**3GPP TSG-S4 Meeting #115e**

**, – 27th August 2021**

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| *CR-Form-v12.1* |
| **Pseudo CHANGE REQUEST** |
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|  |  | **CR** |  | **rev** |  | **Current version:** | 0.2.0 |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network | **X** |

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|  |
| ***Title:***  |  |
|  |  |
| ***Source to WG:*** | Ericsson LM, BBC, EBU, Sennheiser, Dolby |
| ***Source to TSG:*** | S4 |
|  |  |
| ***Work item code:*** | FS\_NPN4AVProd |  | ***Date:*** | 12/08/21 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | 17 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
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| ***Reason for change:*** | The current version of the technical report does not separate between cloud and remote production. |
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| ***Summary of change:*** | The description is updated and extended, clarifying the differences between cloud and remote production. |
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| ***Consequences if not approved:*** |  |
|  |  |
| ***Clauses affected:*** |  |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  |  |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
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| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

\*\*\*\* First Change \*\*\*\*

# 5 Relevant media production use cases

## 5.1 General

## 5.2 Use-Case X: Audio Visual production

### 5.2.1 Description

Audio/Visual (AV) production includes television and radio studios, outside and remotely controlled broadcasts, live news gathering, sports events and music festivals, among others. All these applications require a high degree of reliability, since they are related to the capturing and transmission of data at the beginning of a production chain. This differs drastically when compared to other multimedia services because the communication errors will be propagated to the entire audience that is consuming that content both live and recorded for later distribution. Furthermore, the transmitted data is often post-processed with nonlinear filters which could actually amplify defects that would be otherwise not noticed by humans. Therefore, these applications call for high quality data, and very low probability of errors. These devices will also be used alongside existing technologies which have a high level of performance and so any new technologies will need to match or improve upon the existing workflows to drive adoption of the technology.

The performance aspects that are covered by/in TS 22.263 [3] (Service requirements for Video, Imaging and Audio for professional applications) also target the latency that these services experience.

In recent years, production facilities have moved from bespoke unidirectional highly specialised networks to IP-based systems and software-based workflows. This migration is expected to continue, and wireless IP connectivity is key to a number of these workflows.

Typical set ups require multiple devices such as cameras, microphones and control surfaces that require extremely close synchronisation to maintain consistency of pictures and audio. Often devices need to communicate directly to each other for instance a camera to a monitor or a microphone to a Public Address (PA) system.

Video and audio applications also require extremely high quality of service metrics as the loss of a single packet can cause picture or sound breakup in the downstream processing or distribution. Often this is a legal, regulatory or contractual agreement to maintain a high-quality, stable and clear video or audio signal.

Today’s digital AV network transport is typically handled separately for wireless and wired transfers. Wireless AV transmissions are implemented with application-specific solutions that allow deterministic data transport of a single isolated audio or video link. Wired AV transmissions are typically either Ethernet- or IP-based. Network Quality of Service in AV IP networks is mainly achieved with IP DiffServ/DSCP-based prioritization of packets in network switches. This method is sufficient for most AV use cases since jitter resulting from packet collisions is small, for example in the order of 10 µs per concurrent data stream in gigabit Ethernet.

Live video production is a complex subset of production activity that typically is served by evolving specialized technologies, networks and radio solutions. The high bandwidth and low latency required to produce real-time high-definition video requires dedicated point-to-point connections that have evolved from analogue production, via digital, to IP-based solutions. Current IP solutions for the studio are based on managed wired networks and the mobility required by cable-free cameras, microphones and monitoring have been adapted to interface with these networks via gateway devices but still supporting legacy integrations.

The COVID-19 pandemic has also led to an increase in distributed production where control surfaces are not necessarily co-located with the equipment they control. Cloud-based solutions are emerging to support these workflows and this use case should support distributed compute functionality.

Other technologies used include optical fibre for fixed links, satellites and the physical transport of media storage devices with previously recorded content. In this sense, wireless connectivity plays a major part in production where there is a need to have mobility, flexibility and reliability.

### 5.2.2 Wireless camera workflows

#### 5.2.2.1 Scenario 1: Wireless cameras within a production workflow

Different types of network may be deployed depending on how the camera is used. For a single point-to-point (PTP) link, a dedicated peer-to-peer solution can be achieved with a simple transmitter and receiver set up. These may use either omnidirectional or directional antennas. For more complex setups, such as a studio or sporting event, a mesh network with multiple receivers may be set up. This allows the cameras to move freely within the coverage area while maintaining Quality of Service. Finally, for large area events, aerial relays may be deployed to cover a moving camera on the ground.

While these solutions are extremely robust, they do require specialist skills and knowledge to set up.

When deployed in real world scenarios these types of camera are usually matched against other cameras that are connected directly to the production network by fibre or coax connections. It is important that in this scenario the latency of any radio-connected device is minimised and any cuts between a wired and wireless camera are synchronised. This is currently done by sending a special signal to an on-board clock generator that times the various functions of the camera to match other cameras in the network.

There are also requirements for near-real-time responses to instructions or control of a camera. If, for instance, the focus of the camera is controlled remotely then the operator will need to see the image in under 100 ms in order to be able to respond and control the lens on the camera.

The types of camera used for this type of production are usually highly specialised and have a modular design with various elements such as a lens, viewfinder and microphones added as required. Different cameras rely on different protocols to control various elements but there are also some standard protocols that are used where specialist control is not required. Some signals, such as lens control, will pass through the camera unit itself, while others will connect directly to the end user device.

Within Media Production scenarios, the wireless camera act as a UE. Multiple, partially optional application flows are between the wireless camera and one or more network side media production function.



Figure 5.2.2.4-1: Flows by one camera unit

Figure 5.2.2.4-1 illustrates a set of important data flows, namely:

- *PGM Video (Program Video):* The uplink video stream.

- *Return video:* In some production events the camera receives a return video and renders it in the viewfinder. The return video may be a CGI- enhanced version of the captured video, or else a video stream from a different camera. The camera operator considers the return video when composing the camera shot.

- *Teleprompter:* In some production events a speaker in front of the camera reads from a rolling script projected directly in from of the camera lens through a half-silvered mirror.

- *Tally:* the small red light indicating which camera is “on-air”.

- *Telematics – Camera Control:* Different functions of the camera like the shutter speed, iris, etc can be locally or remote controlled. The telematics signal may also contain information about the camera status, such as battery level.

- *Follow Focus:* A focus control mechanism to help the operator be more precise while adjusting the focus and maintaining it while the camera is moving relative to the subject/object.

- *Intercom:* In some production events, the camera operators can talk to each other and the programe director using a separate speech channel.

NOTE: Intercom is traditionally integrated into a camera. However, Intercom might become more and more independent devices in media production, since intercom typically is setup first and torn down last.

- *Timing – Sync:* The camera needs to time synchronized, (A) for timestamping the media packets and (B) for synchronizing the frame capture pulse (GenLock).

- *Audio:* In some production events (specifically news gathering), the camera is equipped with a microphone to capture audio. In other production events (like sports), the microphone positions are different from camera positions to capture “atmosphere”.

- *AR/VR tracking:* Accurate camera positioning is of paramount importance to incorporate virtual and augmented reality studio sets in live productions.

#### 5.2.2.2 Scenario 2: Outside broadcast contribution

Over the past few years, broadcasters have been using mobile networks for some workflows, specifically using 4G networks to send a live video stream to a production centre. This type of communication has helped revolutionise the way news and events are produced, as reporters and teams can work from anywhere, at any time if an acceptable coverage is available. To do this, a backpack or camera-mounted device is used to encode and broadcast video without the need for mobile units (vans) and/or many cables and devices.

However, the use of 4G networks can bring several disadvantages. For example, due to the bandwidth required, mobile solutions require multiple connections and therefore multiple SIM cards to provide adequate service; this method of connection aggregation is known as “link bonding”. Additionally, when these devices are outside the mobile network provider coverage area, other SIM cards are required to use an alternate network. The video must be highly compressed due to network bandwidth restrictions, which degrades content quality in later stages of the production and distribution chains. These technologies tend provide a single video link and so if more than one camera is required it either needs multiple units that are often timed differently or people and infrastructure on site to support multiple camera operation. There is also no differentiation between the networks to which these devices connect and public networks, so in large events 4G connections become unreliable as they struggle for connectivity and bandwidth with other users.

It can be expected that 5G solutions will evolve to meet these workflows with little or no interventions but there is also a demand for a technology that allows multiple audio and video sources to be connected and synchronized as well as better interoperability with existing workflows.

The scenarios for contribution may be focused on newsgathering and lower budget production. In these scenarios content may be more static with less temporal change or fixed backgrounds, so more intense compression may be applied.

#### 5.2.2.3 Considerations on remote and cloud-based production

Productions typically require long preparation times with large audio and video equipment that is physically moved to external event sites, as well as configured and adjusted for a specific production activity. Remote Production enables remote control of audio–visual capture equipment (such as microphones and cameras) deployed at an outside broadcast site from a more convenient production location, typically a broadcast centre. Remote Production thereby reduces the requirement to move all production equipment to the outside broadcast site. This may lead to cost reductions or allow more coverage of complex events. For example, multimedia sources such as cameras or microphones would be deployed at the outside broadcast site, but much of the equipment may be in production centres and be connected over the network to the remote site. Examples include audio and video mixers, switching matrixes, storage devices and multi-viewers.

Some functions are coordinated in master control rooms (MCRs). These MCRs pull together multiple internal and outside sources and organise them for presentation to operational galleries. Large broadcast centres have signal routing matrices that allow multiple audio and video signals to be organised and packaged for both incoming and outgoing feeds.TR 22.827 [4] includes the following definition:

***Remote Production****: Content being acquired is remote to the broadcast centre but configured and controlled from the broadcast centre. This may include video or audio content but also command and control functions to operate the technical facilities located at the outside broadcast site.*

Cloud-based production is a special case of Remote Production in which workflows are executed in a cloud-based infrastructure. This cloud-based infrastructure can be public or private and may even be deployed within the 5G operator’s infrastructure itself (leveraging Edge Computing capabilities).

A 5G NPN could allow audio–visual capture equipment (such as cameras and microphones) deployed at an outside broadcast site to connect to a production facility, whether the latter is local or remote, and whether it is operated within a central broadcast centre with the support of fixed equipement or deployed in a cloud infrastructure. The various application flows, latency and bit rate requirements depend on the scenario envisaged.

<describe the different flows, potentially traffic characteristics (events vs continuous), and potentially the need for separate prioritization>

### 5.2.2 Collaboration models and deployment architectures

Editor’s Note: No input yet.

<Should we add a Remote Production use-deployment, with an SNPN on-prem and then remote functions?>

\*\*\*\*Last Change \*\*\*\*