**3GPP TSG-WG SA4 Meeting #119 *S4-220689***

**Online,**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  | **26.805** | **CR** |  | **rev** | **-** | **Current version:** | **1.2.0** |  |
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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:***  | [FS\_NPN4AVProd]: Proposal of a study conclusion clause |
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| ***Source to WG:*** |  |
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| ***Work item code:*** |  |  | ***Date:*** |  |
|  |  |  |  |  |
| ***Category:*** | F |  | ***Release:*** | Rel-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-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | The Study on Media Production via 5G NPN is finalizing. This document proposes a conclusion, some recommendations for further work and some suggestions. |
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| ***Summary of change:*** | The conclusion section is provided. |
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| ***Consequences if not approved:*** |  |
|  |  |
| ***Clauses affected:*** |  |
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|  | **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 \*\*\*\*

# 7 Guidelines to Media Producers and Device Manufacturers

Based on the disccussion in this TR, the following guidelines are collected to be taken into account by device manufacturers and media producers when using 5G Systems and NPNs for media production:

1. *Avoid multiplexing of different media components (e.g. MEPG‑2 Transport Stream):* the 3GPP network supports different traffic priorization schemes. Key Issue #2 discusses how to use 3GPP Quality of Service (QoS) and Network Slicing features to prioritise the media streams of a production device. It is suggested to separate media components into separate UDP/IP flows for independent prioritisation, e.g. a native RTP payload format, such as that defined in RFC 7798 [47] for H.265/HEVC.

2. When MPEG-2 Transport Stream *is* used, then the following suggestions should be considered:

a) *Allow extra jitter buffer for PCR timeline:* 3GPP networks change the radio Modulation Coding Scheme depending on the current channel conditions of a device, resulting in a varying bit rate. MPEG‑2 Transport Stream is designed for a constant bandwidth channel and extra care needs to be taken to maintain the Program Clock Reference (PCR) timeline.

b) *Do not insert null packets:* It is a common practice to add null packets (padding to make the stream a constant bit rate stream) into the MPEG‑2 Transport Stream in order to fit a constant bit rate transmission channel. Null packets are ignored by the receiver. In a 5G System, these null packets waste capacity that could otherwise be assigned to lower priority traffic and introduce unnecessary radio interference. It is therefore recommended to use a setup which does not insert null packets.

c) *Encapsulate MPEG-2 Transport Stream in an RTP session according to IETF RFC 2250 [x]:* This allows the receiver to estimate and reduce any network-induced jitter and to synchronize relative time drift between the transmitter and receiver using the RTP timestamp.

3. *Use GBR QoS flows to carry constant bit rate streams.* For higher tier productions, there is a strong desire to use constant quality streams, i.e. avoiding dynamic quality-bit rate adaptation as, for example applied in RTP/AVP or Dynamic Adaptive Streaming over HTTP (DASH). Constant quality generally requires a constant bit rate transmission path. In order to secure such a network QoS, it is recommended to use a Guaranteed Bit Rate (GBR) QoS flow and to provision the 5G System in such a way that the bit rate can be maintained with very high reliability. This requires very strict packet admission control to be applied by the network to prevent overloading.

4. *Use dynamic bit rate adaptation to avoid packet loss.* For lower tier productions, or when packet admission control cannot be very strict, it is recommended to employ a bit rate adaptation scheme (see Key Issue #5) to prevent congestion-related packet losses.

5. *Provision network QoS end-to-end.* For remote production scenarios, it is suggested to provision the full end-to-end network path (i.e. the 5G System and also the network segment between the 5G System and the remote production site) with the desired network QoS, and to account for additional network capacity needed to support a bit rate adaptation scheme and packet loss recovery.

6. *Use client-initiated control protocols to avoid problems with firewalls and NAT.* 5G Systems are typically shielded from public data networks using a firewall. Usage of Network Address Translation (NAT) allows for independence of IP address allocation within the 5G network. Media production devices are often remotely configured and controlled from a production gallery so that the user (e.g. cameraman) can concetrate on the creative capturing. Specifically, in remote production scenarios, it is recommended to use client-side initiated protocols such as MQTT [48] or remote configuration and control in order to mitigate issues with NATs and firewalls.

7. *Use unicast IP data flows in preference to multicast IP*. The usage of IP multicast is very common in Media Production Networks. The usage of IP multicast on Wide Area Networks is typically not supported, due to lack of cross-domain routing.

a) The 5G System also supports carriage of Ethernet frames, when selecting PDU type Ethernet. Usage of this PDU type is appropriate for local deployments e.g. within Standalone NPNs. When using PDU type Ethernet, multicast IP packets can be encapsulated into Ethernet frames and sent as Ethernet PDUs (in unicast PDU Sessions) via the 5G System.

b) The 5G System also supports multicast distribution using 5G Multicast–Broadcast Services. However, this is typically intended to simultaneously target a large population of UEs. The use of MBS is therefore not recommended for media production scenarios.

8. *Use precise time synchronisation.* Wireless media production applications often need precise time synchronization of devices. The use of Precision Time Protocol, as defined in SMPTE 2059-2 [26], is supported in the 5G System from Release 17 onwards according to TS 23.501 [84].

a) The 5G System supports various enhancements for *Ethernet-based time synchronization (gPTP)*, and support for delay-sensitive flows is documented clause 5.27 and clause 5.28 of [84].

b) In order to support *IP-based time synchronization* for media production (e.g., as mentioned in clause 6.3.2), the 5G System supports PTP-based time synchronization as documented in clause 5.27.1 of [84]. 5GS also supports different PTP profiles (see clause 5.27.1.4 of [84]), including the SMPTE Profile for Use of IEEE Std 1588 Precision Time Protocol in Professional Broadcast Applications (ST 2059-2:2015).

9. *Use packed-based transmission for audio streams with a single parameter set.* Legacy circuit-switched audio systems cannot be connected to the 5G-system directly: an adapter function is needed to convert from circuit switching to packet-based audio transmission. The 5G System then acts as a transparent transport layer. Audio-over-IP (AoIP) solutions are supported natively when the 5G System is configured and optimized for the traffic specification. For compatibility, it is suggested to use only one AoIP implementation with a defined parameter set. Mixing different parameter sets and AoIP standards may introduce unknown side effects. Details of implementation depend on device manufactor and system provider.

\*\*\*\* Next Change \*\*\*\*

# 7 Summary and Conclusions

The present document contains an elaborative description on different protocols and workflows used in media production at the time of writing. Several different standardization and industry fora are defining Ethernet- and IP-based protocols for media production purposes.

The capabilities of media production devices – more specifically video cameras – are studied extensively. One observation is that the 5G Media Streaming in the uplink direction is relevant to media production scenarios, but typically needs to be deployed together with 5GMS downlink media streaming components for example to support return video

Media production devices such as cameras include support for speech for Intercom or Push-to-Talk use-cases. 3GPP-defined solutions might be relevant, but this has not been studied in detail.

In the context of this study, *device onboarding* refers to the process of allowing a UE to access the network resources of an SNPN or a PNI-NPN. TS 23.501 [x] already supports multiple methods. Details are found for:

- SNPNs in clause 5.30.2.3 of [x] “UE configuration and subscription aspects”.

- PNI-NPNs in clause 5.30.3.3 of [x] “UE configuration, subscription aspects and storage”.

As described in clause 6.9, *5G mmWave* is capable of providing similarly large data rates as Ethernet cables and with a low network Round-Trip Time. Nevertheless, to operate production scenarios at several hundred megabits per second over a mmWave radio link, content delivery protocols and codecs are needed that can compensate for the mmWave channel characteristics.

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\*\*\*\* Next Change \*\*\*\*

Annex X (informative):
Summary of 5G-MAG workshops (information)

# X.1 General

The 5G Media Action Group (5G-MAG) organized several workshops to reach out to various media producers and device manufactures with respect to 5G network usage. This annex contains a summary of the workshops, including links to the 5G-MAG website.

# X.2 First 5G-MAG Workshop

The first 5G‑MAG workshop on the topic of Media Production over 5G Non-Public Networks, held on 21st April 2021, aimed to gather input from different stakeholders in the media and ICT industries around the objectives of the new feasibility study in 3GPP SA4 responsible for generating the present document.

Three sessions tackled different aspects of Media Production over 5G NPNs, with the final one organized as an interactive exchange. The main objectives of the workshop were:

1. To collect input on the objectives of the Study Item from the media vertical around relevant media production use cases, media device and network orchestration solutions and other media-related aspects of Media Production use cases.

2. To introduce relevant 5G System features coming from 3GPP and collect input around e.g. NPNs, Network Slicing, QoS classes, network event reporting and assistance, etc. that may be useful for media production.

3. To facilitate collaboration and discussion around reference architectures for media production (including media and control flows), relevant QoS requirements and KPIs, protocols, codecs and service layers, etc.

Detailed agenda, presentations and recordings of the session can be found here: <https://www.5g-mag.com/post/5g-mag-workshop-media-production-over-5g-npn>

# X.3 Preparation session for a second 5G-MAG Workshop “Media Production and 5G Non-Public Networks: Deep dive into media production protocols”

This interactive workshop, held on 15th December 2021 [[S4-220144](https://www.3gpp.org/ftp/tsg_sa/WG4_CODEC/TSGS4_117-e/Docs/S4-220144.zip)], aimed to gather input from different stakeholders in the media and ICT industries around the work in the 3GPP SA4 study. In particular, we were interested in discussing how the diverse set of media production and transport protocols that may have to interface and be supported by the 5G System.

Agenda:

1. Welcome Ian Wagdin (CP-C Chair, BBC).

2. The technical activities in 5G-MAG Thibaud Biatek (CP-T Chair, ATEME).

3. Technical Report on Media Production and 5G NPNs Thorsten Lohmar (3GPP SA4 Study Item NPN4AVPROD Rapporteur, Ericsson).

4. QoS and Prioritization David Butler, Ivan Hassan (BBC).

Linked to this workshop, 5G-MAG members prepared a questionnaire for attendees in order to get their view around several aspects on the workflows supporting wireless connectivity.

Recordings and presentations are available at <https://www.5g-mag.com/post/5g-mag-workshop-media-production-over-5g-npn-deep-dive-into-protocols>

# X.3 Second 5G-MAG Workshop (19th of January 2022)

5G-MAG requested input from media companies in order to present their workflows and relevant trials linked to the use of wireless connections.

A total of eight presentations were given as follows:

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| --- | --- | --- | --- |
|  | Company | Presenter | Link to presentation |
| 1 | Vislink | David Edwards | [Download Presentation Slides](https://drive.google.com/file/d/1EccXxhrGinD0bsRJaW6Nxf0jw4wU_k8T/view?usp=sharing) |
| 2 | NuLink | Laurent Zwahlen | [Download Presentation Slides](https://drive.google.com/file/d/10knQKYvzkpIWyw5vpk7_wPycDQVflIzX/view?usp=sharing) |
| 3 | Qualcomm | Yiqing Cao | [Download Presentation Slides](https://drive.google.com/file/d/1d-48aGGuV4ba1EC_TF9ORgPEymqIuNx4/view?usp=sharing) |
| 4 | NRK | Erik Vold | [Download Presentation Slides](https://drive.google.com/file/d/1ELKrkyndvgZtJB71ZgIqkN8ggUuOc9Hn/view?usp=sharing) |
| 5 | France TV | Jacques Donat-BouilludSamy Nicolas Bouchalat | [Download Presentation Slides](https://drive.google.com/file/d/1rWlSI3S2t4rL-_LmKelbpI3KeY9VsEp9/view?usp=sharing) |
| 6 | Ross Video | Tom Crocker | [Download Presentation Slides](https://drive.google.com/file/d/1m8ZFH6EvDgYG3W_LFp5NODnZeP_pubqb/view?usp=sharing) |
| 7 | Agile Content | Johan Bilon | [Download Presentation Slides](https://drive.google.com/file/d/1BBGA33xpsInVsTF1gE72GJ-SVAZTxZJN/view?usp=sharing) |
| 8 | BBC R&D | Sam Hurst | [Download Presentation Slides](https://drive.google.com/file/d/17uagiw4fnHgJxhUIdSCTfWppnISHq04e/view?usp=sharing) |

Recordings and presentations are available at <https://www.5g-mag.com/post/follow-up-workshop-media-production-over-5g-npn-deep-dive-into-protocols>.

Summary of the presentations:

1. **Vislink** highlighted the main critical advantages of an SNPN deployment: security, constant bandwidth availability, predictable latency, in general non-contention with other users. In contrast, adaptive bitrate is currently used in cellular bonding scenarios to when non-contention cannot be guaranteed. Vislink provided a proof-of-concept to compare 5G and OFDM, finding similar latencies with a small (but acceptable) difference between the two. The latency of a cellular bonding system may be of several seconds.

2. **NuLink** presented several solutions in which media production devices have been integrated with 5G user equipment to be deployed in private networks. The solutions are integrated with NDI providing different functionalities such as camera/return, teleprompter, return video monitor, intercom, integration of PTZ cameras with joystick control… Solutions for audio are also available enabling microphone input and headphone output or the integration with loudspeakers.

3. **Qualcomm** presented a live 8K production using mmWave. The focus was on the capabilities of mmWave uplink carrier and dual connectivity to achieve peak data rates in the range of Gbps. Qualcomm has been testing different codec configuration options including HEVC/AVC (in the sub-6 commercial bands) and JPEG XS (in mmWave ranges).

4. **NRK** did trials with a proprietary solution (VideoXLink) which allows using SRT. NDI 5, which introduces reliable UDP, will be tested in the future alongside the use of prosumer equipment (e.g. smartphones for video mixing).

5. **France TV** presented a proof-of-concept trial using 5G for uplink contribution with two 4K streams at around 35 Mbit/s. Different tests were performed, including a single SIM card experiment with HD at 10 Mbit/s, 4K with six SIM cards to obtain 90 Mbit/s and 4K with two SIM cards at 35 Mbit/s. Very few details on system internals were presented.

6. **Ross Video** focused on media contribution, streaming and file-based workflows. For remote connected workflows, the presentation highlighted the opportunities around automation of workflows and gathering information and metadata on the actual usage of the equipment, location, configuration… that could be used to optimize such workflows.

7. **Agile Content** presented the two different approaches between “primary production”, involving the production of feeds, with accurate mixing sync and with related processing, bandwidth and storage capacity, and “secondary production” on the field of streaming, personalization, feeds from social networks, segmentation, etc. On “primary production” Agile Content was concentrated on enabling different versions (low-quality-low-latency vs high-quality-higher-latency) that allows new ways of performing mixing from remote locations. For this an open-source protocol, called ElasticFrame, is proposed.

8. **BBC R&D** presented research work on contribution transport protocols and the proposal to introduce QUIC-based RTP tunneling for high-quality and low-latency ingest of media over public networks.

# X.4 Press releases and announcements of various trials

5G‑MAG is maintaining a list of trials, which are announced through different press releases. The list is continuously updated with new trials and press-releases.

The list of trials can be found here: <https://www.5g-mag.com/trials>

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