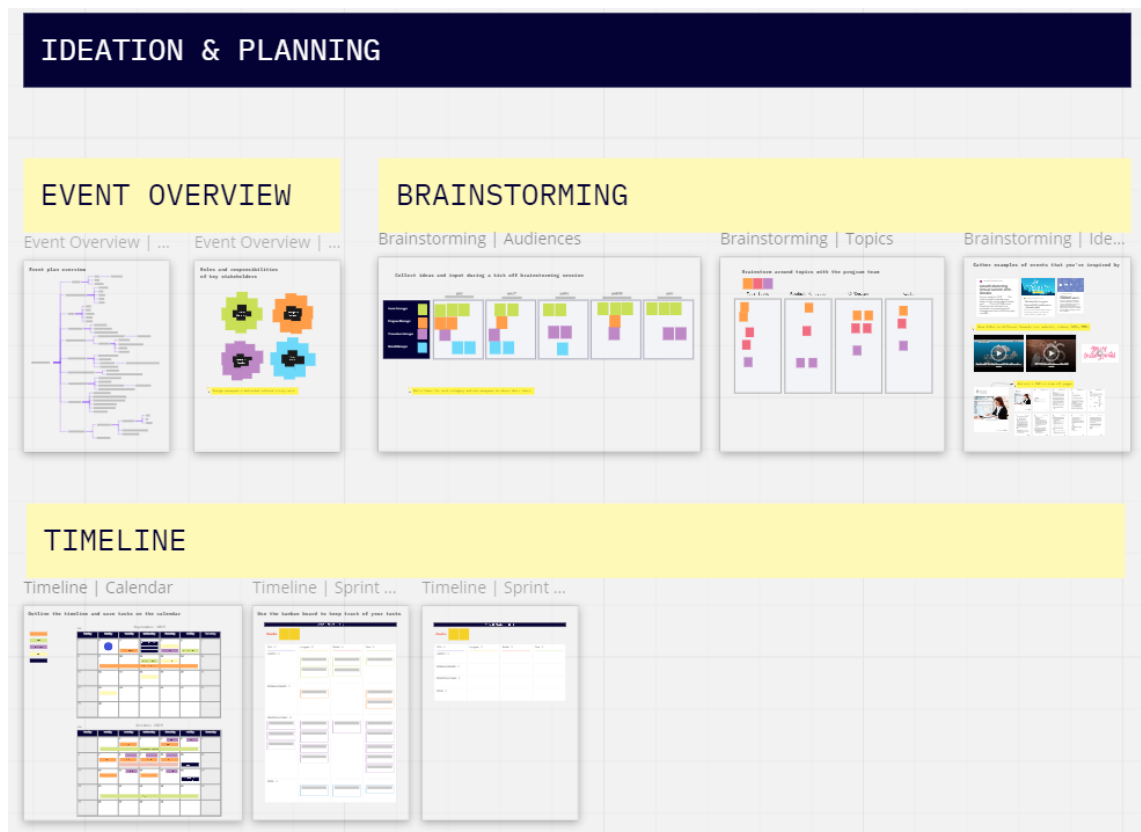
Some questions to clarify what the event's technical producer needs to know:

- What is the purpose of the event?
- Is it fully online or a hybrid event?

- What is the platform?
- Is there a company home page or some other landing page online guiding them forward to their destination?
- How are the links distributed to the participants?
- Is it going to be a live event or recorded to be broadcasted later?
- If recorded, is the recording going to be on-demand after the event? For how long after the event?
- Is there a need for a keynote broadcast?
- Is there an audience? If yes, is the audience going to be online or present in a studio? Both maybe?
- How many speakers are there in total?
- How many speakers are going to speak at the same time?
- What are the names and titles of the speakers in the broadcast?
- Are there presentation slides? If yes, do the speakers need to see their slides during their presentation?
- Is there a need for background music?
- Is there a need for live music?
- What is the graphical outlook and layout? Is there a strict brand and its rules that the technical team and designers need to follow?
- Is there a need for post-production like video editing, sound design, title animations etc.
- Is there a need for writing subtitles or other accessibility related post-production work?

(Chodor & Cyranski 2021, 59-70.)

Technical planning relies on information about the event. Mind maps and planner apps can be used to determine the needs for the event. When the format of the event is clear, the technical plot and the script can be made. (Kim n.d.) Figure 2 above and Picture 2 below present the general virtual event production phases. These can be used as a reference when technical plots and script is written.



PICTURE 2. An example views of a virtual event ideation mind map planning tool Miro (Kim n.d.)

The general producer oversees the virtual event's main planning, but the knowledge of the event is also used in technical planning. When the groundwork is done using the questions listed above, the technical plots are drawn and pushed to the online management tool of the team's choice, such as Miro. This way the whole team is updated on what other team members are doing and the collective knowledge is accessible for everyone (Innovation training 2021).

2.6 Technical plots

A technical plot is a diagram that represents the system plan. It is constructed using colours, symbols, text and connecting arrows. In short, the technical plot is a detailed flowchart of the devices and how they are connected. One of the tasks for the technical producer in the planning phase is drawing the technical plot. A good plot also has a legend that explains what the designer means with the colours and symbols. (CS Odessa n.d.) Contact information should also be written clearly in case someone has questions about the plan.

Figure 3 presents a simplified technical plot and the main sections of signals in broadcasts. The broadcast has video and audio signals. Video signals originate from cameras and other video input sources. Audio signals originate from the microphones and other audio input devices, such as phones and computers. Audio and video signals are combined and synchronised at the end of the signal chain and then sent out to the viewers to watch. Figure 3 is a simplified technical plot for a small hybrid corporate webinar event.

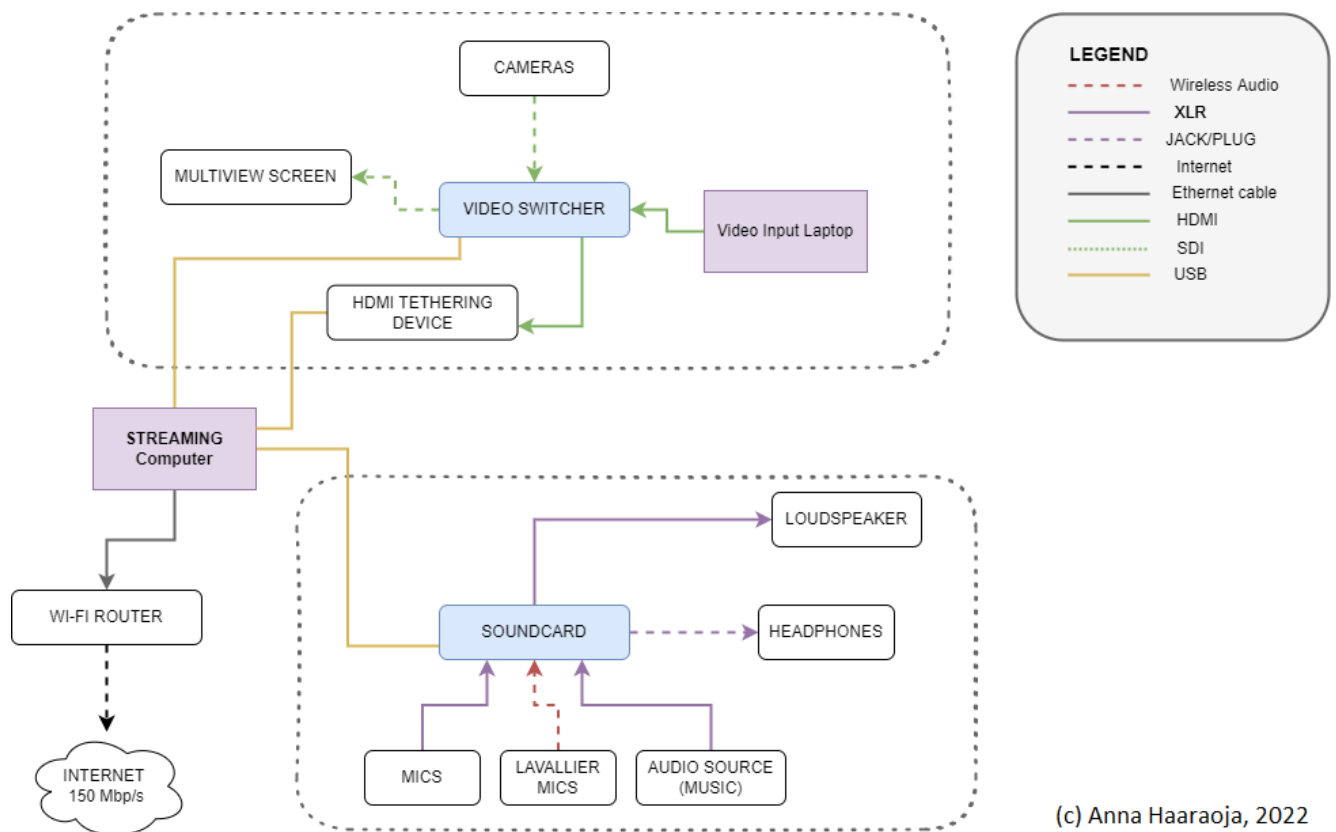


FIGURE 3. A simplified technical plot for a corporate online or hybrid event

The technical needs, format and goals are specified after the discussions with the customer (Chodor & Cyranski 2021, 33). Technical producer of the event is responsible for technical management and in streaming context also drawing a plot of the needed gear and equipment. Sometimes the technical producer also hires the staff for the event, but this varies depending on the scale of the event and other circumstances. (The Radio Academy 2020.) The plot also has the list of the gear as text as its appendix so that the needed gear can be reserved from the company storage or rented from a third-party gear renting company.

The plot can be made in whatever software that the maker of the plot knows how to use. Online diagram creating apps, flowchart creating tools, photo editing software or any other kind of tool that supports importing and exporting images, dragging them around and adding text will do. Examples of the tools that can be used are photo editing software like Photoshop, online flowchart creating app Draw.io or online canvas creator Canva. If it works for you, the tool is great for the purpose.

Drawing the plots can be tricky at first since it requires experience and knowledge about several aspects of streaming technology. Some things that need to be thought through already when drawing the plot are the understanding of the signal flow, what device is controlled with a physical controller and what device is controlled in a web browser, knowledge about the devices currently on the market, technology that might be slightly out of date but still being used, and finally trying to adapt to the ever changing reality of new technologies and devices being released. There is some rule of thumb though that technical producer can use when planning their system.

When the technical producer knows what devices will be used for the event, the images of the devices can be searched from the internet and dragged for example to the draw.io diagram creating tool. Writing down the exact name of the device is recommended so that the people in the team can also search information about the devices themselves if they have some questions. Inputs, outputs, and connections of the devices are demonstrated with arrows of distinct colours. Devices under the same purpose are grouped close to each other for clarity. Even better if the devices are marked with colour codes. The colour code can then be implemented to the actual set by using corresponding coloured electrical tape. The detailed AV plot of a working and tested setup can be found in figure 12 in chapter 5.

2.7 Technical script of the broadcast

Technical script of the broadcast is a document that organizes data the customer has provided of their event. In the screenplay world this document is called a

shooting script. A technical script is an adaptation of a shooting script. It has all the speeches, performances, media, and transitions in every detail in chronological order. (Hellerman 2019.) The team does not usually know the people in front of the camera, so they need commands instead, such as the director telling them to “switch to camera one” or “play a media file”. The technical script can be written in Excel or any other software that allows writing spreadsheets.

Time	Number	Content	Camera	Sound	Notes
8.50	1	DDR1: Countdown Starts			
9.00	2	DDR1: Logo with Music		Theme Music starts	
	3	STUDIO: Zooms in to hosts	CAM. 3 Zooms in	Theme Music Fades	
	4	STUDIO: Hosts introduce show	CAM. 3	HOSTS - Applaud sound effect	
	5	STUDIO: Hosts introduce the teams	CAM. 3	HOSTS	
	6	STUDIO: team shown	CAM. 1	HOSTS	
	7	STUDIO: Hosts continue introductions	CAM. 2	HOSTS	
	8	STUDIO: team shown	CAM. 4	HOSTS	
	9	STUDIO: Hosts introduce selves	CAM. 2	HOSTS	

FIGURE 4. An example of a technical script (Isabella Presnal 2021)

This script has time-relevant information displayed with light yellow background color. The parts where the content might need reactivity are displayed with blue background color. The script contains the information for the team to draw their own conclusions of what they need to do to make what is written in the script happen.

For example, the video switcher will follow the media content and camera commands list. If the team has a director, the switcher will follow their orders. If the switcher works alone, they will follow the script and the show and switch between the cameras and media content themselves.

Sound technicians usually have the Multiview screen in their control room and follow the show and the script simultaneously. They will write where their sound sources are and enable the audio signal to pass through their mixer into the stream broadcast. For example, in this case the audio source is in the Digital Disk Recorder or the DDR, which is in the media player within the TriCaster live production system. The audio mixer has the stereo channels set for the TriCaster audio and the sound technician unmutes these channels when the script tells them to do so. When the show proceeds to the studio cameras, the sound technician unmutes and monitors the host's mics.

Camera operator follows the instructions of the floor manager or the studio manager. Their job is to prepare the best sets of imagery and keep the relevant things in their cameras. Usually, they will follow the same side of the stage so that the video switcher can rely on always having at least something presentable. In the pre-planned events this kind of prediction is easy, but in the live event setup, everything is harder. This is tricky especially in the live music festivals where the set design, the sun, smoke effects, pyros and fast movement of the band can create situations where no one from the camera crew knows what is happening in the first place.

2.8 Visual layout and sound design of the broadcast

Sound design and visual layout sets the atmosphere for the stream broadcast. Event broadcasts do not necessarily need any design, but most of the cases require some. Minimally the design means one title slide with the event's name on it and background music. (Merhar 2022.) I have noticed though in my work as a stream technician is that the event should at least have three slides:

- Stream starts [timer]
- Technical difficulties
- Thank you for watching

With those three slides, technicians are prepared for starting, pausing, and ending the stream in a professional manner.

Graphics can be used as an overlay suiting customers' wishes or their company brand. Graphics overlay can contain information of the sponsors, the company or business partners. The names of the speakers with their titles are also brought to the broadcast as an overlay. (Merhar 2022.) The title graphics are pre-programmed to be called by the video switcher or graphics operator during the event.



PICTURE 3. A screenshot of a welcome graphics animation

Graphics can also be animated, and it adds professional value and interestingness to the broadcast. If the broadcast is going to last long or it is going to have a lot of heavy information, it is important to add breaks for the viewers, participants, and the technical team. This is more familiar from the TV world, where commercial breaks cut the main broadcast in smaller segments. In the event broadcast breaks, there is a possibility for the companies to display their projects with short videos or share information about their plans for business. (Macy 2022.) Sometimes only the schedule of the event and information of what is next is enough for this kind of break. Some background music with simple animations along with a timer overlay are also great.

Sound designers and the sound technicians work for the pristine sound signal. Human brain is wired in such a way that it usually tolerates mushy video quality but cannot tolerate it if the audio is not right. This is because the brain has a tough time deciding which sound is important and what is not. Being exposed to bad

audio quality can lead to brain fatigue eventually. The first sign is annoyance, which in the live event context, leads to the visitor leaving the broadcast. (Kock 2021.) That is why it is important to keep audio well maintained through the whole signal chain all the way from the mics to the broadcast output.

Micing technicians make sure that the speaker has the right mic for them. They also take care of the visual aesthetics by choosing and positioning mics in a way that they are not disruptively blocking anything that the video crew wants to have on camera. Micing technicians work is to put wireless lavalier mics for the speakers and hide them in their own clothing. (Audio-technica n.d.)

3 EQUIPMENT

3.1 Cameras

There is a high variety of cameras that can be used for a broadcast. Even mobile phones can be used for wireless camera input using for example NDI HX Camera Application. It is an app for Android and iOS that uses NDI technology to convert the device's camera to an input that can be routed to a live event production system, like vMix or TriCaster. NDI HX Camera App has several ways to control the input including, but not limited to, muting, and unmuting the input audio, focus controls, leveling the zoom and adjusting the exposure. (NDI n.d.)



PICTURE 4. NDI HX Camera Application's User Interface (NDI.tv n.d.)

As explained above, a smartphone can be used as an NDI camera input in a broadcast setup. (NDI n.d.) This requires building a Wi-Fi network. A sim card with internet access is installed to the Wi-Fi router and the router works as a network switch from there on. The NDI HX Camera app is installed to the smartphone and the smartphone is connected to the Wi-Fi network. This way the live production system can see the smartphone device in the NDI network system and use it as a camera input. (Richards 2020.)

We have been talking about NDI and its possibilities in live event production, but what exactly is NDI? Network Device Interface or NDI is a video connectivity protocol developed by NewTek. NDI can transmit video, audio, and metadata in real-time. The technology is free to use, and anyone can download their NDI Tools applications on their website. It also allows controlling the devices as demonstrated in the Picture 4 above. (Namatinia 2021; Richards 2020.)

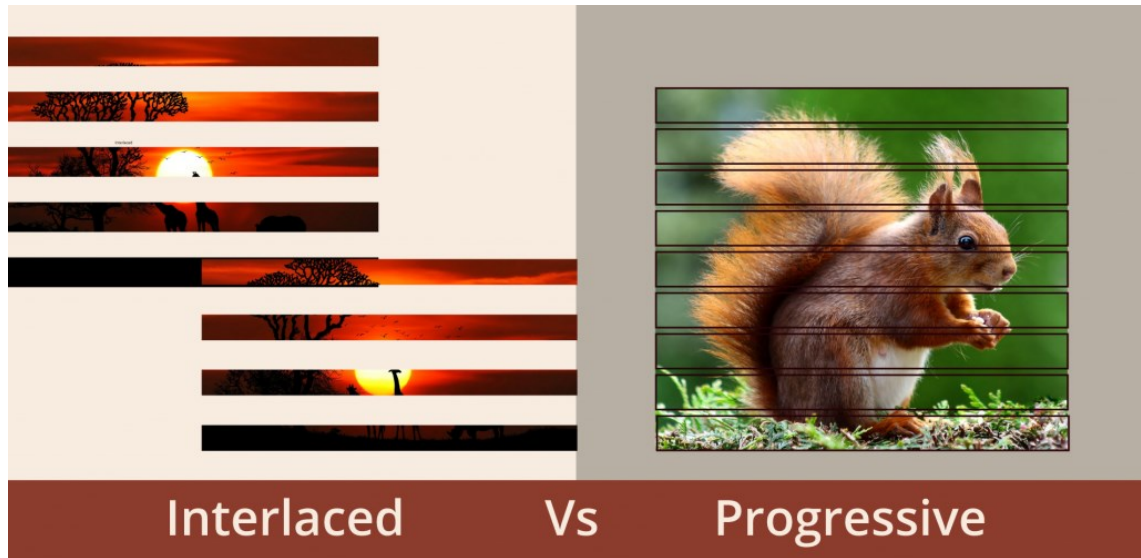
Most commonly cameras are connected to the system with SDI or HDMI cables. HDMI, or High-Definition Multimedia Interface, is a consumer-focused video signal transmitting protocol that can carry lossless data. When the length of the HDMI cable exceeds 15 metres, the quality of the signal starts to decrease when using standard cables. If High speed cables are used, the maximum length of a cable is only 8 meters. If the cable needs to be longer than that, HDMI cable requires a repeater. A HDMI repeater is a device with a power supply that strengthens the signal. (Afterdawn n.d.)

SDI or Serial Digital Interface is a video signal transmitting protocol. The SDI cable locks in place and can carry lossless data up to 91 metres. SDI cables are used in environments where distances between devices are greater than 15 metres and connectors need to stay attached. SDI cable's locking mechanisms ensure that the cable will stay in place, even if someone pulled on the cable unintentionally. Nevertheless, in professional events, the cables would be taped down to avoid these kinds of accidents in general. (BoxCast 2022.)

Choosing whether to use SDI or HDMI depends on what outputs your cameras have and what inputs your switcher control surface has. For example, if your video switcher has SDI inputs, you will need to either have cameras that have SDI outputs or have HDMI to SDI converters.

A practical thing to remember when dealing with cameras and live broadcasting systems from different eras of technology is to check what scanning method your live production system and cameras are using. Interlaced technology draws the image as separate fields, but it has a low requirement for bandwidth. Progressive

scanning method draws the whole image at once, but it requires more bandwidth. (Sony 2019.)



PICTURE 5. Interlaced and Progressive scanning methods (Synchronous 2021)

If your system supports an interlaced method, you will need to check your camera's settings that it's sending interlaced signals to your system. If your system supports progressive scanning method, you will need to choose the progressive system method. The settings with the resolution of 1280x720, aspect ratio of 16:9 and framerate of 25 might look something like this with the interlaced scanning method: 720-50i fr25, and like this using the progressive scanning method: 720-50p fr25.

Figure 5 explains the signal flow of the camera signals. After the configuration of the camera settings the signal travels from the camera through converters, the switch, ethernet ports in the wall, server rack, the control room ethernet ports on the wall and finally arrives at the live production system like vMix or TriCaster. In this case the camera has SDI output, which first needs to be converted to a HDMI signal and after that to a signal suitable for network transferring. This system is NDI based, which means that a computer that has NDI Tools installed and is used by a person knowing the IP-configurations and passwords, can find and control the signal.

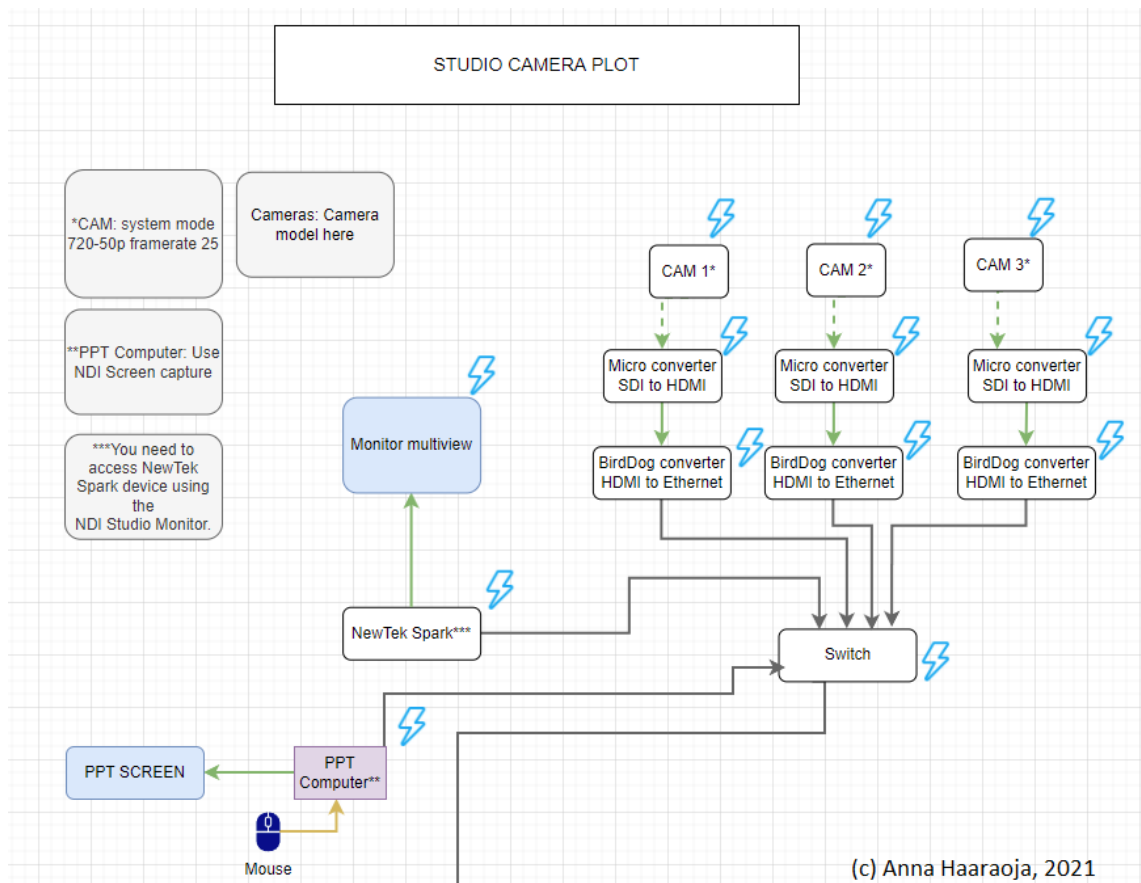


FIGURE 5. Studio camera plot

Cameras can be hand operated TV cameras, NDI equipped mobile devices or remote-controlled robot cameras. Robot camera controlling can be done on a computer that has access to the camera via the network. NDI technology supports this method, and it has its own control surface software, NDI Studio Monitor, for robot camera controls. Robot cameras can also be controlled using a physical control surface. The benefits of using robot cameras are that they are remotely controllable and the camera angles, zoom settings and focus can be saved as presets. The person in control can then quickly switch between scenes. (Caniglia, Walker, Beesley, Gardner, Eddershaw & Cuomo 2021.)

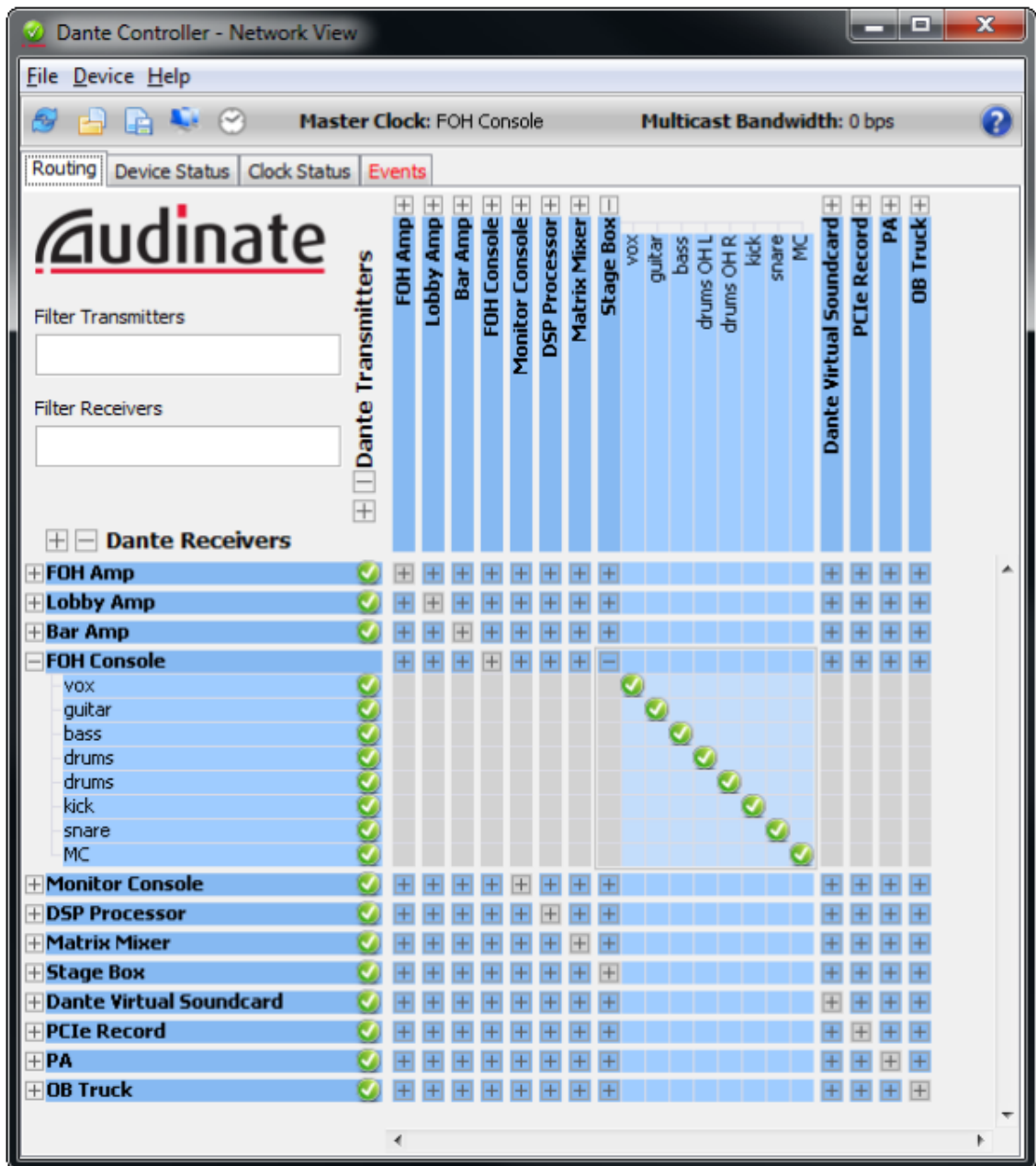
The other equipment used in the studio are the PowerPoint Computer or the PPT computer. It serves two purposes. Firstly, it is a media input computer that the live production system can see as an input in the Multiview. Secondly it is a guide for the person presenting their slides. The slides are shown in the studio using the PPT screen. A PPT Computer is not necessarily a camera, but it is a media input that is handled like the camera inputs.

3.2 Audio equipment

Sound cards, mixers and audio racks are devices dedicated to process sound. Other devices used in the virtual event production such as video mixers, live production systems and computers are also equipped with internal audio processing capabilities. Very often the audio processing capabilities in laptops' internal audio processing systems alone are not sufficient to fulfil the needs of an event that is going to be needing mics, many audio sources, and controllers. Events usually have speakers, audio-visual media and remote guests which requires adequate audio equipment. Mixers are the beating heart of any virtual event. (Yamaha n.d., Overview of the gear used in broadcasts.)

Dante is an audio over Ethernet and audio over IP technology that allows lossless audio signal transmitting from source to destination. (Audinate n.d. What is Dante.) According to Audinate's other article "Audinate's Dante Now Supported in More Than 3,000 Devices" (2021), Dante is the industry-leading protocol for audio-over-IP digital audio networking (Audinate 2021).

The audio technicians need to be able to control all audio signal traffic and manage complex systems with ease. The audio is controlled and routed using dedicated hardware mixers, sound cards of various kinds, and software IP-based protocols such as Dante. Picture 6 demonstrates the Dante's User Interface or UI and how a Dante Receiver, in this case FOH Console on the horizontal axis is receiving signal from the Dante Transmitter, in this case a stage box. FOH is an abbreviation of Front Of House.



PICTURE 6. Receivers and Transmitters in Dante Controller (Biamp Systems 2021)

When a Dante Virtual Sound Card is installed and running and streaming equipment is connected to each other with CAT-cables and switches, these connected devices can be patched and controlled using the Dante controller. In simple terms, the Dante Virtual Sound Card is a software saying, “I’m here” and the Dante Controller says, “I see you.” This way the audio engineer can patch multiple sources to multiple destinations. Dante’s network capacity is 700 channels with 48 kHz/24-bit sampling and 1Gbps network. Maximum available sample rate is 192 kHz (Journal of the AES 2009, 735).

Signal chain starts from the audio sources. A signal travels from the microphone to a stage rack, from there it travels to the network. In the digital audio transmitting the signal does not yet know where to go, so it needs to be patched. In other words when the signal is in the network, the audio engineer can then patch the signal using Dante Controller to the desired destination. In this case the engineer might want to patch the mic signals to corresponding audio channels in their mixer so that the microphone's audio levels can be controlled.

Figure 6 represents how the signal travels from the mics, lavalier mics and talk-back mics to the Dante-equipped Yamaha Tio1608-D stage rack. A stage rack is a device that has multiple audio inputs and outputs. It allows patching and transmitting audio digitally. (Yamaha n.d., Professional Audio.) The stage rack device is Dante equipped, which means the audio engineer can see this device's inputs and outputs in their Dante Controller. The virtual patching is then made and the signal travels from the stage rack to the ethernet ports and further to the server rack.

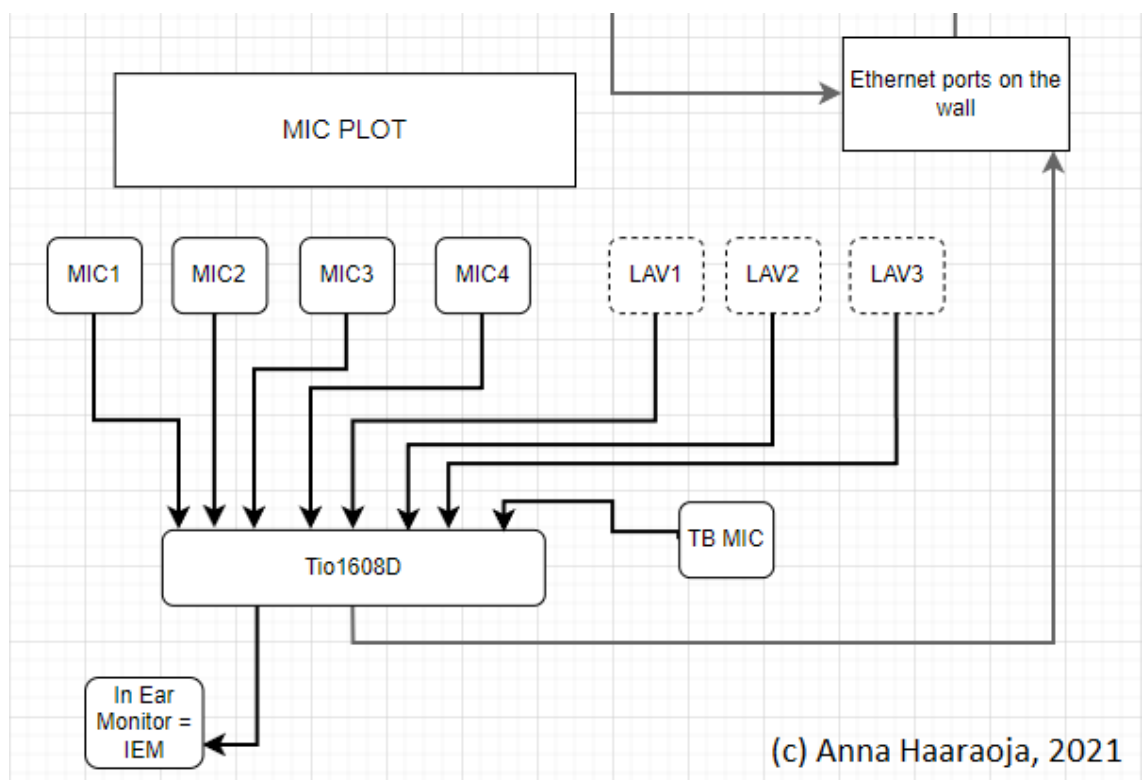


FIGURE 6. Studio mic plot

Figure 7 presents how the signal travels from the server rack to the ethernet port in the audio control room and finally to the mixer, which in this case is a Yamaha QL1. The audio engineer can watch the broadcast and all the camera inputs from the monitor Multiview. This way they can also see both the Program, PGM and Preview, PVW. This gives advantage to predict what is to come before the video switcher hits the Program button. Talkback microphone is for the communications between the audio control room and the studio.

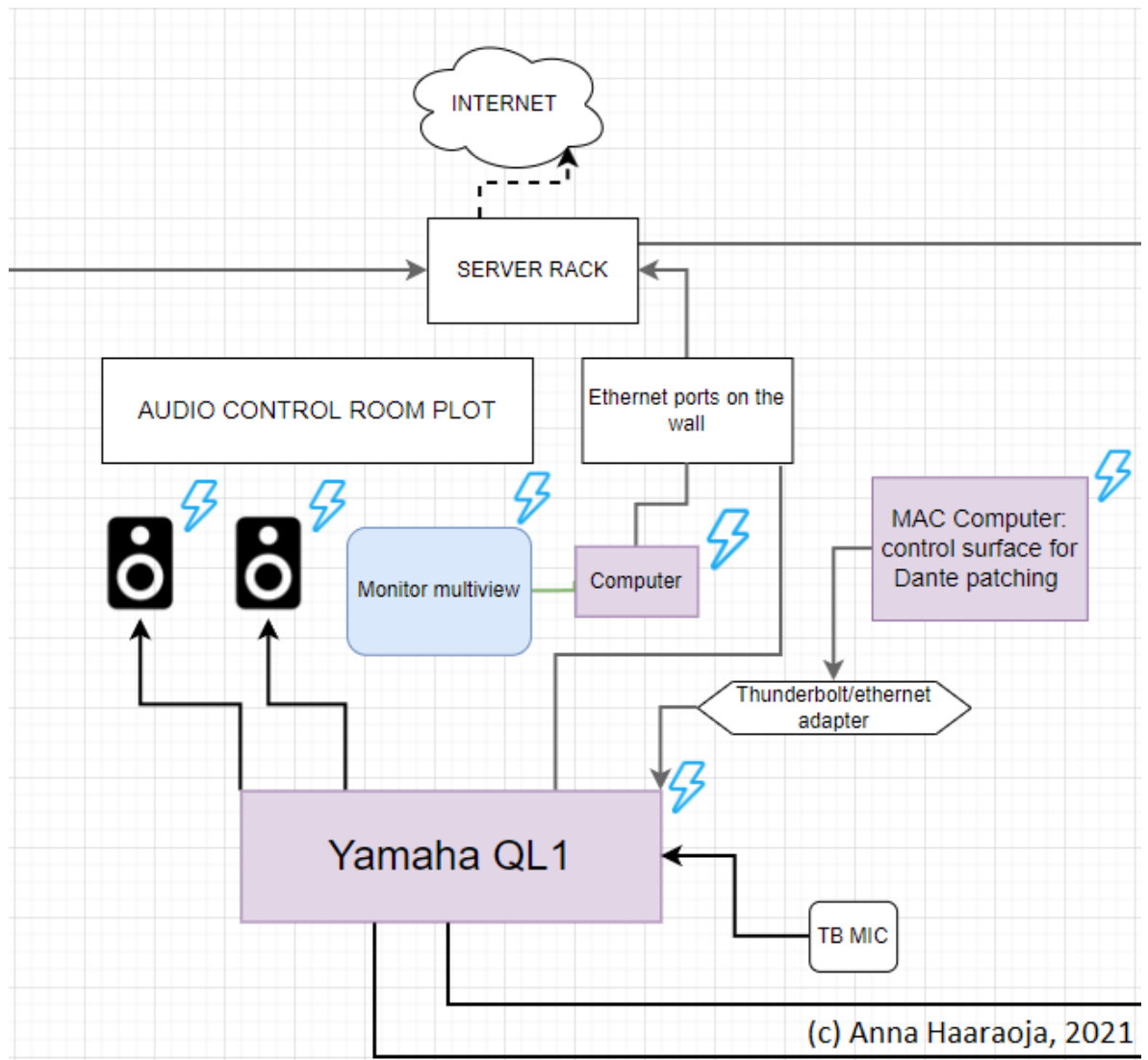


FIGURE 7. Audio control room plot

Mics, racks, cables, monitors, screens, mixers, loudspeakers, loudness meters headphones and laptops are the equipment the audio engineer needs. All of this aims for a pristine audio quality that is not too quiet or too loud. The loudness meter is a device or a software that shows how loud the master output is. Mike

Kahsnitz (2021) writes in their LUFs article that the recommended loudness level, EBU R 128, for broadcasts is -23 LUFs. This means that the audio engineer should follow their signal levels so that the overtime loudness is not too much less or more than -23 LUFs (Kahsnitz 2021).

Finally, the combined audio signal with the effects it needs is sent to the encoder or to the streaming computer. This really depends on the setup itself, but in this case there's an encoder in the system. The encoder combines the video and the audio sent to it and sends it to the pre-programmed destination such as YouTube or Vimeo.

3.3 Computers and live production systems

Computers and laptops are crucial devices in the online event production. When the choice of computers and live production systems has been made, the software and computers themselves need licences and passwords that prevent unauthorized usage. Licenses, passwords, or users are not covered in this thesis in detail, but they are worth mentioning, since without them, buying, configuring, and using the equipment's software is not possible.

Different live production systems have their own technical specs recommendations, so rather than listing all the different computers that can be used for streaming purposes it is better to study the streaming software's individual system requirements. Hardware portable switchers are important when a technician wants to have a compact streaming equipment. Roland's downloadable controller works with the Roland's hardware switcher. Hardware video mixers or control surfaces are not covered in this thesis in detail. System requirements for OBS Studio, vMix and the TriCaster are covered in this chapter.

Almost any computer that has at least a solid state hard-drive with i7 processor and 16GBs of RAM is a safe choice for streaming purposes. (Richards, 2021.) OBS Studio recommends having AMD FX series or Intel i5 2000-series processor or higher, DirectX 10 capable graphics card and at least 4 GB of RAM (Wilbert 2021). A computer also needs a place to store data to for example record material

for on-demand use. It's safe to say that having a 1 TB SSD is enough for the streaming and recording purposes. (vMix n.d., vMix Reference Systems.) Also, if the streamer wants to use vMix Instant Replay, having a dedicated SSD that has at least 500GB is recommended, but having 1TB or more gets the streamer on the safe side of things. (StudioCoast n.d.)

VMix recommendations are detailed, and they have their minimum and recommended system requirements listed. VMix has following statistics on their homepage:

TABLE 1. System requirements for the vMix software (vmix.com n.d. vMix support page)

	Minimum	Recommended
Operating system	Windows 10	Windows 10
Processor	2Ghz Quad-Core Processor	Intel Core i7 Processor 3Ghz+
Memory	4GB DDR4	8GB DDR4
Hard Drive	7200 RPM Hard Drive (for recordings)	Solid State Disk
Graphics Card	Dedicated DirectX 10.1 Compatible Graphics Card	Dedicated Nvidia Card with 2GB+ Memory
Screen Resolution	1280x720	1920x1080

Having a discrete graphics card is necessary. A graphics card is also referred to as GPU. Graphics cards come in two forms: an integrated GPU or a discrete GPU. An integrated GPU is a built-in piece of equipment and cannot be replaced. Usually, integrated GPUs do not have the needed performance for streaming purposes, and therefore discrete GPUs are used. Discrete GPUs can also be replaced and upgraded, whereas integrated GPUs cannot. (Johnson 2021.)

VMix has listed their recommendations of graphics cards in three sections (Table 2). First section presents the lowest performance, the middle section presents the mediocre performance and the lowest is the highest performing graphics cards. Luckily, these requirements are not out of reach for a semi-professional streamer or even a consumer. For example, NVIDIA GeForce 1060 is still, in the year 2022, the most popular GPU according to Steam's hardware survey conducted in February 2022 (Valve Corporation 2022). NVIDIA GeForce 1060 was released in 2016, which makes it a bit old in technology's perspective, but even today, NVIDIA GeForce 1060 holds up (Szewczyk 2022).

TABLE 2. Graphics Cards and what they can process (vmix.com n.d., vMix support page, modified.)

Performance	GPU	HD Inputs	Outputs
Low	Intel HD Graphics 530 / 630 or higher	2 Cameras + 4 Inputs	1080p recording or 720p recording + streaming
Mediocre	NVIDIA GeForce 1050 / 1650 / 3050	4 Cameras + 8 Inputs + Instant Replay	1080p recording and streaming
High	NVIDIA GeForce 1060 / 1660 / 2060 / 3060	2 4K or 8 HD cameras + Instant Replay	1080p recording and streaming

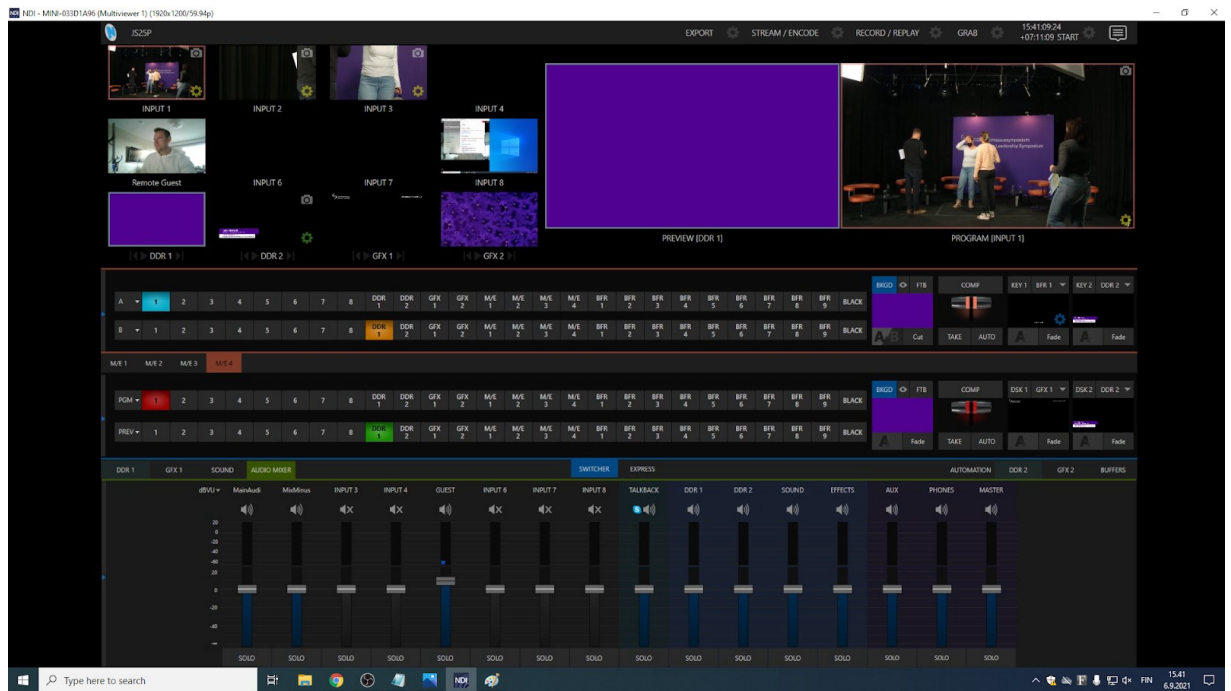
NewTek is a company developing video connectivity called Network Device Interface or NDI, NDI cameras, control panels and live production systems. Most essentially NewTek develops their main product, the TriCaster, which is an all-in-one live production computer system. (NewTek, n.d., Features in Depth.) This means that the software and the hardware come in the same package, whereas vMix is just a downloadable software for any computer that meets the technical requirements.

TriCaster is a stand-alone computer system that supports multi camera inputs and can broadcast, stream and record simultaneously. There are multiple TriCaster products such as 2 Elite, 1 Pro, TC1, TC410 Plus, Mini 4K and Mini SDI/HDMI. (NewTek n.d., TriCaster.) This thesis will only introduce the TriCaster Mini 4K, since that is the device that has been studied for this thesis.



PICTURE 7. TriCaster Mini 4K is an all-in-one live production system (NewTek n.d., TriCaster Mini 4K)

There is a full list of technical specs on the TriCaster's home page, but this thesis will cover only the most relevant specs. TriCaster Mini 4K supports 8 IP video inputs via NDI. It also supports having up to 8 PTZ or Pan-Tilt-Zoom robotic cameras. A Skype call can be set as an input for remote guests. Two Stream Outputs can be configured to work independently. Four recording channels either from NDI or Mix Outputs can be used. It can play and control media and audio. TriCaster is controlled by its own hardware control surface. (NewTek n.d., Technical Specifications.)



PICTURE 8. Overall view of the TriCaster live event production system

3.4 Adapters and converters

All devices are not compatible due to the fact they do not have the matching outputs and inputs. There might also be some project relevant issues that require converters. The reasons for having converters and adapters can vary, but one thing is for sure: you seem always need them. There is a need for a large variety of different adapters and converters depending on the available devices and their inputs and outputs. Usually, the more adapters and converters in your toolbox, the better are the chances that the stream will be a successful one. Converters convert the transmitted signals to a format that the receiving end understands. Most common or useful converters and adapters used in the live streaming context are presented since there is just so many situations where an adapter is needed, and thus all possible scenarios are not covered in this thesis. (Sewell 2022; BoxCast 2022.)

It's very common that devices don't have matching inputs and outputs (Figure 8; Figure 9). Figure 8 presents a situation where the AV team has an HDMI video

switcher and SDI cameras which means that the cameras only have an SDI output, but the desired format is an HDMI input signal. To get there, there must be an SDI-HDMI converter for the video switcher to understand the signal.

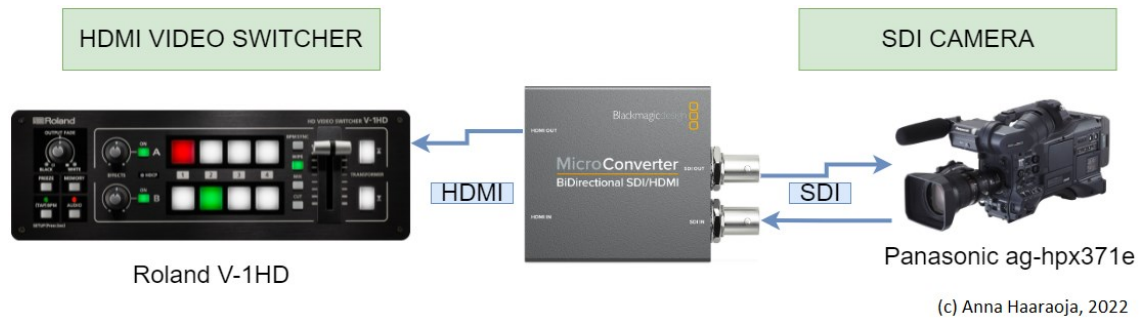
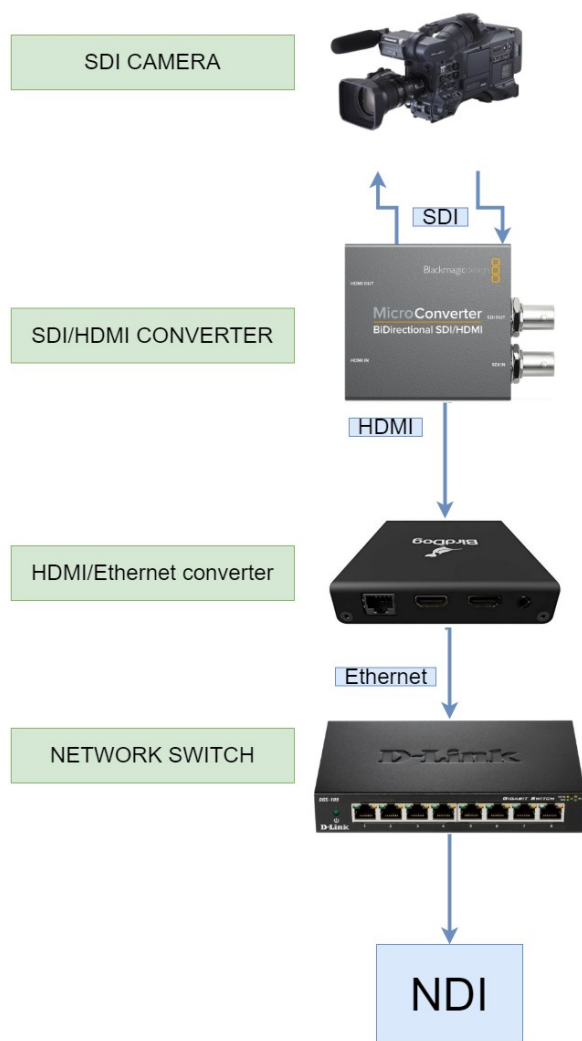


FIGURE 8. SDI signal travels through a converter and is received by a HDMI video switcher

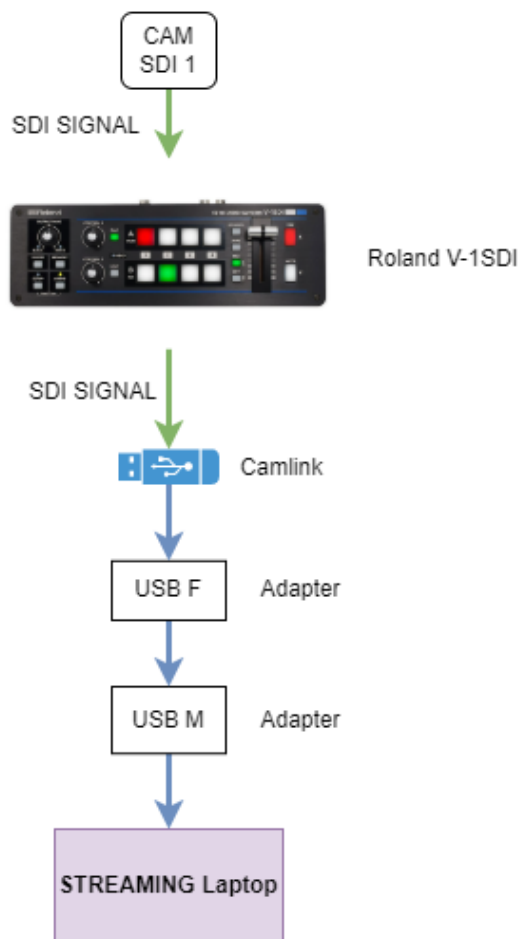
Figure 9 presents the situation where the cameras only have an SDI output, but the desired format is an NDI signal. To get there, there must be an SDI-HDMI converter and then another HDMI-Ethernet converter to have the video signal in the network. When the streaming engineer is working with an IP-based NDI system, all the signals need to be converted to NDI. Converting to NDI makes the signals in the network be found, fetched, and controlled. For example, conversion from an SDI signal to IP-based NDI requires two converters.



(c) Anna Haaraoja, 2022

FIGURE 9. Conversion from SDI signal to IP-based NDI requires two converters

Figure 10 explains the usage of web camera converters and tethering devices as adapters. The HDMI tethering device and the USB-adapter allows the otherwise unrecognisable video signal to be seen as a web camera by the streaming computer. This allows the streaming supervisor to route the web camera to a Zoom, Teams, YouTube, or other locations.



(c) Anna Haaraoja, 2021

FIGURE 10. Elgato CamLink 4K converts the video signal for the computer to see it as a web camera

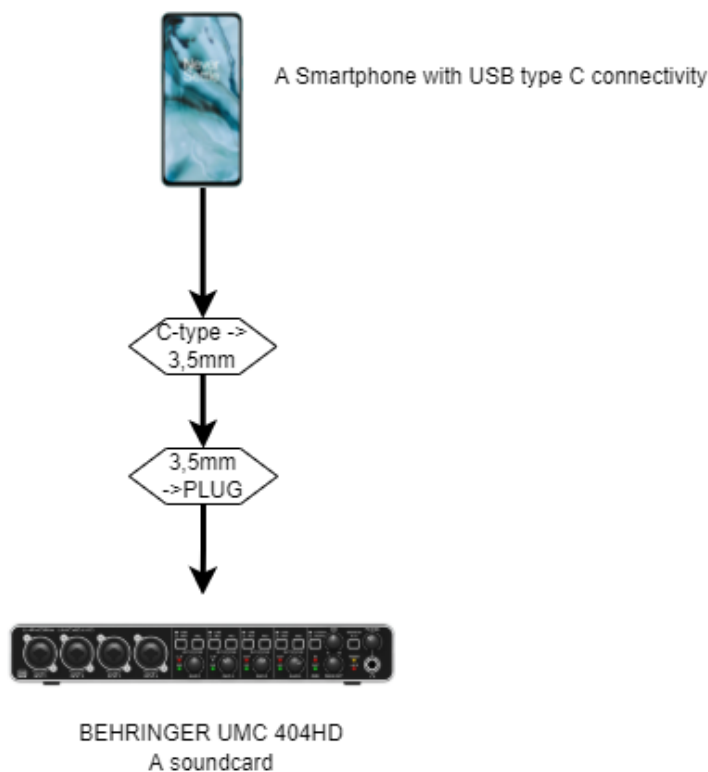
One thing worth mentioning is the limitations in the HDMI signal. HDMI signal's quality starts to decrease after 15 metres. HDMI repeaters can lengthen the distance that the signal can be transferred, but if there's a need for long distance transmission, it's suggested to use SDI instead. (Afterdawn n.d.)

Audio adapters are a mandatory tool in the professional toolbox of any streamer and especially the audio engineer. There is a wild world of many different adapters in the audio field and thus this thesis will present only the most common and most used adapters:

- XLR to 6,4 mm plug
- 6,4 mm plug to XLR
- 3,5 mm to 6,4 mm plug
- Stereo Plug to mono L-R cable

- USB-C to 3,5 mm
- 3,5 mm to 6,4 mm plug
- 3,5 mm to XLR
- RCA to 6,4 mm plug

These adapters are used for example for headphones, loudspeakers, and mobile phones. There is a ton of other situations where an adapter saves the day but listing all the possible situations wouldn't be practical or necessary. The knowledge of the needed adapters is a skill, which is trained by doing virtual events and seeing the situations where an adapter is needed. For example, sometimes, the customer wishes to have background music which they did not mention before. This is when having a free input in your sound card, your mobile phone and an adapter comes in question. Nowadays some of the newer smartphones do not have 3,5 mm output and it's replaced with the USB-C output. This is when the technician needs two adapters: USB-C to 3,5 mm and 3,5 mm to 6,4 mm plug. An example of these adapters can be found in Figure 11.



(c) Anna Haaraoja, 2021

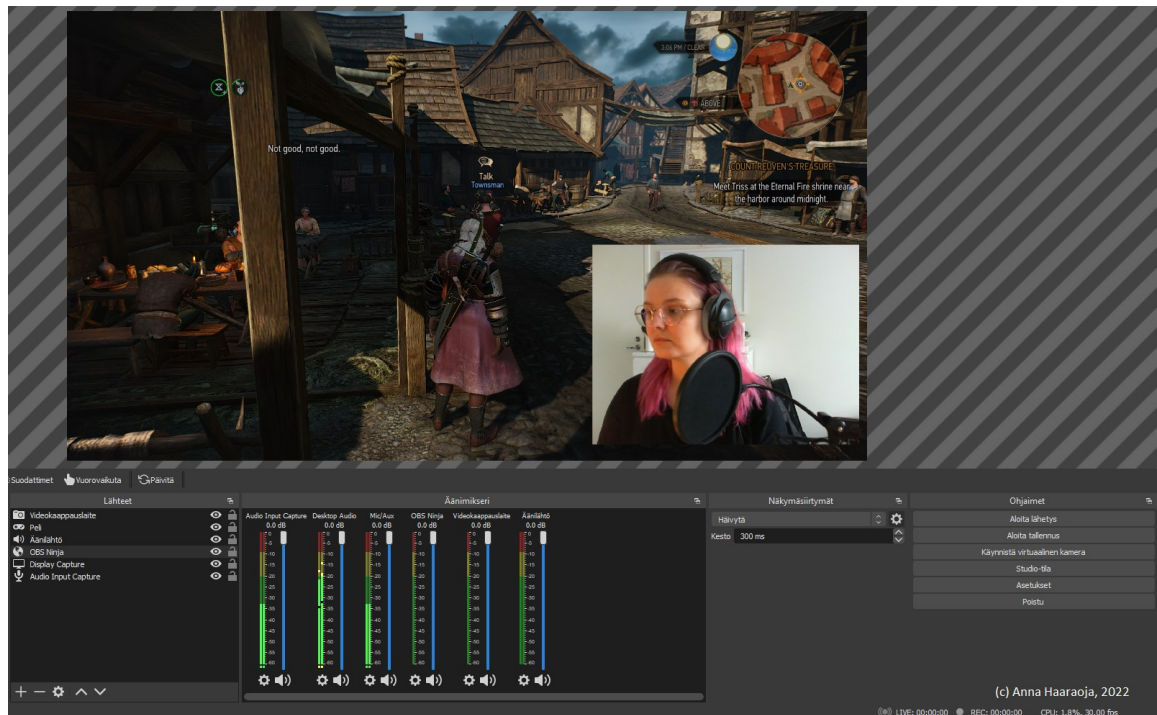
FIGURE 11. USB-C to 3,5 mm and 3,5 mm to 6,4 mm plug in a chain

3.5 Streaming software, platforms, and internet connection

Finally, at the end of the signal chain it is time for combining the audio and video signals together. This combining happens in slightly various places in the signal chain depending on the devices that are used. For example, when using an encoder, the signal is combined in the encoding device. Encoders are devices or software that convert the RAW video files into digital file form. (Epiphan 2022, products.) Encoders are explained in more detail in chapter 3.6.

In a small streaming setup, the combining happens in the streaming laptop. From there the master audio-visual or AV signal is sent out to the world using the Wi-Fi router that is configured for an internet connection. The sound card is routed as a mic in the streaming platforms. Platforms that have a live event streaming feature are for example Zoom, Teams, Youtube, Vimeo, Twitch, Discord, Periscope, Instagram Live, Facebook Live, TikTok Live (Shahzeidi 2021).

OBS Studio is a software in home streaming productions. A gaming stream doesn't usually need a huge multi camera production but a way to route the computer screen, the person playing the game, audio input for speech and possibly one input for background music. OBS Studio also has an NDI plugin so that the OBS Studio can also be used as a full streaming software too. In other words, streaming in a home environment can be done with a smartphone, web camera, laptop, OBS Studio software, a basic sound card and a mic.



PICTURE 9. A screenshot of OBS Studio as an example of a basic game stream setup

As explained earlier, a stream needs audio and video inputs, internet connection and a software that pushes the AV-production out to the broadcasting platform. The streaming platform's credentials, such as YouTube or Twitch, can be routed to the OBS. When the broadcast button is pushed, it remembers the preconfigured route for example to the twitch account and the streamer is ready to go.

Having a stable internet connection is crucial. A portable setup should have 150 Mbp/s internet connection. The upload bandwidth is also particularly important in the streaming context. For example, YouTube has listed their recommendations of the upload bandwidths and the video quality the speed can offer in Table 3.

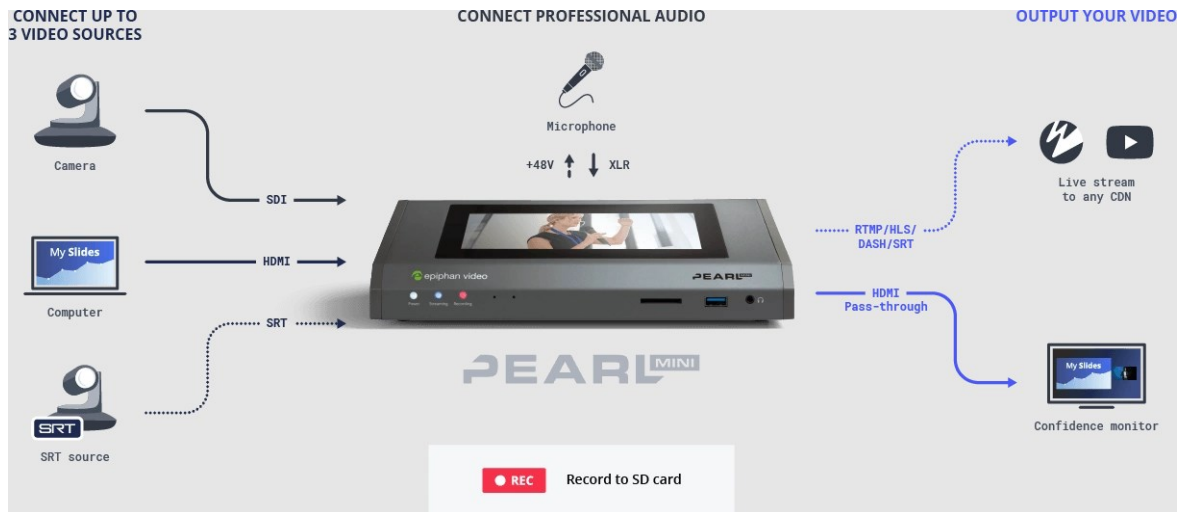
TABLE 3. Required upload bandwidths for YouTube Live (YouTube Marketing 2020, 12)

Standard definition video	3Mbps
720p and 1080p high definition	5–10 Mbps
4K ultra high definition	25 Mbps

The well-established broadcasting companies have built their own transmission networks and they are not dependent on the public service providers such as mobile phone plans. Mobile phone plans are used for having a sim card in the Wi-Fi router and sometimes this can cause problems in the internet speed if the stream is taking place in an environment or area that has heavy internet traffic in general. A freelancer that does not have the access for the big broadcasting companies' networks, is dependent on the public market's internet speed.

3.6 Encoder, controllers, switchers, and other supporting tools

Encoders are devices or software that convert the RAW video files into digital file form. Software and hardware encoders work the same way, but hardware encoders are usually used in the advanced video productions. OBS Studio, vMix and TriCaster work as an encoder too, but hardware encoders share the computing load off from the main switching machine. (Dacast 2022.) Epiphan Pearl Mini is one of the many encoders out there. It is controlled with Epiphan Cloud, which is a web-based interface for controlling and operating the hardware remotely. The hardware encoder is capable of live streaming into multiple destinations simultaneously. It can also record live streams, which is very handy if the live production system is already working hard. (Epiphan 2022.)



PICTURE 10. Epiphan Pearl Mini Encoder workflow (Epiphan 2022)

Portable hardware switchers such as Roland V-1HD and Roland V-1SDI are devices that connect, and switch HDMI and SDI based systems. With CamLink the video signal can be converted into a form that the streaming computer understands. SDI-based switchers have the advantage of distance since SDI cables can carry the signal longer than the HDMI cables. The switcher supports Full HD 1080p and it can have 3 3G-SDI and 2 HDMI inputs. Also, it has 2 3G-SDI and 1 HDMI output. The switcher also has a 14-channel audio mixer included. (Roland Professional A/V, 2022.)



PICTURE 11. Roland V-1SDI video switcher (Roland Professional A/V 2022)

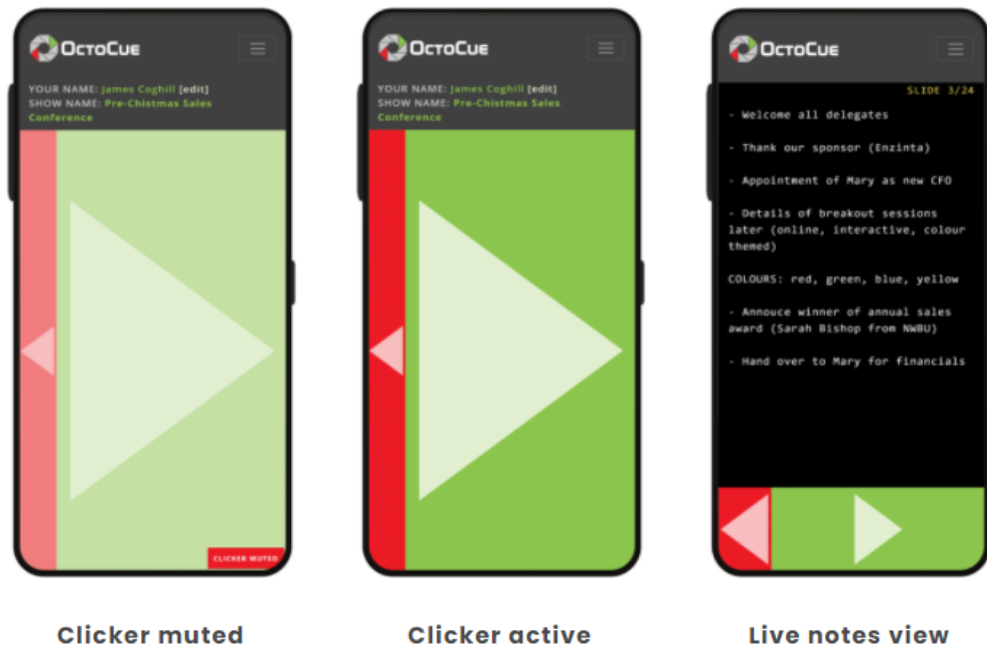
Elgato Stream Deck devices are a family of customisable control surfaces. The smallest control surface, Stream Deck Mini, has 6 keys while the biggest control surface, Stream Deck XL, has 32 keys. Own custom icons can be made with Key Creator. The macros and automation can be configured in the Stream Deck Software. (Elgato n.d., Developer Documentation.) One thing to remember is that the

buttons can be configured into the press or release mode. This means that one button can have two actions.



PICTURE 12. Stream Deck is a customisable control surface (Elgato n.d. Stream Deck)

Octocue is a remote slide controller. It is a web-based service that allows controlling both for the virtual event producers but also for the presenters. For virtual event producers Octocue gives the tools to mute and activate presenters and for the presenters themselves it gives remote control over their own slides while they are standing far away from any computer. (Octocue 2022, Presenter quickstart.)



PICTURE 13. Octocue UI design is remarkably simple and pleasant to use (Octocue 2022, Professional, seamless slide control)

The show control dashboard allows the event organizer to see who is online and who can control the clicks. The dashboard also shows the recent actions, the countdown clock and which PPT file they are presenting. The UI both in the clicker and the dashboard is made remarkably simple, which is great in the hectic and many times stressful corporate events. Only the essential and relevant information is shown to make the presentation and event go smoothly. (OctoCue, 2022. Show control dashboard.)

The screenshot displays the OctoCue Show control dashboard, which is organized into several functional panels:

- PRESENTERS:** A vertical list of three presenters:
 - RAYMOND:** Status is 'CONNECTED' (green). Last click: 'NEXT' 1m ago. A red 'MUTE' button is visible.
 - ASHA:** Status is 'CONNECTED' (green). Last click: 'UNKNOWN'. A green 'ACTIVATE' button is visible.
 - MICHELA:** Status is 'CONNECTED' (green). Last click: 'UNKNOWN'. A green 'ACTIVATE' button is visible.
- ACTION:** The central panel shows 'NONE' in large text. Below it, 'LAST CLICK: NEXT FROM RAYMOND 1m AGO'. A 'Sounds:' toggle is currently 'OFF'. A 'CLOCK PAUSED' section shows the time '09:40' and a '10:00' timer. Below the clock are 'Jog minutes' (+10 +5 +1 -1 -5 -10) and a 'Show on clickers:' toggle which is 'ON'.
- RECEIVERS:** A panel on the right with a dropdown menu set to '(none)'. Below it, a receiver named 'WINTI-VM' is 'CONNECTED' (green). It shows 'PPT add-in running' and 'PPT mode: Slideshow' with 'Filename: Final deck v2.pptx'. The notes field contains 'Welcome to...'. A red 'STOP RECEIVING' button is at the bottom.
- Navigation:** At the top right, there are red and green arrow buttons for navigation.
- Footer:** A dark bar at the bottom contains the text: 'ACCOUNT: ACTIVE SHOW CODE: 35sdn SHOW NAME: Sales conference update'.

PICTURE 14. Show control dashboard is a practical way for the event organizers to control the presentation

4 VIRTUAL EVENT TEAM

Producing and executing an event is very often done in a team. A virtual event production team is very much like a TV crew and the tasks and tools used are often the same. (Billings n.d.) The roles presented in this chapter are the roles that the work in the virtual event team has taught me. Billings (n.d.) mentions other roles too, but since their view on the production team comes from the TV production side, it is not necessary for me to include for example the role of the costume designer or roles that fall under other titles of the virtual event team.

Some productions are challenging and require a lot of people to work while a smaller production requires less work force. A virtual event team can be as small as four to five people, but in bigger production the team can be even fifteen or more. Those numbers are just mere estimations and the amount team members in each production are decided case-by-case.

Camera operators are an obvious part of the virtual event team. They work for pristine video quality and ensure that the signal from their camera to the system is well maintained. Camera operators specialize in different cameras such as TV cameras, handheld cameras, and robot cameras. The tasks include, but are not limited to, configuring the camera settings, colour grading to even out the colour differences between cameras and adjusting the focus. There is usually one person controlling all robot cameras at once, but a hand-controlled TV camera requires one person per camera. (GTI Futures 2022.)



PICTURE 15. Robot cameras are controlled remotely by the camera operator (Luiza Preda 2021)

Event Lead/Executive producer is the head of the team. They plan what happens, who does what, where they need to be and when things need to happen. The executive producer can also oversee hiring people for the virtual event production team. Event lead decides the date of the event, locations, and budget. (Chodor & Cyranski 2021, 167.) They will also make sure that the hard drive has enough disk space for show recordings. If they are too busy to do it, they'll delegate this task to someone else in the team.

Technical producer takes care that everything works as it should. Technical producer oversees managing the virtual event's technical solutions. Understanding the end-to-end signal chain is required. (The Radio Academy, 2020.) Technical producer draws the AV plot, rents, or reserves the needed gear and sometimes also hires the technical crew for the event if the team is small enough.

Marketing and promotion are crucial for any line of business, and the event industry is no exception. People in the marketing team are specialized in their field and they ensure the event is promoted to the right target group and the campaign is well-timed. They set marketing goals and how to achieve them. They will

segment the audience so that the target groups of the event will find their message. (Chodor & Cyranski 2021, 173.)

Remote guest coordinator is in contact with the remote guests. This job title is new, and the tasks might fall under the production assistant (Chodor & Cyranski 2021, 182). They will usually meet the guests in a video conferencing platform prior to the event to discuss the details of their presentation. They will ensure that the remote guests' web camera works, mic works, asks if the guests have any PPT slides to be sent to the tech crew or if they have any questions before their presentation. They will prepare the guests by telling them briefly what is going to happen in the broadcast, how they'll ensure their video and audio is received by the studio mixer and remote guest video input, and what to do if something goes wrong. Remote guest coordinator is customer service work, and it is important to maintain a calm tone and habitus even if the broadcast was about to rip at its seams.

Studio manager/Floor manager works with the camera team in the studio and is in talkback connection with the director in the control room. They will forward orders of the director and prepare the cameras for the control room Multiview screen. They also have a copy of the technical script that they follow closely, and they give orders to their team in the studio. (Billings n.d.)

Director collaborates with the technical crew in the control room and is supervising the Multiview and telling the video switcher what cameras need to be in the program view. Director communicates with the studio manager, and they will do the countdown in and out for the filler videos. Studio manager follows this countdown and prepares the camera crew for the switch back to the cameras. (Billings n.d.)

The video switcher or vision switcher is at the heart of the action. They use the live event production system's controls. They are in charge either by themselves or in cooperation with the director, of what is sent out to the broadcast. They will follow the Multiview screen that has all the media and camera inputs and set the pace of the broadcast by switching between the inputs. (Billings n.d.)



PICTURE 16. Video switcher controls TriCaster, the live event production system (Luiza Preda 2021)

The technical script is guiding them, and the switcher follows this document very carefully. If the switcher is not able to follow the script due to high tempo broadcast, the director will tell them what the script is telling the team to do. (Billings n.d.)

The Graphics Operator oversees controlling the interactive graphics. Sometimes when there is a lot of speakers in an event and interactive graphics and animations, the video switcher can't handle graphics alone. Then the graphics operator steps in. Their task is to use a control surface for example online which is the same system the video switcher is using. They will operate the name titles, graphics and animations in correct order and timing. (Billings n.d.) As seen in the Picture 16, the video switcher is also doing some of the graphics operating on the touch screen on their left-hand side.

Scenographers/set designers work closely with the lighting designers and camera operators. They build the set according to the wishes from the customer of the event lead. Their task is to set the stage to look like a room, a street, or any

space the director has planned. Set designers need to think practically and handle both a power drill and a needle. (Berklee college of music, set designer 2022.)

Lighting designers oversee planning the spots and lights of the studio or scene. Lights are an important part of the visuals and atmosphere. Lighting designers work closely with the **lighting technicians or lighting engineers**, and often are technicians themselves too if the scale of the event is simple enough. Lighting engineers draw plans of the lights and execute their plan. They reserve the needed gear according to their plan, place the lights and rig them to the ceiling if needed. (Berklee college of music, lighting designer 2022.) Lighting technicians and designers control their setup with a lighting control surface, which is comparable to an audio mixer, but in the visual world.



PICTURE 17. Lighting engineer controls the lights with their control surface (Luiza Preda 2021)

Audio Engineers work for the pristine audio signal, and they keep audio well maintained through the whole signal chain from the mics and other audio inputs to the broadcast output. Audio engineers are the people working with the audio mixer. If the event has live music, the skill set for the audio engineer is more demanding than taking care of the speech only audio signal. If the event is big

enough, there might be a need for a separated main audio output technician and a monitor mixing engineer. (Berklee college of music, live sound mix engineer 2022.)

The audio engineers set up the mixer and make sure all the necessary audio is present when needed. The transitions between scenes are important to be mixed correctly since missing audio signal for example from the main keynote speaker is just not the way to go. Audio engineers also play the background music from their system when needed. (Berklee college of music, live sound mix engineer 2022.)



PICTURE 18. Audio engineer sets up the mixer for the show and controls the audio (Luiza Preda 2021)

Audio engineer team also includes the micing technicians that work closest to the talent or the keynote speaker. Their task is to make sure that the keynote speaker has the right mic for them, be it a wireless lavalier or a shotgun mic rigged to the ceiling. They make sure to have one back up mic and know how to hide the lavalier mics and their transmitters. What I have noticed in my work is that audio engineers also always should have a pack of AA-batteries, a Swiss knife, electrical tape, and adapters in their pockets always.

Audio Designers are technicians that take care of the theme songs, background music, sound effects and all sorts of sound design related tasks. They search for fitting music online or compose it themselves. Audio designers can work both in the pre-production and post-production phases, depending on what is the final product agreed with the customer. If the desired product is a live broadcast, sound designers can collaborate closely with the graphic designers and animators so that the title graphics or animations get the suitable audio. If the final product is an edited video, audio designers can also work as the mixing and mastering engineers so that the audio has appropriate loudness levels and sounds great. (Berklee college of music, Sound designer (games and tech) 2022.)

Graphic Designers oversee the visual atmosphere, name title graphics, brand colors and animations. The final job description depends on what the graphic designer has experience on, meaning that the designer does not necessarily need to know all the aspects written above. If a graphic designer usually works with animations, then the graphics are more animation based. A designer more familiar with artistic and technical drawing, the design leans more towards that world. Most important thing is that the designer knows their tools and can work with the given brand guidelines. (BrainStation 2022.)

Photographer is a person documenting the production. Visual presentation is important for the companies. Having a good photographer in the set documenting the behind the scenes and the on-air atmosphere is interesting to see. The photos that the photographer takes can be used in the company's social media, their final reports and sometimes technicians can use them in their professional resumes. (McKay 2019.)

If the production is big enough, the photographer is hired only to work taking the onset and behind the scenes photos. More often the size of the teams is not this big, and the photographer is someone in the team that is not tied with their post during the broadcast. For example, people that work mostly in the pre-production and post-production or are some other ways free to leave their posts like the set designers, audio designers and editors, graphic designers, marketing professionals and promoters can be the people taking the photos if they have it in their skill set.

Catering, both for the technical team and the talents visiting the venue is an important, but sometimes overlooked part in the event productions in smaller productions. Production caterers are either third party professionals or someone from the technical team. Their task is to take care that everyone gets enough food that is suitable for different diets. Having someone to take care of bringing in food for the crew and the visitors is especially important if the venue does not enable keeping food refrigerated or the location is far away from restaurants. (Morrison 2019.)

PowerPoint operator, often referred as PPT operator, is the person taking care of the slideshows and presentations during the event (Audio visual nation 2019). The signal from the PPT computer is sent to the system using the NDI tools but also to a studio screen if the speaker needs to see the presentation during the show. That is when you need someone to work with the NDI tools settings and studio screen. Slideshows are often controlled with a remote-control device such as OctoCue (OctoCue 2022). PPT operator makes sure the controller is fully charged, both receiver and transmitter work and the speaker find the controller.

The computer PPT operator is using can also be used as a media input computer in a smaller scale virtual event. In this case PPT operator falls under other job titles and for example the graphics operator or the stream supervisor. Working as a PPT operator is a good place to start working in the virtual event field.

Stream Supervisor is the last piece in the signal chain and in charge of the general outlook of the broadcast. Their responsibility is to create the links and send them to the customers or the person that has been in contact with the customer. They make sure audio and video are synchronized, the broadcast is loud enough, and they inform the team if they see something's off. (Grayson 2021; Game Streaming Academy Team 2019; Hotmart, 2021 & Altexsoft, 2020.)

The job of a stream supervisor is new and still evolving. It combines elements from a chat moderator, quality assurance, technical guidance, customer service and a signal flow analyst. This means there is no accurate job description of a

stream supervisor, but it's a combination of many. (Grayson 2021; Game Streaming Academy Team 2019; Hotmart, 2021 & Altexsoft, 2020.)



PICTURE 19. Stream supervisor oversees delivering the signal to the customer (Luiza Preda 2020)

Stream supervisors' job description often overlaps with a moderator. Their job can also include customer service by keeping up the spirit in the chat box of the stream. The viewers might have something to ask and since the stream supervisor is the only person in the team directly in contact with the customer carrying the team's brand, their job is to answer as a representative of the event. (Game Streaming Academy Team 2019.) They should have timetables at hand, know what happens next, and make sure the viewers find their destination. Starting as a stream supervisor in the virtual event team is a suitable place to begin if one is interested in the virtual event production team. Streaming supervisor gains knowledge of the overall production and signal-flow and this makes it possible to move to other tasks in the production too, but at the same time deepen critical thinking skills.

5 VIRTUAL EVENT EXAMPLE

5.1 Portable virtual event setup

Now that the segments and phases of virtual event production are covered, it is time for the implementation of the knowledge. The needs of the customer have been discussed, the AV plot is being made, the technical script is on its way and the team is getting ready.

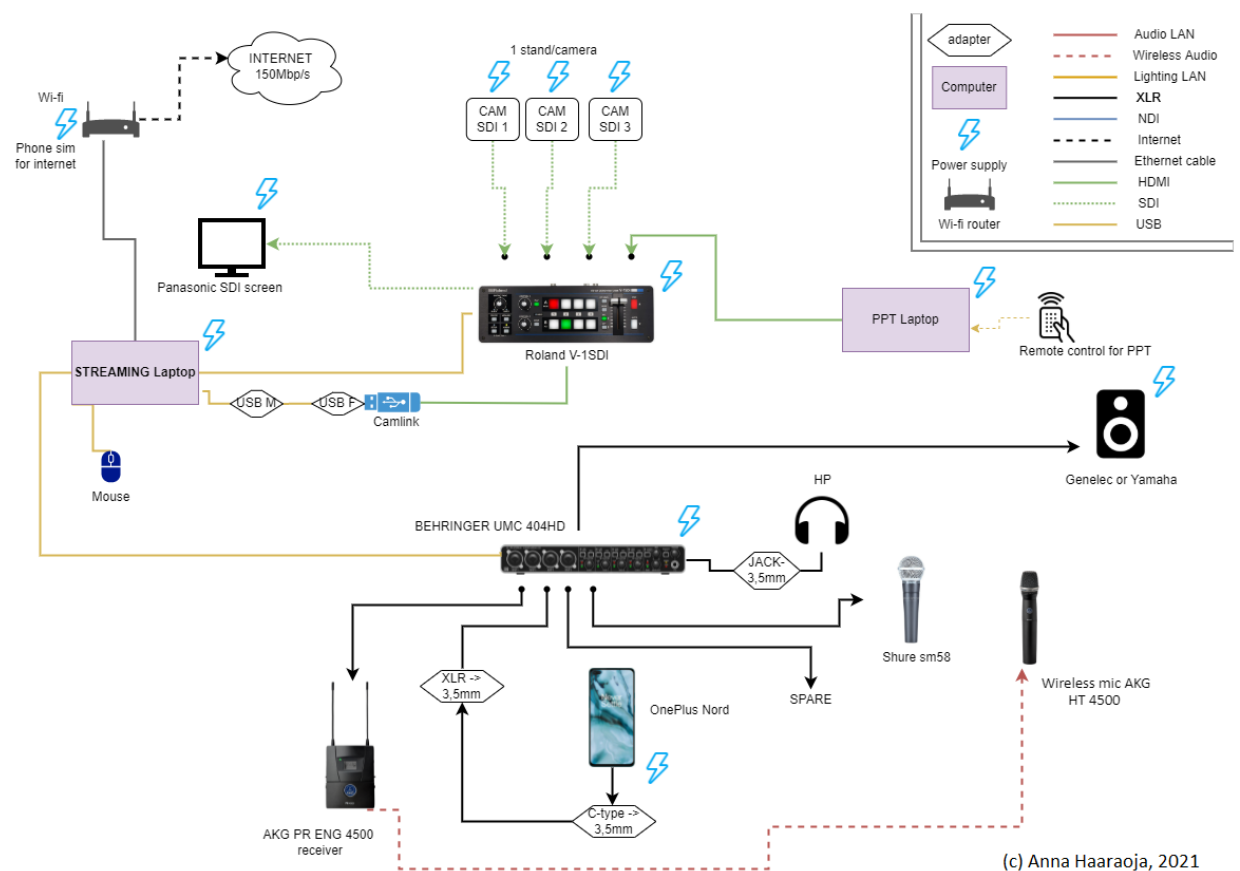


FIGURE 12. A completed technical plot for a corporate online or hybrid event

Figure 12 is a complete AV plot for a simple virtual event. It is the complete version of the simplified AV plot previously presented in this thesis in the chapter 2.5, Figure 3. The customer was happy with the results and the system did not have any dropouts. This system has been proven to work in a small organizational hybrid event.

An organizational event took place on 2.6.2021 in Nokia Kehräsaari. The event was a hybrid event for companies that were reflecting their impact on the environment and the actions their company has done and can do to reduce their carbon footprint. We had a team of five people. Two people operating the cameras, one operating audio and video switching, one photographer and a producer.

Our team knew that we needed one wireless handheld mic and some background music. The speaker and the local audience needed to hear the speaker and the attendants in the Zoom call if they had questions. The communications were possible because of the loudspeaker and the handheld mic. The customer wanted to have the guest speakers with their slides shown both in the local venue, but also in the Zoom call. The PPT laptop had the slides, which were controlled by handheld remote control. The slides were shown to the remote attendant in Zoom switching between the cameras and the PPT laptop.

Roland video switcher has built-in downstream key, or DSK, overlaid graphics and it can be programmed to work with your media input computer. Rob Read (2016) is demonstrating how Keynote, a slide presentation software developed by Apple, can be used for creating titles. The slides are in the media computer. A Windows user can use PowerPoint instead of Keynote. (Read, 2016.) An example of an overlaid graphics is presented in Picture 20. It is the name and the title on a blue background in the lower third of the screen.



PICTURE 20. The name and the title are made using DSK (Read 2016)

Our team did not use DSK on this event because we were called in to work in a short notice. We also did not have in-depth knowledge of the equipment we are going to be using. Therefore, we did not use this opportunity. We also were wondering if showing a slideshow simultaneously with DSK graphics is even possible. We needed to play safe because the time-limit gave us truly little time to plan.

The video projector is not in this AV plan, but it was used in the event since the customer wanted to show the slides also to the local audience. The reason it was not included in the actual plan was that, as in every event, there is always something that changes and having a projector wasn't originally in the customer's wishes. This was not an obstacle to our team, and we adapted on set.

Benefits of this setup are the mobility and simplicity. It is also affordable and can be operated with a small team. One example of the composition of the team would be two of the cameras being operated by two camera operators and switching is made by third person. The fourth person manages the audio mixing and media content such as videos and graphics. If the switcher is very experienced, they can manage the audio mixing and the media content while switching, but this is still not advisable since the risk of errors accumulates if too many tasks are thrown on one person.

5.2 Challenges of this setup

Challenges of this setup are the technical limits. The sound card does not have the capabilities that higher end sound cards have. For example, in this sound card model, the drivers make it impossible to truly have four inputs to the Zoom. The drivers would let the user only have two stereo pairs, which meant that if IN 1-2 was active, signals IN 3-4 would be ignored by the system. The spare Shure SM58 mic was in the INPUT 3 which meant that if it were used, the audio operator would have had to switch between audio sources manually. In a slow-paced event, which this event was, this would not be a problem, but this setup is not recommended for events that require fast reactions.

The wireless connection is always a risk since the bandwidth is shared with other devices. The audio interface allows simple mic setup for the streaming platform, but the sound card is limited with its four inputs. There were not any problems with the computer performance during the event but having just an ordinary laptop as a streaming computer is also a risk. It is better to have designated devices for each task so that the computing will not become too CPU heavy.

A smartphone can be used as an NDI camera input in a broadcast setup. (NDI n.d.) This requires building a Wi-Fi network. A sim card with internet access is installed to the Wi-Fi router and the router works as a network switch from there on. The NDI HX Camera app is installed to the smartphone and the smartphone is connected to the Wi-Fi network (Richards 2020). This way the live production system can see the smartphone device in the NDI network system and use it as a camera input. There was not much internet traffic, and we did not experience any drops in the connection.

Overall, this event was a successful one. All the inputs could be seen in the SDI multiview, cameras worked, music was played from a mobile phone with the use of adapters, wireless handheld mic was loud and clear, on-location audience saw and heard everything and the remote visitors also liked what they saw. Even though this event was a successful one, I would like to propose some improvements.

5.3 How to improve this setup?

I would improve this setup by taking it to vMix. I would like to make it more portable by having a smartphone or two with NDI HX Camera installed and running for still image cameras “safe shots” and having a robotic camera among the handheld cameras. I would replace the Behringer sound card with a proper digital mixer. I would also like to have a computer that has a discrete GPU so that this setup could be used in more demanding situations. And to have more controls and macros, I would have an Elgato Stream Deck for the graphics controls and automation.

The improved setup could be used for example in a small-scale live music festival environment. Having the possibility to route a program output for example to the AV-screens in front of the venue stage makes following the gig more accessible. Especially people following the gig from the back, but also the height differences of the attendants can create situations where people cannot see what is going on the stage. The output could also be routed to a streaming platform and that way people who cannot join the event physically can attend wherever they are. The improved setup can also be used for organisation context.

6 SURVEY FINDINGS

A survey for live event professionals was conducted to understand how streaming technology was initialized during the global pandemic amongst the live event professionals. The survey was anonymous, and answers only used for research purposes for this thesis. The survey ran for 14 days from 18th of March 2022 until the 31st of March 2022. A total of 15 professionals gave their answers. The survey was made using Google Forms.

The survey was published in social media communities in Facebook: “TTVO: Keikat – Gigs” and in “Media-alan työtori”. TTVO: Keikat – Gigs is a forum for students, teachers, and alumni of Media and Arts degree program located in Mediapolis Tampere. Media-alan työtori is a forum for media professionals to inform about the available jobs. I chose these two places because I knew these forums are the most potential places to reach out to live event professionals. Questions were also sent personally to people who I knew had worked in the traditional live events or emerging live event solutions.

The response rate of this survey is low since it was posted on a public social media community wall. It had large coverage, but low engagement rate. Creating engagement in this type of situation is very demanding and this has been the case in this survey. Data gathered is not sufficiently large to draw conclusions. (Qualaroo, n.d.) Interesting data was gathered, nevertheless.

First step in the survey was to find out what job titles the professionals have. Audio technicians, light technicians, freelancers, producers, a camera operator, an entrepreneur, an AV technician, narrator, a sound designer, and an EIC or Executive-In-Charge took part to the survey.

1. What is your current job title?

15 vastausta

Lighting technician
Narrator
freelancer
Freelancer
Audio technician
Light technician
Freelancer / Sound designer
Camera operator
Entrepreneur
Producer
AV Technician
Producer, entrepreneur
EIC
Valomestari
Audiovisual Technician

PICTURE 21. Survey results 1

The median years in the live event productions for respondent were 10 years of work in the field. 66,6% of responders have worked in the live event productions for more than 5 years. 20% have worked in the field for 2-5 years. Rest 13,7% is divided equally with 0-1 years and 1-2 years of service. Both 0-1 years and 1-2 years of service had 6,7% of responders. Figure 13 demonstrates these proportions.

2. How many years have you worked in live event productions?

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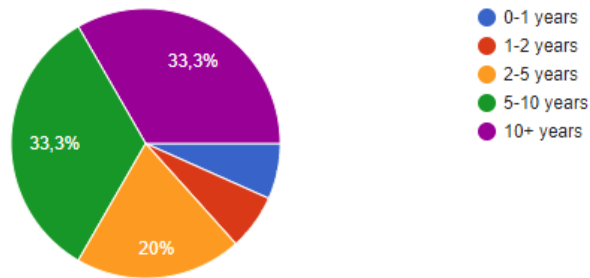


FIGURE 13. Survey results 2

The job title does not necessarily determine what the tasks are in the actual job. Next question wanted to study, what tasks people working in the live event productions are doing. This question allowed respondents to choose multiple tasks. Most of the respondents' work tasks, 46,7%, include technical production and stream supervising. 33,3% of the tasks include camera operating and audio engineering.

3. What are your main tasks? (Can select multiple.)

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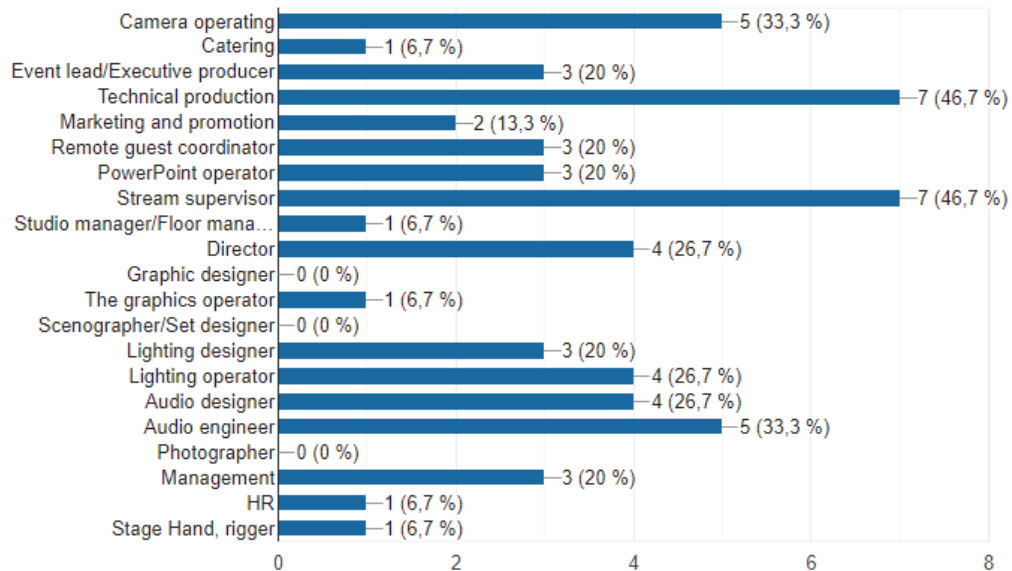


FIGURE 14. Survey results 3

The next question revealed extraordinary uniformity amongst the respondents. Full 100% of the respondents work in the traditional on-location events. The reason for asking this, maybe obvious question, was to find out if some of the professionals had switched fully to the virtual event world or if new professionals had entered the working life during pandemic and haven't had the chance to work in the on-location events. This question doesn't specify if hybrid events are also considered as online events, so it could be that some of the respondents might have included hybrid event solutions to their answers. Nevertheless, this demonstrates that regardless of the global pandemic, the on-location events are still a considerable employer.

4. Do you work in the traditional on-location events?

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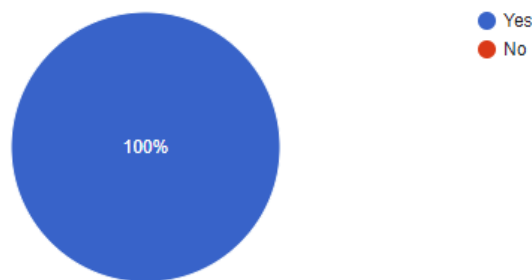


FIGURE 15. Survey results 4

Most of the respondents, 73,3%, reported that the number of remote events increased considerably compared to on-location events. 20% of the respondents reported that the number of online events increased slightly. This means that 93,3% of all respondents reported that the number of online events increased in some level. Only 6,7% reported a decrease in the number of online events compared to on-location events.

5. Did the number of remote events change compared to on-location events during the pandemic?

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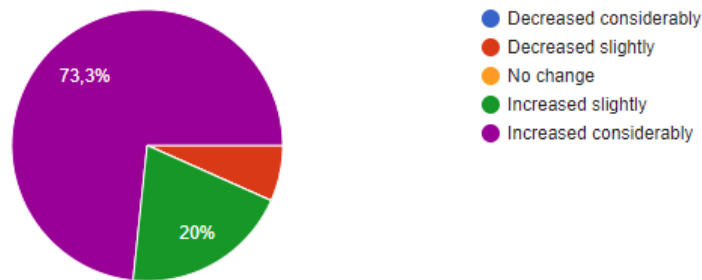


FIGURE 16. Survey results 5

Following questions are straight forward questions, where the answer was either yes or no. As seen in Figure 17, 60% of the respondents reported that their job description had changed because of the pandemic. 40% of the respondents stated that their job description did not change due to COVID-19.

6. Did your job description or tasks change because of the pandemic?

15 vastausta

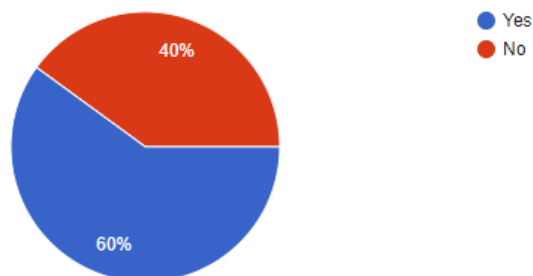


FIGURE 17. Survey results 6

Rest of the questions concentrated on the technical aspects of the event production. I wanted to find out if the respondents were familiar with certain technological solutions before the pandemic and if they are using it currently (Figure 18; Figure 19). I wanted to examine if respondents were familiar with Dante before the pandemic and if they are using it currently. 60% were familiar with Dante before the pandemic and 40% were not.

7. Dante is an audio over Ethernet and audio over IP technology that allows lossless audio signal transmitting from source to destination. Were you familiar with Dante before the pandemic?

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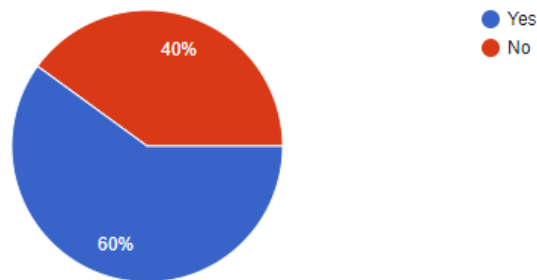


FIGURE 18. Survey results 7

Most of respondents, 40%, reported that they are currently using Dante at their work. 60% reported that they are not using Dante at their current work. It seems, that in this case people who were familiar with the Dante technology before the pandemic, are not currently using it at their work. This is logical since this survey targeted the live event sector in general. Dante is a tool for the audio technicians and this technology is not relevant for a person working as a camera operator or a manager.

8. Are you currently using Dante at your work?

15 vastausta

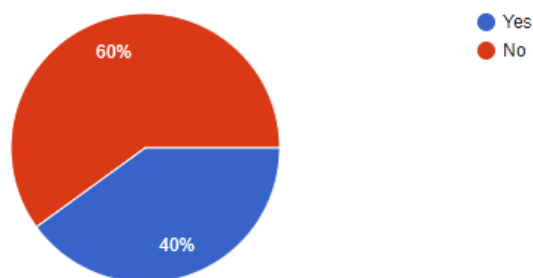


FIGURE 19. Survey results 8

As seen in Figure 20, most of the respondents were not familiar with the NDI technology before the pandemic. 73,3% of the respondents reported that they were not familiar with the NDI technology while 26,7% reported that they were familiar with this technology.

9. NDI is a video connectivity protocol developed by NewTek. Were you familiar with NDI before the pandemic?

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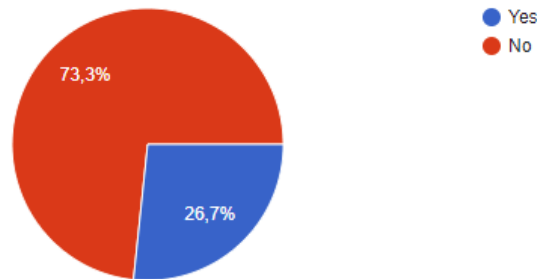


FIGURE 20. Survey results 9

Figure 21 demonstrates that 60% of the respondents are currently using NDI at their work while 40% of the respondents report that they are not. This means that according to this survey's results, there's a significant increase in the usage of NDI during the pandemic.

10. Are you currently using NDI technology at your work?

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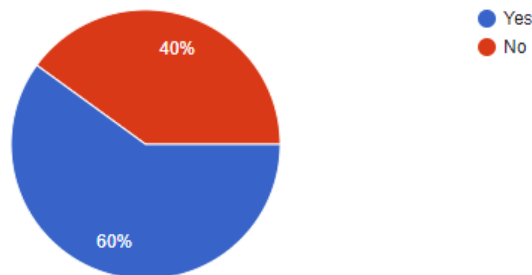


FIGURE 21. Survey results 10

As seen in Figure 22, Vmix was not very known before the pandemic. 73,3% of respondents reported not being familiar with the software. 26,7% knew vMix before the pandemic.

11. Vmix is a video streaming software mixer that can switch, record and stream media content. Were you familiar with vmix before the pandemic?

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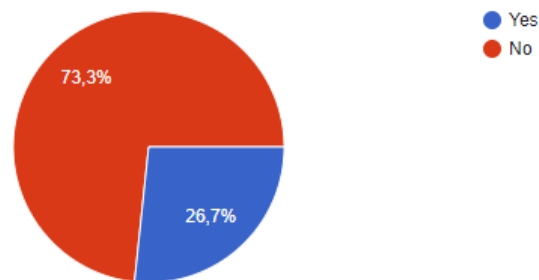


FIGURE 22. Survey results 11

Also, as seen in Figure 23, vMix is not used in the current work of the respondents. This is understandable since vMix is usually operated for example by video switchers, technical producers, and remote event coordinators. 80% of the respondents reported not using vMix at their current work while 20% of the live event professional reported using it at their current work.

12. Are you currently using vmix at your work?

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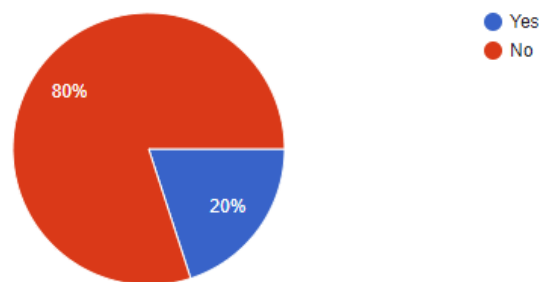


FIGURE 23. Survey results 12

Majority of the respondents reported designing and technical planning of some kind being part of their job. 66,7% reported that drawing AV-plots, technical maps or designing virtual event setups were part of their job while 33,3% stated that their work doesn't include design processes.

13. Have you been drawing AV-plots, technical maps or designing virtual event setups?

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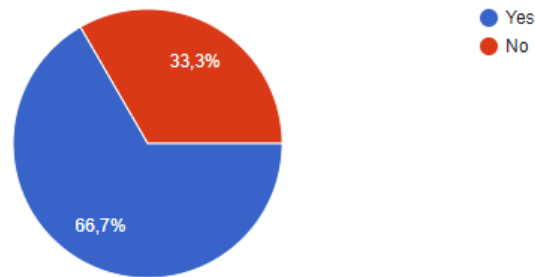


FIGURE 24. Survey results 13

Next question was aimed for the respondents who reported designing process being part of their tasks. Picture 22 states that three respondents reported using traditional and tactile design tools: pen and paper. Rest of the respondents reported using a digital design tool of some kind. Vectorworks, Capture 2018 (sweden), Lightwright, Draw.io, Photoshop, Adobe Illustrator, multiple adobe software products and Google Drive Tools, Visio and Vectorworks were mentioned.

This reveals that there is a variety of different approaches, but all are aiming for the same goal. The best design tool seems to be the one that works the best in the context.

14. If you have been planning AV-plots, technical maps or designed virtual event setups, what tools do you use? (For example, CalcArray, draw.io, Photoshop etc.)

10 vastausta

Vectorworks, Capture 2018 (sweden), Lightwright
Pen and paper.
Draw.io, photoshop
Adobe Illustrator
Pen & paper
Multiple Adobe Software products and Google Drive tools.
Pen & Paper
Visio
Capture, vectorworks
Draw.io

PICTURE 22. Survey results 14

And lastly the respondents had a chance to describe shortly how the pandemic affected their work and the number of live streams compared to the time before the pandemic. As seen in Picture 23, people had different experiences. For accessibility, here are the answers both in text form and as a picture.

- It practically started my own small business. So, I was a winner in this "shit". I hope I can continue after it...
- More to do
- There weren't any live streams before, there have been almost nothing else during.
- Worldwide tech leap
- All live events stopped during the pandemic. During 2020 and 2021, the majority of the event were virtualy made. In 2022, I've worked mainly on hybrid events and a few full live events.
- The pandemic transformed some events that would most likely have been organized as live events into online events. But of course only a few live events became online events, so there was a lot of lack of work.

- It decreased my work into amount that I started to study a bachelors degree in media
- Double
- I didn't do any remote events before the pandemic. I don't do live events anymore, but not because I don't like the work. I think it's as good work as any – with the right people and right equipment.
- I got started in virtual events because of the pandemic. During most of 2022 - 2021 that was all I was doing. I am relatively new to the industry so I can't speak to the number of live streams pre pandemic.
- Live streams increased considerably because our event venue could not have audience, so all events were streamed instead. Several events were also cancelled all together. In light design specifically we made sure the lights looked good on camera through monitors, which meant it often looked completely bland for human eye.

15. (Optional) Describe with your own words: How much did the global pandemic affect your work and the number of live streams compared to the time before pandemic?

11 vastausta

It decreased my work into amount that I started to study a bachelors degree in media

I didn't do any remote events before the pandemic. I don't do live events anymore, but not because I don't like the work. I think it's as good work as any – with the right people and right equipment.

There weren't any live streams before, there have been almost nothing else during.

I got started in virtual events because of the pandemic. During most of 2022 - 2021 that was all I was doing. I am relatively new to the industry so I can't speak to the number of live streams pre pandemic.

Live streams increased considerably because our event venue could not have audience, so all events were streamed instead. Several events were also cancelled all together. In light design specifically we made sure the lights looked good on camera through monitors, which meant it often looked completely bland for human eye.

More to do

The pandemic transformed some events that would most likely have been organized as live events into online events. But of course only a few live events became online events, so there was a lot of lack of work.

Double

Worldwide tech leap

It practically started my own small business. So, I was a winner in this "shit". I hope I can continue after it...

All live events stopped during the pandemic. During 2020 and 2021, the majority of the event were virtually made. In 2022, I've worked mainly on hybrid events and a few full live events.

PICTURE 23. Survey results 15

7 CONCLUSIONS AND DISCUSSION

Focus of this thesis was to present the fundamentals of streaming technology, to examine the needed equipment and expertise when preparing for a virtual event broadcast, and study how virtual event technologies can be used in event production. The phases of the technical production were presented and analysed and how a portable virtual event setup for Nokia Kehräsaari event on 2.6.2022 was planned and used. A survey for live event professionals was conducted to study how the pandemic affected their work. The results of this study and survey revealed that the number of virtual events increased significantly, but live event professionals work in the traditional on-location events too.

The increases of the companies' investments suggest that virtual events and audio-visual content are here to stay. Audio-visual content, webinars and other forms of virtual events gained their place during the pandemic and those tools are highly likely to be used in the future too. This creates a demand for professional virtual event producers.

The goals of this thesis were achieved. Findings of this study were the basics of streaming, equipment, and professional staff, how to plan virtual events, what to consider when planning an event and the technical planning aspects. My own goal for the future is that this thesis could help people gain knowledge of streaming and webcasting. This thesis can be used as a guide on how to produce a virtual event.

The study was based on the reference material and my personal experience in the virtual event production and technology. I also made practical and informational videos and documents of the issues and their solutions. These videos and documents were uploaded to a non-public OneDrive so that people in the virtual event team could find help for their technical problems.

The survey was conducted ethically and anonymously using Google Forms. The survey has a margin of error because the survey received very few replies. Therefore, the results of the survey can't be used for reliable academic analysis, but are rather interesting, nevertheless.

Global pandemic created a demand for remote event solutions. The pandemic created a huge need for live event professionals too. Knowing how virtual events are produced and how the technical devices can be used in the event production is important, since the demand for the events is most likely to be increased even after the pandemic.

The technology studied in this thesis can be used in all kinds of events, such as live event production, corporate events and for educational purposes, which makes the world of events more accessible for many.

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APPENDICES

Appendix 1. Thesis survey questions

Thesis survey for the live event professionals

1 (4)

My name is Anna Haaraoja and I'm writing my thesis on the fundamentals of streaming.

With this survey I'm conducting research to understand how streaming technology was initialized during the global pandemic amongst the live event professionals.

This survey data is collected and used as research material for my bachelor's thesis. (TAMK, Bachelor's Degree Programme in Media and Arts, Music Production).

The anonymous answers are only used for research purposes. The answers will not be used to single you as a person. The survey will run until the 31st of March 2022.

This survey should take about 5-7 minutes.

The survey consists mostly of yes/no questions.

If you have any questions, please don't hesitate to contact me!

Anna Haaraoja

anna.haaraoja@tuni.fi

*Required

1. What is your current job title? *

Your answer:

2. How many years have you worked in live event productions? *

- 0-1 years
- 1-2 years
- 2-5 years
- 5-10 years
- 10+ years

3. What are your main tasks? (Can select multiple.) *

- Camera operating
- Catering
- Event lead/Executive producer
- Technical production
- Marketing and promotion
- Remote guest coordinator
- PowerPoint operator
- Stream supervisor
- Studio manager/Floor manager
- Director
- Graphic designer
- The graphics operator
- Scenographer/Set designer
- Lighting designer
- Lighting operator
- Audio designer
- Audio engineer
- Photographer
- Management
- HR
- Something else?

Your answer:

4. Do you work in the traditional on-location events? *

- Yes
- No

5. Did the number of **remote events** change compared to on-location events during the pandemic? *

- Increased considerably
- Increased slightly
- No change
- Decreased slightly
- Decreased considerably

6. Did your job description or tasks change because of the pandemic? *

- Yes
- No
- Your own answer:

7. *Dante is an audio over Ethernet and audio over IP technology that allows lossless audio signal transmitting from source to destination.*

Were you familiar with Dante before the pandemic? *

- Yes
- No
- Your own answer:

8. Are you currently using Dante at your work now? *

- Yes
- No

9. *NDI is a video connectivity protocol developed by NewTek.* Were you familiar with NDI before the pandemic? *

- Yes
- No
- Your own answer:
-

10. Are you currently using NDI technology at your work now? *

- Yes
- No

11. *vMix is a video streaming software mixer that can switch, record and stream media content.* Were you familiar with vMix before the pandemic? *

- Yes
- No
- Your own answer:

12. Are you currently using vMix at your work now? *

- Yes
- No
- I'm using some other live production system for video switching. Your answer:

13. Have you been drawing AV-plots, technical maps or designing virtual event setups? *

- Yes
- No

14. If you have been planning AV-plots, technical maps or designed virtual event setups, what tools do you use? (For example, CalcArray, draw.io, Photoshop etc.)

- Your answer:

15. (Optional) Describe with your own words: How much did the global pandemic affect your work and the number of live streams compared to the time before pandemic?

- Your answer: