3GPP HIGHLIGHTS

Standards for 5G

ISSUE 03
October 2021

TECHNICAL NEWS

Both our Radio Access Networks Chair and Service and System Aspects Chair have contributed, to herald the start of 5G's second phase (5G-Advanced), as the groups look ahead towards what will be in the Release 18 package of features.

We also have articles from Working Groups SA2, SA4, SA5 & SA6 in this issue, as well as an interview with our RAN3 Chair.

PARTNER FOCUS

In November 2021 we will be at our first physical conference and exhibition since the end of 2019. Inside this edition we welcome back the Critical Communications World conference, the TCCA's flagship event.

There are also articles from several of the 3GPP partners (AECC, IPv6 Forum, ESOA) and an interview with WEN Ku, Secretary-General of 3GPP Organizational Partner CCSA.

A LOOK INSIDE

We have details of the timeline for Release 17 completion and on the newly agreed Release 18 schedule.

There is news of a highly merited achievement award. We also look at one of the new tools (NWM), helping delegates to organize and keep-up with e-meeting discussions.

Finally, we have details of which companies have joined the work and the latest calendar of meetings.

FORE - WORD

Looking forward to meeting again

Welcome to the third issue of 3GPP Highlights, a publication that aims to bring you news from the project and to provide an insight into how 3GPP is opening up to new challenges.

Summer, in the North, has brought some relief from new Covid-19 outbreaks and new variants, offering us the hope that - with continued vigilance - we can continue to plan for a return to physical meetings when the time is right.

INSIDE ISSUE 3

We have two interviews that reflect our changing leadership. Our newly appointed WG RAN3 Chair, Gao Yin, tells us about the new innovations to be specified in the group, but also about the pressure created by a very busy meeting cycle. In our second interview, we welcome Wen Ku, the new Secretary-General of the CCSA. He talks about his priority to strengthen international exchanges and cooperation and offers some encouragement to 3GPP to renew efforts to improve efficiency in working methods and to strive harder to balance the needs of the members.

Two of our TSG Chairs have also contributed. On the early pages of Issue 3 we have a detailed first look at the RAN features under consideration for their 'package approval' for Release 18, followed by our TSG SA Chair's thoughts about the recent decision on the timeline for Release 18 and the start of detailed discussions about its candidate features, for approval in December 2021.

> *"The market partners in 3GPP bring us new ideas and encouragement that 3GPP is on the best course with our work planning."*

The market partners in 3GPP bring us new ideas and encouragement that 3GPP is on the best course with our work planning. In this issue we hear from the ESOA about 3GPP progress on Non-Terrestrial Networks, as satellite work items and technical specifications make it into Release 17, with evolution on NR-NTN and IoT-NTN high on the agenda for the next release.

Other Highlights content includes news from the automotive edge, the case for a solid mission critical services test platform and a piece about how IPv6 can help unleash the potential of 5G.

We hope that you enjoy Issue 3 of 'Highlights'. If so, please tell a friend to subscribe. If not, please tell me and I will work to be better next time.

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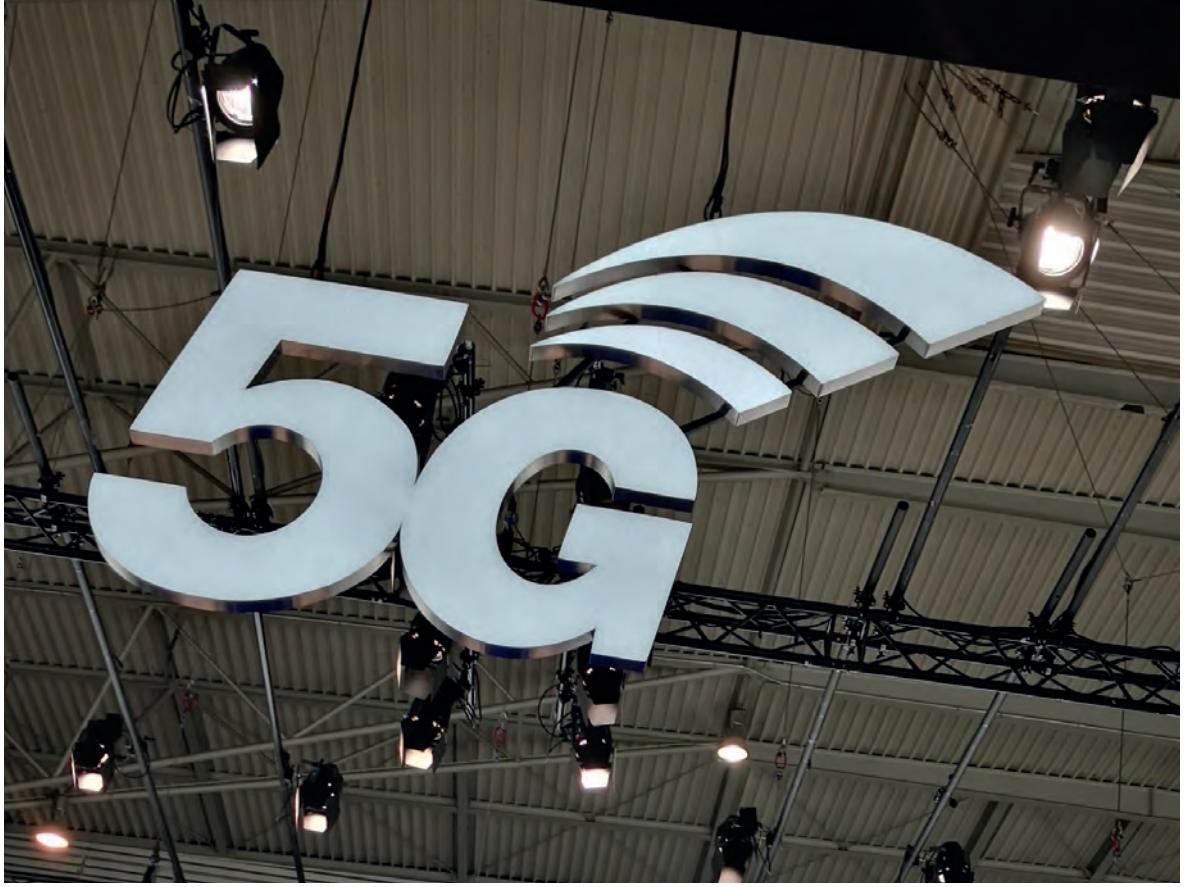


CONTENTS

AN EARLY VIEW OF THE RAN TOPICS FOR 5G-ADVANCED

By Wanshi Chen, 3GPP TSG RAN Chair

3GPP is playing an increasingly important role in driving the standardization and commercialization of 5G NR, not only for traditional enhanced mobile broadband (eMBB) services, but also for expansion into new services in the so-called vertical domain (e.g., V2X, industrial, broadcast and multicast, etc.). This is evidenced by the successful completion of the first 5G NR releases (Releases 15 and 16) and the meticulous work in completing the latest 5G NR release (Release 17) despite the extreme challenges faced due to the COVID-19 Pandemic.

The Release 18 workshop comes at the right time, as 5G NR enters its "2nd phase" of standardization in 3GPP. 5G NR in Release 15 built a solid foundation in accommodating diverse services, a wide range of spectrum, and various deployments scenarios. Expansion into vertical domains got a tremendous boost in Release 16, which was further accelerated in Release 17. In April 2021, the Project Coordination Group (PCG) in 3GPP approved the term 5G-Advanced and a new logo to be used from Release 18, the "2nd phase" of 5G NR's evolution in TSG RAN.

> *"5G-Advanced: A great opportunity for the group to look into projects - not just for incremental enhancements, but aiming a bit further towards the horizon."*

During an already busy time, we recently organized our 3GPP RAN Release 18 workshop (June 28 – July 2), a first step towards the finalization of TSG RAN projects starting from December 2021 and March 2022, the time when Release 17 reaches its functional freeze date in RAN WG1, and in RAN WG2/WG3/WG4, respectively.

The start of 5G-Advanced from Release 18 in 3GPP warranted a more thoughtful organization of the RAN workshop. It offers a great opportunity for the group to look into projects not just for incremental enhancements but aiming a bit further towards the horizon. To that end, the agenda was drafted by inviting proposals in three different tracks:

- **eMBB-driven evolution;**
- **Non-eMBB-driven evolution;**
- **Cross-functionalities for both eMBB-driven and non-eMBB-driven evolution.**

The RAN workshop drew tremendous amount of interest. There were more than 500 contributions submitted before the deadline, sourced from about 80 different companies and organizations. Similar to other 3GPP meetings in 2020 and 2021, the workshop was hosted electronically via emails and conference calls. The number of checked-in participants for the conference calls was more than 1,200!

It is evident that the submissions to the RAN Rel-18 workshop exhibit a generally balanced evolution, in terms of the following aspects:

- **Balanced mobile broadband evolution vs. further vertical domain expansion,**
- **Balanced immediate vs. longer term commercial needs, and,**
- **Balanced device evolution vs. network evolution.**

This is consistent with the general objectives for 5G-Avanced. I expect that the demand for a well balanced evolution will be reflected in the subsequent email discussions and also in the final Rel-18 package.

TOPICS UNDER DISCUSSION

As well as taking a tentative decision on an 18-month duration for Release 18, the RAN workshop endorsed a list of topics for subsequent email discussions. Some of the topics in the following list also have a set of example areas, serving as a starting point for further refinement:

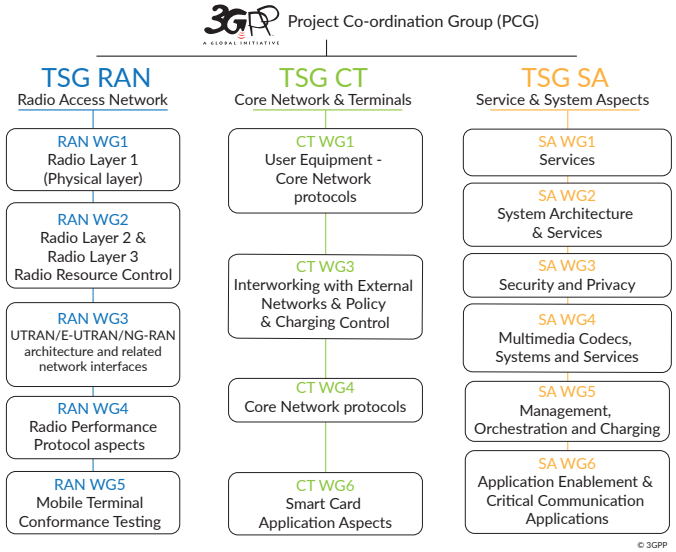
- **Evolution for downlink MIMO,** with the following example areas:
  - o Further enhancements for CSI (e.g., mobility, overhead, etc.)
  - o Evolved handling of multi-TRP (Transmission Reception Points) and multi-beam
  - o CPE (customer premises equipment) -specific considerations
- **Uplink enhancements**, with the following example areas:
  - o >4 Tx operation
  - o Enhanced multi-panel/multi-TRP uplink operation
  - o Frequency-selective precoding
  - o Further coverage enhancements
- **Mobility enhancements**, with the following example areas:
  - o Layer 1/layer 2 based inter cell mobility
  - o DAPS (Dual Active Protocol Stack)/CHO (Conditional HandOver) related improvements
  - o FR2 (frequency range 2)-specific enhancements
- **Additional topological improvements** (IAB and smart repeaters), with the following example areas:
  - o Mobile IAB (Integrated Access Backhaul)/Vehicle mounted relay (VMR)
  - o Smart repeater with side control information
- **Enhancements for XR (eXtended Reality)**, with the following example areas:
  - o KPIs/QoS, application awareness operation, and aspects related to power consumption, coverage, capacity, and mobility
    - * Note: only power consumption/coverage/mobility aspects specific to XR
- **Sidelink enhancements (excluding positioning)**, with the following example areas:
  - o SL enhancements (e.g., unlicensed, power saving enhancements, efficiency enhancements, etc.)
  - o SL relay enhancements
  - o Co-existence of LTE V2X & NR V2X
- **RedCap evolution (excluding positioning)**, with the following example areas:
  - o New use cases and new UE bandwidths (5MHz?)
  - o Power saving enhancements
- **NTN (Non-Terrestrial Networks) evolution**
  - o Including both NR & IoT (Internet of Things) aspects
- **Evolution for broadcast and multicast services**
  - o Including both LTE based 5G broadcast and NR MBS (Multicast Broadcast Services)
- **Expanded and improved Positioning**, with the following example areas:
  - o Sidelink positioning/ranging
  - o Improved accuracy, integrity, and power efficiency
  - o RedCap positioning
- **Evolution of duplex operation**, with the following example areas:
  - o Deployment scenarios, including duplex mode (TDD only?)
  - o Interference management
- **AI (Artificial Intelligence)/ML (Machine Learning)**, with the following example areas:
  - o Air interface (e.g., Use cases to focus, KPIs and Evaluation methodology, network and UE involvement, etc.)
  - o NG-RAN
- **Network energy savings**, with the following example areas:
  - o KPIs and evaluation methodology, focus areas and potential solutions
- **Additional RAN1/2/3 candidate topics, Set 1:**
  - o UE power savings
  - o Enhancing and extending the support beyond 52.6GHz
  - o CA (Carrier Aggregation)/DC (Dual-Connectivity) enhancements (e.g., MR-MC (Multi-Radio/Multi-Connectivity), etc.)
  - o Flexible spectrum integration
  - o RIS (Reconfigurable Intelligent Surfaces)
  - o Others (RAN1-led)
- **Additional RAN1/2/3 candidate topics, Set 2:**
  - o UAV (Unmanned Aerial Vehicle)
  - o IIoT (Industrial Internet of Things)/URLLC (Ultra-Reliable Low-Latency Communication)
  - o <5MHz in dedicated spectrum
  - o Other IoT enhancements/types
  - o HAPS (High Altitude Platform System)
  - o Network coding
- **Additional RAN1/2/3 candidate topics, Set 3**:
  - o Inter-gNB coordination, with the following example areas:
    - * Inter-gNB/gNB-DU multi-carrier operation
    - * Inter-gNB/gNB-DU multi-TRP operation
    - * Enhancement for resiliency of gNB-CU
  - o Network slicing enhancements
  - o MUSIM (Multiple Universal Subscriber Identity Modules)
  - o UE aggregation
  - o Security enhancements
  - o SON (Self-Organizing Networks)/MDT (Minimization of Drive Test)
  - o Others (RAN2/3-led)
- **Potential RAN4 enhancements**

DECISIONS IN DECEMBER

It is reasonable to assume that many of the topics listed above will be part of Release 18. Additional steps, via emails and electronic meetings, are now planned to ensure that the Release 18 package can be approved in December 2021. TSG RAN is primarily focusing on projects led by RAN WG1, WG2 and WG3 in December 2021, followed by focusing on projects led by RAN WG4 in March 2022.

All of the above demonstrates that the process of reaching a consensus for RAN Release 18 projects is very involved, which is a reflection of the importance of the start of the work towards 5G-Advanced. The release will have a focus on a balanced evolution, one that delivers clarity and openness as we see the further spread of the 3GPP system into new areas.

More about TSG RAN here: www.3gpp.org/specifications-groups



5G ADVANCED IN THE MAKING – THE TSG SA APPROACH TO RELEASE 18

By Georg Mayer, 3GPP TSG SA Chair

Over the last 20 years 3GPP has continuously produced specifications to enable companies to implement and deploy a global mobile communication infrastructure, which in its fifth generation not only serves smartphone users with faster connections, more bandwidth and higher reliability but also enables mobile services for a large and growing number of industries.

5G roll out is accelerating, already over 30% of all countries have 5G coverage. Public Safety networks are being migrated to 5G technologies. Car, train, ship manufacturers and infrastructure providers develop new products which wouldn't be possible without the specifications developed by 3GPP.

Our eyes are now also turned to the skies, as satellite operators and manufacturers work to provide 5G access, so that every location on our planet will provide a connection to the 5G eco-system. Many of these advancements were just visions and buzzwords in 2015, when 3GPP started working on 5G in Release 15. By the end of 2017 the first set of 5G specifications was released, enabling operators to roll out early deployments, bringing the first 5G phones to the market in less than four years from the start of specification work.

Based on our release concept, where one release usually has a length of 15 to 24 months, 3GPP has now further evolved the 5G radio and network related architectures, introducing modern generic service enabling technologies and integrating more requirements from different industrial sectors, such as manufacturing, health care, utilities and agriculture.

3GPP Release 18 – Over 70 Items Proposed

Now, as Release 17 is nearing its completion, we see new ideas, technologies and requirements on the horizon which ask not only for a straight evolution of the existing 5G system but need special focus. With this in mind, 3GPP decided to take an important next step in the succession of mobile communication generations by making Release 18 (Rel-18) the first "5G Advanced" branded release.

In September 2021 a two day Workshop on 3GPP Rel-18 was held by 3GPP Technical Specification Group Service and System Aspects (TSG SA), during which all companies could present their visions and plans for the new release. Over 40 contributions from different members of 3GPP were received and showed the variety and diversity of what the different industries expect 5G to become over the next few years.

The candidate items for Rel-18 include:

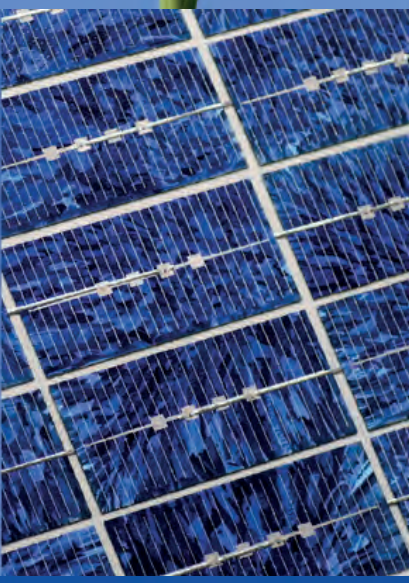
- Immersive Media and Virtual/Artificial/Extended Reality (XR) Media support in Working Group (WG) SA4 and WG SA2.
- New work areas for Internet of Things (e.g. passive IoT (WG SA2) and application capability exposure for IoT platforms (WG SA6)).
- Proposals to for Artificial Intelligence and Machine Learning Services Transport and Management (WGs SA2, SA5).
- Concepts for integration and migration of existing vertical infrastructure, e.g. for railway networks (WG SA6).
- Examples for proposed enhancements to existing 3GPP services and functionalities include:
  - o Network Slicing (WGs SA2, SA5)
  - o Edge Computing (WGs SA2, SA5, SA6)
  - o Autonomous Networks (WG SA5)
  - o Service Based Architecture (WGs SA2, SA5)
  - o Northbound APIs (WG SA6)
  - o Non-Public Networks (WG SA2)
  - o Satellite 5G Networks (WG SA2)
  - o Drone support (WG SA2)
  - o 5G Multicast and Broadcast (WG SA2)
  - o Location Services (WG SA2, SA6)
  - o Management Data Analytics (WG SA5)
  - o Mission Critical Services (WG SA6)

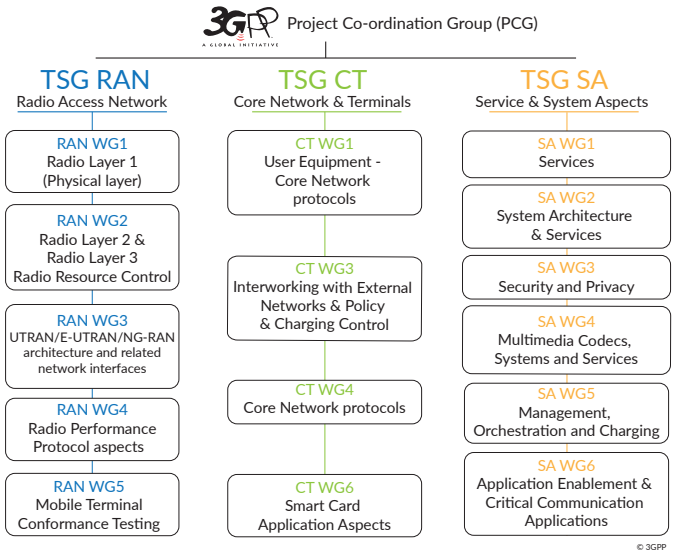
This provides only a very short overview of the over 70 study and work items which are currently proposed in 3GPP to become part of the first 5G Advanced release.

> *"...the topic of energy efficiency will get more attention from Rel-18 onwards."*

Also, the topic of energy efficiency will get more attention from Rel-18 onwards. 3GPP TSG SA is currently discussing different mechanisms to ensure that all its technologies are developed to be inherently energy efficient.

As every release has only limited time, not all proposed items will make it into the final Rel-18 content, to be approved by 3GPP TSGs SA, RAN and CT in December 2021. Therefore, at this moment in time no reliable statements can yet be made about the content of Rel-18 will be.





Release 18 timeline decided

During the September meetings, all three 3GPP Technical Specification Groups have approved the Rel-18 timeline, which sets the date for completion of all protocol related work (so-called "stage 3 freeze") to December 2023.

> *"Over 40 proposals for Rel-18 items are currently under discussion."*

This decision was taken although the ongoing Covid-19 pandemic situation still forces 3GPP to operate in a setting where only electronic meetings are possible. With the timeline being fixed it is now possible to plan the amount of technical work which can be done by the individual 3GPP Working Groups. Nevertheless, as said above, the content of Rel-18 is still under discussion.

Release 18 content – decision in December

3GPP WG SA1 started to work on Rel-18 requirements more than a year ago and will finish the related work by December 2021.

In WG SA2, the Architecture Working Group of TSG SA, over 40 proposals for Rel-18 items are currently under discussion. An initial rough estimation of the required time for those items would require more than twice the amount of time available based on the agreed timeline.

As the architectural decisions strongly influence the Rel-18 work in other 3GPP WGs, it was decided to go through a prioritization process of the WG SA2 items. For that purpose TSG SA will hold another 2 day workshop in December 2021 during which the proposed items will be further modified and streamlined.

Not all of the currently available items will become part of Rel-18, but everything that gets into the first 5G Advanced release will need the approval of all companies in 3 GPP SA, as 3GPP is based on consensus led decisions.

The principle of consensus is key in this discussion. Some jokingly say that it guarantees that everybody is equally unhappy with the outcome, but there is a more important role to it. Consensus means that the Rel-18 3GPP specifications will have the support of all companies represented in 3GPP – be it terrestrial or satellite operators, UE, chipset or network vendors or companies from the diverse vertical industrial sectors. This broad agreement shows that companies are willing to support the related features and gives a guarantee for the upcoming years, so that companies can plan their products and services based on 3GPP specifications.

Most of the other 3GPP SA Working Groups are currently also starting their discussions and work on Rel-18 items. Currently it seems that in WGs SA3, SA4, SA5 and SA6 no prioritization of items will be needed, as the proposed new items will fit into the available time.

For all the items which will be part of the approved Rel-18 content, 3GPP will look into security (WG SA3), charging, operation and maintenance (WG SA5) issues. As the work on these areas is dependent on the outcome of TSG RAN, WG SA2 and SA6, the related activities will as usual start later during the Rel-18 timeline.

3GPP TSG SA has some busy discussions ahead to determine which of the candidate features will make it into Rel-18. Once the content of the new release is approved, in December 2021, 3GPP will work on the technical specifications to provide a major update to the 5G eco-system within two years.

More about TSG SA here: www.3gpp.org/specifications-group

APPLICATION ENABLEMENT STANDARDS IN 3GPP – MAXIMIZING THE POTENTIAL OF 5G!

By Suresh Chitturi, 3GPP Working Group SA6 Chair.

With the most recent 5G standards (Release 15 to Release 17), and the advent of the industry 4.0 revolution, there has been a greater emphasis within 3GPP to develop features that go beyond typical end-consumer expectations (e.g. higher speeds, better coverage), and towards capabilities that can enhance the communications for vertical industries such as public safety, automotive, drones, factories of the future, IoT... and in a manner that such capabilities are natively available within the 5G system.

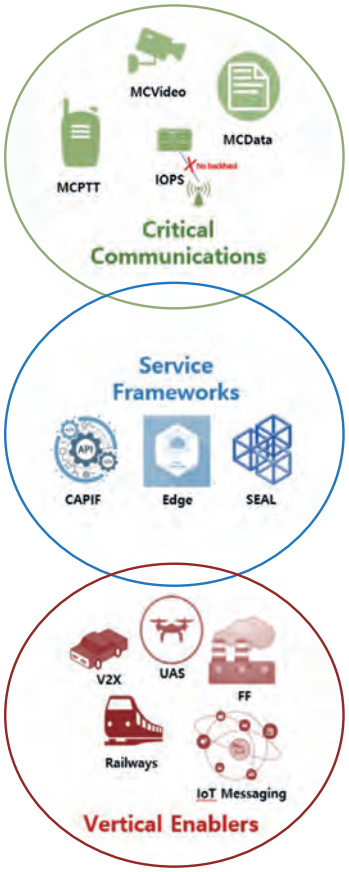
While radio and core network standards are essential to the robust functioning of 3GPP networks, application enablement standards have been receiving significant attention in the recent years.

With the help of these standards, it is now possible for 3rd party application developers and vertical specific application providers to seamlessly integrate and leverage the underlying capabilities of the 3GPP system to its full potential.

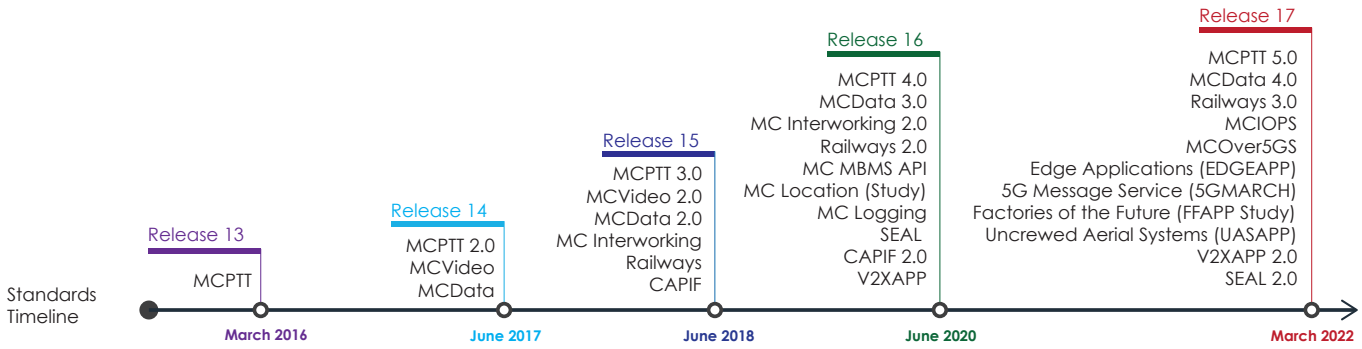
Within the 3GPP Technical Specification Group Service and System Aspects (SA), TSG SA WG6 (SA6) is the application enablement and critical communication applications group for vertical markets.

The main objective of SA6 is to provide application layer architecture specifications for 3GPP verticals, including critical communications applications, service frameworks and vertical application enablers.

Established in December 2014, and since Release 13, SA6 has been the home to global standards for Mission Critical (MCX) Applications such as MCPTT, MCVideo and MCData. While the initial MCX standards were defined to address the needs of public safety industry, we are seeing strong interest in adoption of these standards in other critical communications sectors such as Railways, Utilities, Maritime and Transportation.



Application Enablement Standards



During Release 15, the SA6 Terms of Reference (ToR) were expanded to look beyond critical communications, accelerating the development of application enablement initiatives such as Service Frameworks and Vertical Enablers.

SERVICE **FRAMEWORKS**

- Common API Framework (CAPIF) - a unified Northbound API framework across network/application functions to facilitate a harmonized approach for API development within 3GPP. This ensures that there is a single entry point for vertical applications (a.k.a. API invokers) towards the common API aspects (also called CAPIF APIs) such as onboarding, discovery, authentication and authorization (Refer to 3GPP TS 23.222).
- Service Enabler Architecture Layer (SEAL) - specifies application plane and signalling plane entities for application-enabling services (e.g. group management, configuration management, location management, identity/key management, network resource management); that can be reused across vertical applications (Refer to 3GPP TS 23.434).
- Edge Application Enablement (EDGEAPP) – provides an edge enabling layer and application architecture for enabling Edge Applications on the Edge Data Network, including the exposure of northbound APIs towards Edge Applications, integration with the 3GPP Network, and to facilitate communication between the Application Clients running on the UE and the Edge Application Servers deployed on the Edge Data Network with capabilities such as service provisioning, rich application discovery, and service continuity (Refer to 3GPP TS 23.558).

VERTICAL **ENABLERS**

- V2XAPP - Application layer support for V2X services: enables the efficient use and deployment of V2X applications over 3GPP systems including Platooning, Advanced Remote Driving (ToD), and High Definition Maps. The focus of V2XAPP is to provide key capabilities such as message distribution, service continuity, application resource management, and dynamic group management (Refer to 3GPP TS 23.286)
- UASAPP - Application layer support for Uncrewed Aerial System: specifies application layer capabilities towards UAS applications on the UAV/UAV Controller and the USS/UTM systems to leverage 3GPP transport capabilities, including support for communication between UAVs within a geographical area, QoS provisioning for C2 communication, monitoring of location deviation, and reporting of UAV events (Refer to 3GPP TS 23.255)
- 5GMARCH - Application architecture for MSGin5G Service: offers 5G messaging communication capabilities for massive IoT, including point-to-point, application-to-point, group and broadcast messaging, across multiple UE types (Refer to 3GPP TS 23.554).
- FFAPP - Application layer support for Factories of the Future: identifies key issues and solutions related to support for TSN and TSC communications including network/device monitoring, QoS coordination, group communication, clock synchronization, and integration with existing operation technologies (Refer to 3GPP TR 23.745)

LOOKING **FORWARD...**

As we foray into Release 18 (5G-Advanced) and beyond, the applications hosted on 3GPP networks will be increasingly diverse and infinite, and the role of SA6 will be to identify the right set of application enablement initiatives to maximize 5G adoption across existing and new verticals.

To this end, we are seeing both enhancements to current focus areas in Rel-17 and expansion to new areas such as network slice capability exposure, subscriber-aware northbound API, application capability exposure for IoT platforms, fused location capability framework, efficient data delivery for applications, enablement of application data analytics enablement, and support for new verticals such as smart grid. If you want to shape the future of application enablement standards, **join us @ 3GPP SA6!**

More about TSG SA WG6 at:
https://www.3gpp.org/specifications-groups

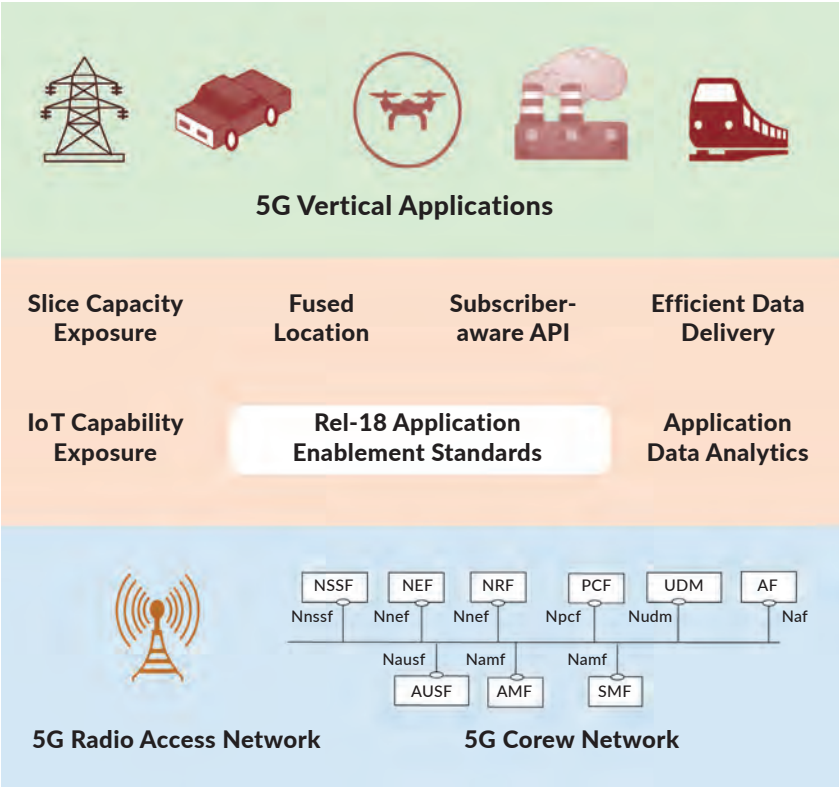


Fig: Rel-18 Application Enablement Standards

RAN3 FLOURISHING IN THIS TIME OF CHANGE

Interview with Gao Yin, 3GPP WG RAN3 Chair.

In May 2021 Gao Yin was elected Chair of RAN3, the 3GPP Working Group responsible for looking at the RAN architecture and for the specification of protocols for the related network interfaces.

She has attended the group's meetings since 2007 and has served two terms as Vice-Chair, in the period immediately leading up to her recent election to the position of Chair. Gao Yin's employer is ZTE Corporation. She is based in Shanghai, where she Leads the RAN project team - contributing to 3GPP specifications.

Highlights: Gao Yin, you have been active in 3GPP RAN3 for fourteen years. With the experience you have, can you sum up the main tasks that RAN3 undertakes?

GAO YIN: RAN3 is responsible for the development of specifications dealing with the overall Next Generation RAN architecture and for the interfaces between RAN nodes. The standardization of wireless network architecture plays a vital role in determining the direction of future network deployments. The open interfaces enable different network vendors to coordinate efforts towards seamless mobility, where inter-vendor operational requirements on wireless telecommunications networks can be met.

3GPP provides an international platform where innovative technologies proposed by the industry can be studied and standardized. With the standardization of these technologies, the network operators, manufacturers, device vendors, industry verticals and others... are working together to drive the industry forward. This is what all standards projects do, but I would say that 3GPP has a very good record of making this happen.

RAN3 has been evolving to meet the strong demand of these new technologies. In the process of 5G standardization, there were various new innovations coming forward to be specified in RAN3, including new QoS architecture support, CU-DU/CP-UP split and network slicing.

In the current Release 17 work, a new study on the applications of Artificial Intelligence and Machine Learning in the RAN, led by RAN3, is also worthy of note (See the Highlights Issue 2 article on that).

Highlights: Looking forward, is one of the major issues on your mind the increasing scale of the effort needed, and how to sustain the level of output achieved - beyond the initial 5G Releases?

> *"Major topics of the moment, based on the current time allocation, are Data Collection for SON/MDT, NR Multicast and Broadcast Services, Integrated Access and Backhaul Enhancements for NR, NR QoE Management and Optimizations for Diverse Services"*

Highlights: No group works alone, but RAN3 does take the lead on improving the interfaces for a wide variety of topics – handling around a thousand contributions each meeting. What are the major topics of the moment?

GAO YIN: Indeed, we have a massive number of contributions in each meeting. That has led to a decision that there is "No more time budget in RAN3" available to take-up in the up-coming meetings in R17. The major topics of the moment, based on the current time allocation, are Data Collection for SON/MDT, NR Multicast and Broadcast Services, Integrated Access and Backhaul Enhancements for NR, NR QoE Management and Optimizations for Diverse Services.

GAO YIN: Increasing the scale of the effort to meet the demands going forward is indeed a challenge. The load of 'Technical Enhancements or Improvement Change Requests' (TEI CRs) on frozen releases is very high in recent e-meetings - about 25% of our work in on Rel-15/Rel-16 corrections – this is a pressure point which needs to be alleviated with some improvements going forward.

We are working on ideas around quota limitation and on issue prioritization and these efforts are reflected in our RAN3 e-meeting guidelines. Later on, when we come back to F2F meetings, the good mechanisms from e-meetings will continue to contribute. I believe that this period of e-meetings will help us to innovate the way we work in the future.

Highlights: As Release 17 takes centre stage for the next few months, will the continuation of e-meetings create pressure on the RAN groups and RAN3 specifically?

GAO YIN: The pressure is always there when each release is close to its freeze date, and the situation is exasperated by e-meetings – as more time is needed to allow us to work across the time-zones.

Highlights: The timeline for Release 17 is firm, but is there a need for a prioritization or the possible down-scoping for Release 17 items? How would this effect RAN3?

GAO YIN: Potential prioritization or down-scoping for Release 17 items has already been taken into account during RAN#92-e in June and more discussion is expected in RAN#93-e in September.

> *"It is important – across the project – for us to focus on features with high priority, those that are essential issues - to ensure Release 17 is delivered in a timely manner."*

The current Rel-17 items progress in RAN3 is fairly good, but I can imagine that there will be a busy meeting cycle in the first quarter of next year. We have two RAN3 meetings planned and we will stick to that even if there is the chance to return to face-to-face meetings.

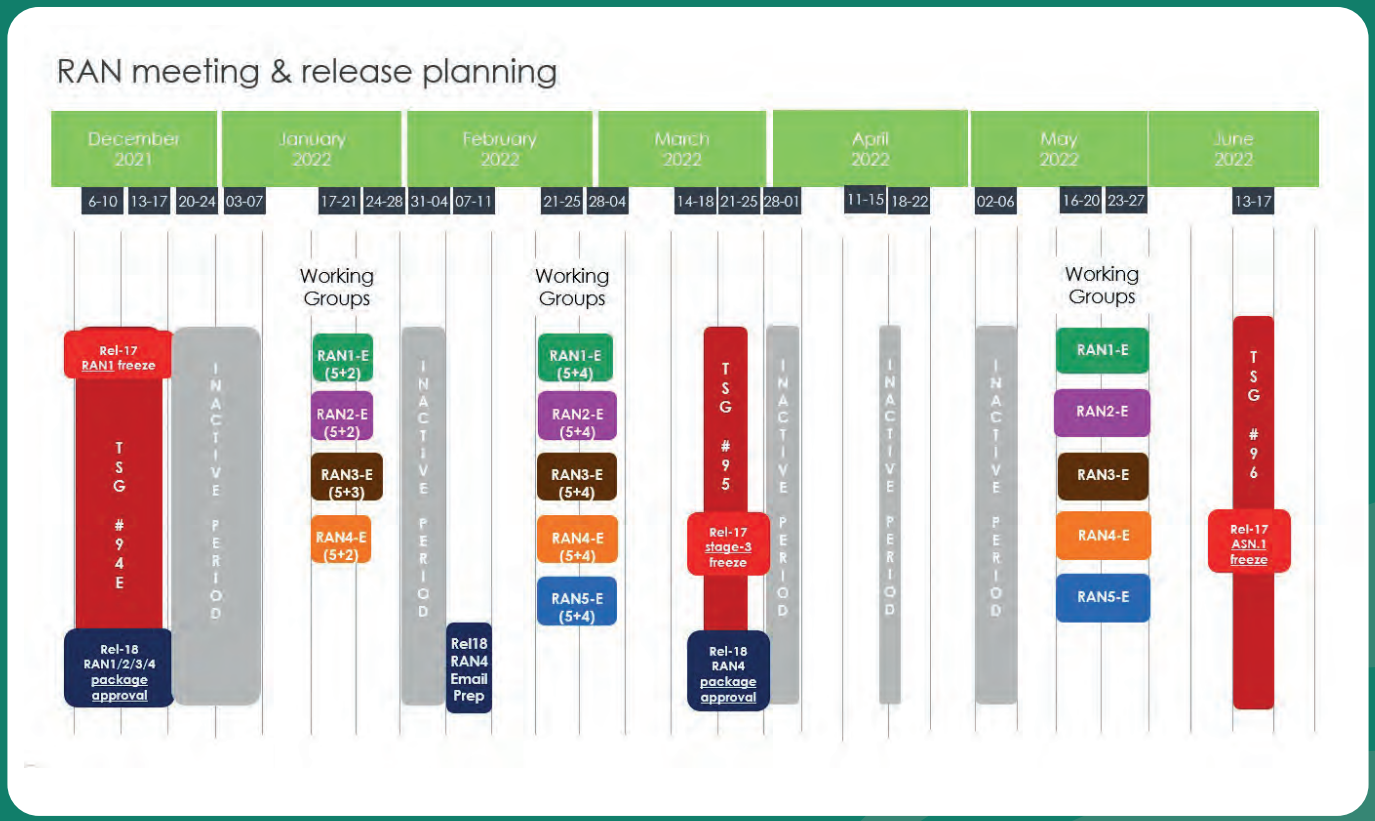
For RAN3, companies will follow the latest agreements from the RAN plenary meeting for each Rel-17 item. This is business as usual really, same as other releases, for those issues with the lower priority subject will be dropped or postponed to the next release according to group decision. It is important – across the project – for us to focus on features with high priority, those that are essential issues - to ensure Release 17 is delivered in a timely manner.

Highlights: Are you looking forward to a return to physical meetings in the new year? Wouldn't it be nice to see colleagues again?!

GAO YIN: Sure, I believe everyone is looking forward to meeting each other in the near future, as soon as the conditions permit, such as the public health advice, travel restrictions and the like. Personally, I am so keen to meet the colleagues- old and new – once again. I am sure we will raise a glass when we finally get back!

Thanks to Gao Yin, who answered our questions via email, over the summer (August) of 2021.

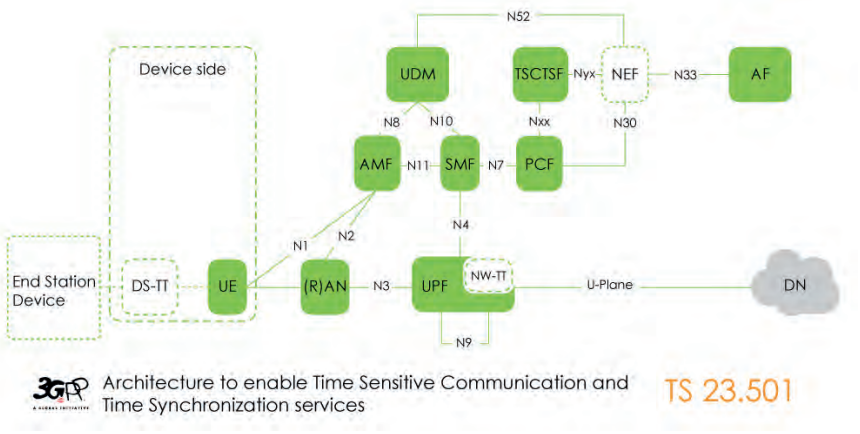
For more information about the work of WG RAN3, go to
www.3gpp.org/specifications-groups



ENHANCED SUPPORT OF INDUSTRIAL IOT IN THE 5G SYSTEM (REL-17)

By Devaki Chandramouli, Work Item Rapporteur

In Release 17, 5G System expands the support for Time Synchronization and Time Sensitive communications for any application. The 5G System architecture enables any Application Function (AF) - in the same or different trust domain - to provide its requirements for QoS, traffic characteristics for QoS scheduling optimization, time synchronization activation and deactivation. If the AF is in a different trust domain from the 5G System, then it provides input via exposure framework, NEF API. If the AF is in the same trust domain as the 5G System, then it provides input directly via the Time Sensitive communication Time Synchronization function (TSCTSF). The Functional Architecture is shown in the figure to the right:

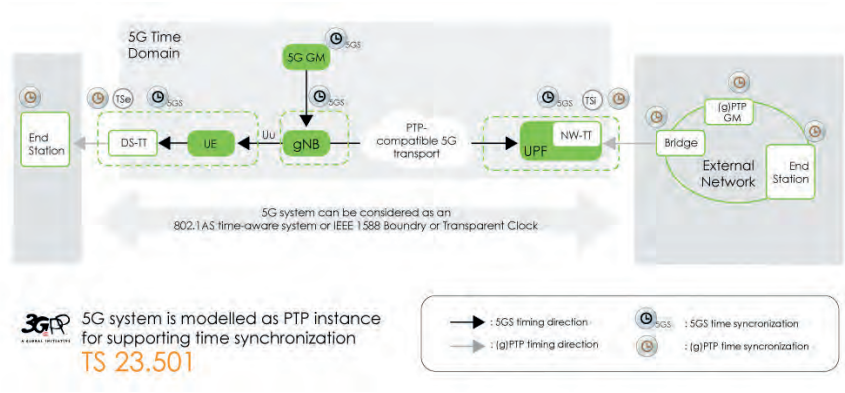


TIME SYNCHRONIZATION

The figure below depicts the two main synchronization methods supported: the 5GS synchronization and the (g)PTP domain synchronization.

- 5G Clock synchronization: Used for NG RAN synchronization and also distributed to the UE. 5G Clock synchronization over the radio interface towards the UE is specified in TS 38.331.
- (g)PTP synchronization: Provides time synchronization service to (g)PTP network. This process follows the standards IEEE Std 802.1AS or IEEE 1588 operation.

The two synchronization processes can be considered independent from each other and the gNB only needs to be synchronized to the 5G Grand Master (GM) clock.



In order to support (g)PtP time synchronization, the 5G System operates in any of the following modes:

1) as time-aware system (IEEE Std 802.1AS).
2) as Boundary Clock (IEEE Std 1588).
3) as peer-to-peer Transparent Clock (IEEE Std 1588).
4) as end-to-end Transparent Clock (IEEE Std 1588).

The 5GS shall be modelled as an IEEE Std 802.1AS or IEEE Std 1588 compliant entity based on the above configuration. The TTs located at the edge of the 5G system (i.e. device side DS-TT and network side NW-TT) are responsible for fulfilling functionalities related to IEEE Std 802.1AS or IEEE Std 1588.

The 5G System is provisioned by the profiles supported by 3GPP specifications that include: Default PTP Profile, IEEE Std 802.1AS PTP profile for transport of timing as defined in IEEE Std 802.1AS, SMPTE Profile for use of IEEE Std 1588 Precision Time Protocol in Professional Broadcast Applications.

Furthermore, (g)PtP time synchronization is supported for the scenarios when Grand Master clock is behind the UE (uplink time sync, UE – UE time sync) and behind the network (down link time sync).

The ability for the AF to influence activation of the 5G reference time distribution to the UE(s) along with time synchronization error budget (based on the accuracy needed for the application) has also been introduced.

TIME SENSITIVE COMMUNICATION QOS

TSC Assistance Information (TSCAI) describes traffic characteristics that may be provided for use by the gNB, to allow more efficiently scheduled radio resources for periodic traffic and applying to PDU session type Ethernet and IP.

TSCAI describes TSC traffic characteristics for use in the 5G System. The knowledge of TSC traffic pattern is useful for 5G-AN to allow it to more efficiently schedule periodic and deterministic traffic flows either via Configured Grants, Semi-Persistent Scheduling or with Dynamic Grants.

5GS determines TSC Assistance Container based on information provided by an AF/NEF and may provide it to PCF for IP type and Ethernet type PDU sessions.

The AF may provide the traffic pattern parameters such as Burst Arrival Time with reference to the ingress port, Periodicity, Flow Direction, Survival Time and Time domain to the NEF. The NEF forwards the received traffic pattern parameters to TSCTSF.

The AF trusted by the operator can be allowed to provide such traffic pattern parameters to TSCTSF directly. The TSCTSF is responsible for determining and forwarding these traffic pattern parameters in TSC Assistance Container to the SMF (via PCF).

Survival Time was also introduced as part of TSCAI in order for the AF to provide the time period an application can survive without any burst. It refers to the time that an application consuming a communication service may continue without an anticipated message. Maximum number of messages (message is equivalent to a burst) or in terms of time units. Single burst is expected within a single time period referred to as the periodicity.

TSC Assistance Information (TSCAI)

Assistance Information	Description
Flow Direction	The direction of the TSC flow (uplink or downlink).
Periodicity	It refers to the time period between start of two bursts.
Burst Arrival time	The latest possible time when the first packet of the data burst arrives at either the ingress of the RAN (downlink flow direction) or egress interface of the UE (uplink flow direction).
Burst Arrival time	Survival Time, as defined in TS 22.261 [2], is synonymous with the time period an application can survive without any burst.

References

- **3GPP TS 23.501, System Architecture for 5G System; Stage 2 (clauses 4.4.8, 5.27, 5.28)**
- **3GPP TS 23.502, Procedures for 5G System; Stage 2**
- **3GPP TS 23.503, Policy and Charging Control Framework for the 5G System; Stage 2**
- **For details of the IEEE work, go to: https://1.ieee802.org/**

▶ Editor's note: Devaki Chandramouli was presented with the 3GPP Excellence Award for her outstanding contribution to WG SA2 work on the 5G System Architecture and Industrial IoT in 2020.

ACRONYMS

5G-AN	5G Access Network
5G GM	Grand Master
5GS	5G System
AF	Analytics Function
CAG	Closed Access Group
DS-TT	Device-Side TSN Translator
gNB	Next generation NodeB
gPTP	generalized Precision Time Protocol
IEEE	Institute of Electrical and Electronics Engineers
LAN	Local Area Network
NEF	Network Exposure Function
NG RAN	Next Generation Radio Access Networks
NID	Network identifier
NW-TT	Network-Side TSN Translator
PCF	Policy Control Function
PLMN	Public Land Mobile Network
PTP	Precision Time Protocol
RAN	Radio Access Network
SA2	Service and System Aspects WG2 (3GPP)
SMF	Session Management Function
SMPTE	Society of Motion Picture and Television Engineers
SNPN	Stand-alone Non-Public Network
TSC	Time Sensitive Communication
TSCAI	Time Sensitive Communication Assistance Information
TSF	Time Synchronization Function
TSN	Time Sensitive Networking
UE	User Equipment
UPF	User Plane Function
VN	Virtual Network

AUTONOMOUS NETWORK STANDARDIZATION IN WG SA5

By Thomas Tovinger, SA5 Chair and Zou Lan, SA5 Vice-Chair

The 5G network is complex due to large number of devices and services. Different autonomy mechanisms are therefore introduced in the industry to reduce the complexity of network management and control.

The ultimate goal of the Autonomous Network (AN) is to enable the telecommunication system to govern itself with minimal to no human intervention by utilizing autonomy mechanisms with AI. Autonomous Networks can reduce the OPEX and improve the service experience for various vertical industries (e.g. autonomous vehicles).

The following SA5 features support the AN in Rel-17: Autonomous network levels, Closed-loop SLS assurance, Intent driven management, Self-Organizing Network and Management Data Analytics. The first three of these are introduced in this article.

Autonomous Network Levels (ANL)

ANL is aiming to provide guidance for how to achieve full autonomy in a step-by-step approach. Using radio network and service optimization management as an example, without adopting ANL, the optimization workflow may need quite some human efforts. Considering that mobile user activity may vary significantly at different locations and different times of day, operators need to adjust coverage configuration parameters with the change of radio network environment.

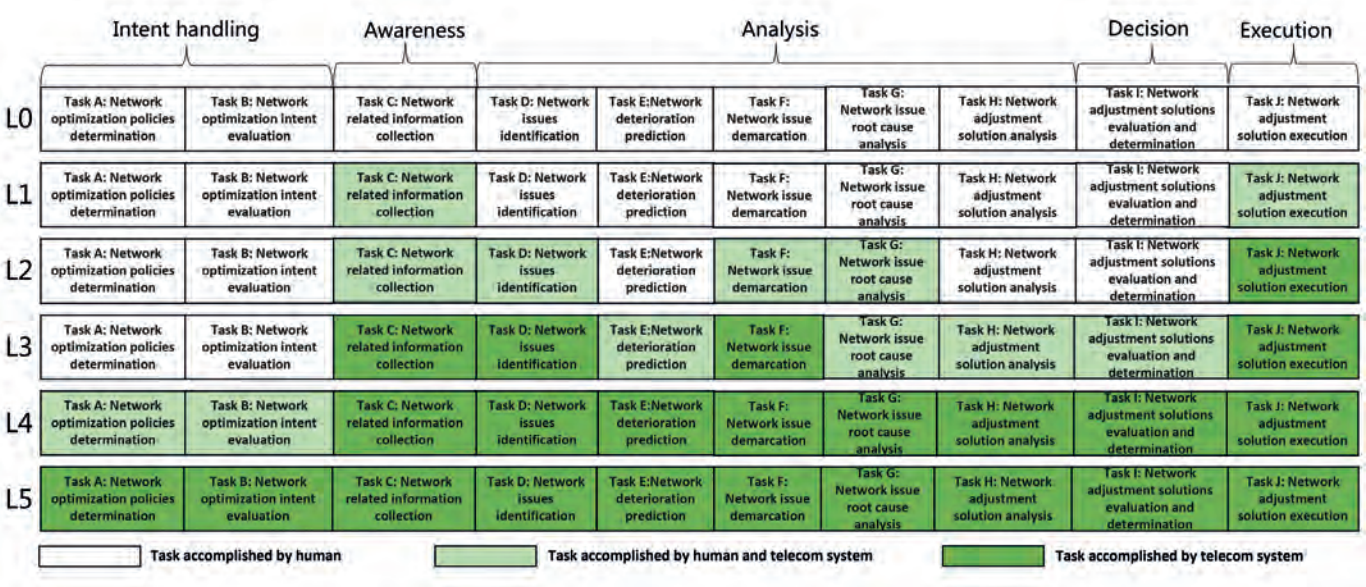
When operators start considering adopting autonomous mechanisms in their process, it is recommended to split the workflow into smaller tasks, then select simpler ones for autonomy at the first step, gradually selecting more complex tasks into full autonomy.

In the figure below, the optimization workflow is divided into 10 tasks (A to J). In level 1, network related information collection (task C) and network adjustment solution execution (task J) are expected to firstly achieve partial autonomy.

With evolving technology, in level 3, network issues identification and demarcation task (D and F) could achieve full autonomy. Based on that, cases related to network deterioration prediction (task E) and network issue root cause analysis (task G) could reach partial autonomy.

Closed-loop SLS assurance

A control loop is a building block for management of networks and services consisting of monitoring, analytic, decision and execution steps. The basic principle of any control loop is to adjust the value of a measured or observed variable to equal the value of a desired goal. E.g. in ANL for network optimization, some closed-loop automation cases can be achieved based on connection to monitoring, analytic, decision and execution related tasks (C, D, F, I and J) from ANL 3.



Intent driven management

Intent is the expectations including requirements, goals and constraints given to a 3GPP system, without specifying how to achieve them. An intent specifies the expectations for a specific service or network management workflow. 3GPP intents could be categorized by user types (e.g. communication service customer, communication service provider or network operator) or by management scenarios (e.g. design phase, deployment phase, maintenance, optimization etc.). An Intent driven Management Service (MnS) is used for exchanging information between MnS Consumer and MnS Producer. Closed-loop automation may be utilized to support the fulfilment of intent. In the example of ANL for network optimization, the intent handling related tasks A and B start being achieved as partial autonomy from ANL 4.

Summary

Reaching full AN needs close collaboration by multiple partners. Standardization of AN helps to guide the industry moving towards this goal in a coordinated manner, as the discussion is open and welcoming all interested parties working together and tackle technical challenges.

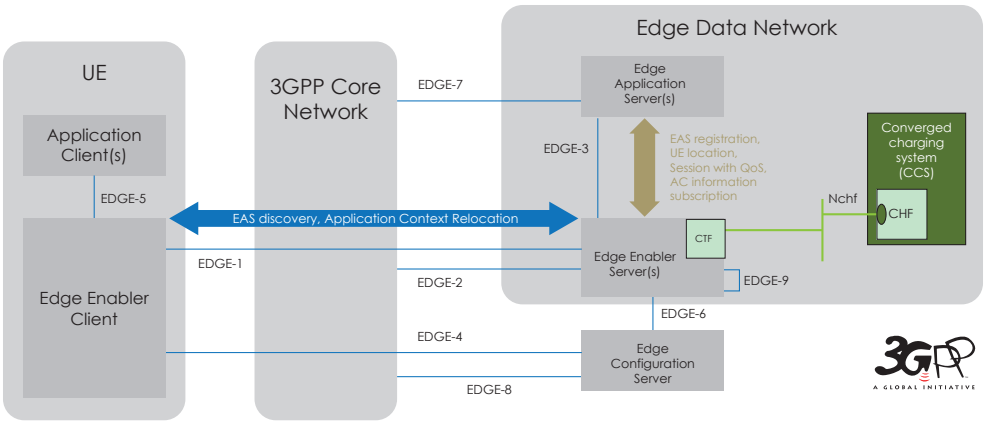
REL-17 EDGE COMPUTING AND NETWORK SLICING CHARGING

By Maryse Gardella, recent past SA5 Vice-Chair and Gerald Görmer, SA5 Vice-Chair.

The start of "Charging aspects of Edge Computing (EC)" normative work was approved at TSG#93e, after the study phase was partially concluded. Beyond monetizing usage by end users of 5GS EC capabilities (e.g. for accessing Edge applications), monetizing usage by providers of EC services is also a key focus.

One of the covered scenarios is the monetization of the usage by Application Service Providers (ASP) of services offered by Edge Computing Service Providers (ECSP), such as edge enabling services (e.g. Edge Application Servers (EAS) registration) or infrastructure resources (e.g. virtual CPU, virtual memory, virtual disk and virtual network resources).

The figure below shows a preliminary framework for monetizing usage of edge enabling services, built on the TS 23.558 architecture - extended with charging capabilities.



Initial charging solutions for Network Slicing were introduced in Rel-16, on Network slice (NS) management (TS 28.202) and NS performance and analytics (TS 28.201). The solutions rely on a new Charging Enabler Function (CEF) which consumes services exposed by Management Service (MnS) Producer and Network Data Analytics Function (NWDAF), interacting with the CHF via the SBI Nchf interface.

The Rel-17 NS charging aspects study investigates further areas for the monetization by Communication Service Providers (CSP) of NS usage by Tenants. Some scalability attributes of the Generic Network Slice Template (GST) defined by GSMA - such as the maximum number of concurrent PDU sessions or maximum number of UEs per NS - are considered for charging solutions. These solutions may allow for flexible rating for the Tenant, depending on actual numbers of PDU sessions or UEs per NS.

NS total volume consumption (aggregated UEs PDU sessions volume) and total duration (from activation of the first PDU session to deactivation of the last active one) are additional NS charging criteria being considered.

More about 3GPP WG SA5 and Management, Orchestration and Charging is found at: www.3gpp.org/specifications-groups




MEDIA PRODUCTION OVER 5G NPN

By Ian Wagdin (BBC), Paola Sunna (EBU), Richard Bradbury (BBC), Thorsten Lohmar (Ericsson, Rapporteur FS_NPN4AVProd)

The creative industries have made use of wireless technologies for several decades with an increasing reliance over time on radio microphones and wireless cameras across all sectors, with sport and event production in particular making use of them to get close to the action.

These devices have evolved over many years in order to support complex workflows used in Programme Making and Special Events (PMSE) with it becoming increasingly difficult to manage the radio frequency bands in which they operate and to assign enough suitable spectrum to support the most demanding production requirements.

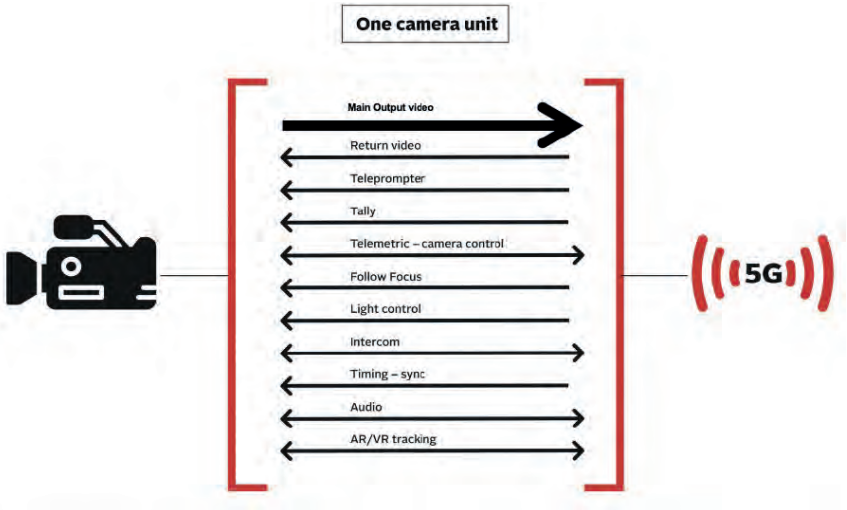
While existing digital wireless production equipment serves a lot of PMSE needs, it does have its limitations. Links tend to be unidirectional and production technicians often have to manage many different radio systems to carry audio, video and other data across multiple frequency ranges. The use of reverse audio, video and control requires dedicated connectivity and infrastructure.

A professional camera can be battery powered, with some functions remotely controlled, requiring instantaneous feedback, and demanding huge uplink bit rates. The prime consumers of power are the media capturing and handling functions. An illustration of the different application data flows for a typical camera unit is depicted below.

The wireless devices and other production networks often have to be interfaced at the receive point rather than at the device itself, meaning that we can't always achieve a complete integration with our wired solutions, which adds complexity and latency.

In the wired domain we are increasingly seeing the move to Internet Protocol (IP) and commodity IT-based solutions for radio and television production studios that offer more flexibility with a single connection. IP-based solutions are capable of carrying a diverse range of bidirectional signals that don't need a dedicated connection for every signal type. IP-based networks also allow us to adopt software-based engineering solutions, and this is increasingly moving to 'on-demand' cloud-based architectures so that we can use technology when we need it and stand it down when we don't.

Our wireless cameras today use COFDM-based radio modulation technology, which has been developed from that used to broadcast digital TV, with our radio microphones sharing the gaps ("white spaces") in the UHF spectrum between broadcast television transmissions. This allocation of spectrum is under review as we move away from traditional broadcast distribution models to IP-based delivery. It is therefore only a matter of time before there isn't enough spectrum for conventional digital wireless production and its technologies, further driving the industry towards IP based workflows.



FACING UP TO THE CHALLENGES

We therefore have two challenges: the move to IP and commodity IT solutions and the need to rethink spectrum. This means we need to look at potential new solutions. 5G is an obvious candidate to support production but we know that we have challenging requirements in terms of quality and reliability.

The media production industry is already transforming and has started embracing more IP and cloud technologies:

- The SMPTE 2110 protocol suite defines a set of media protocols to carry uncompressed and lightly compressed video and audio signals over (fixed) IP infrastructures.
- The AMWA Networked Media Open Specification (NMOS) suite defines a set of media orchestration and control procedures to set up and manage audio–visual flows in IP-based production infrastructure.
- Protocols such as Network Digital Interface (NDI), carrying compressed video, uncompressed multi-channel audio and metadata, are commonly used for smaller scale productions.
- There are numerous protocols that support audio production as well as control and monitoring.

One challenge with media production is that it is not a single identified workflow. The challenges and equipment deployed change depending on the event being covered. A Tier 1 event – like an Olympic Games or football World Cup – is on a completely different scale (in terms of quality and capacity) to a live news insert. Budgets, timescales and skill sets vary wildly: a large sporting event can be planned years in advance with resources deployed to support the event. In this instance, the focus is on resilience and quality. For news production, speed of deployment is often the critical factor, the ability to go live, from anywhere, at any time brings its own challenges.

WORKING WITH 3GPP

The media production industry has been using LTE and 4G for several years to help fill gaps in coverage, to increase flexibility and to reduce cost, and we have been engaged with work in 3GPP to understand how we can use mobile technologies to complement our workflows. These are usually deployed as "best-efforts" links on a Public Land Mobile Network (PLMN), and can work really well for news and small-scale sporting events. However, to meet the demands of existing professional production technologies it may be better to use a Non-Public Network (NPN) to guarantee the network Quality of Service demanded by top-tier live events.

3GPP TSG SA WG1 (SA1) has previously studied media production use-cases in the VIAPA work item and derived requirements in TS 22.263 which identified KPIs, but not the characteristics of the traffic being carried.

> *"The 5G System could be deployed in production studios and outside broadcast locations to carry high bit rate video and/or audio with low latency and high reliability."*

3GPP TSG SA WG4 (SA4) is responsible for the specification of codecs for speech, audio, video, graphics and other media types related to emerging services such as extended reality (XR) and online gaming, as well as the system and delivery aspects of content.

Recently, SA4 began a Release 17 feasibility study called FS_NPN4AVProd focusing on the needs of the media production industry. The 5G System could be deployed in production studios and outside broadcast locations to carry high bit rate video and/or audio with low latency and high reliability. There are often multiple media production devices and other networks that need to interoperate.

The aim for the SA4 study is to identify whether there is a need to develop additional service layer specifications, e.g. extending the uplink streaming capabilities of the 5G Media Streaming Architecture (TS 26.501) for media production.

One clear objective of the study is to identify existing workflows and protocols already used or to be deployed in the media production industry. The general aim is to re-use and possibly extend existing media device control procedures and media protocols when deployed in combination with a 5G System. This is important because 5G services will be an enhancement, rather than a replacement, for many media production functions.

The initial need for the study was identified by the European Union Horizon 2020 5G-RECORDS project which is looking at 5G uses for professional media production. The study started in April 2021 and is aiming to conclude in Spring 2022.

Since April, SA4 has been working with several different industry organizations to collect input. The 3GPP Market Representation Partner for the media industry vertical, 5G-MAG, organized a workshop which was attended by many different media producers and media device OEMs, and has supported drafting activities. Inputs are also circulated through the EBU's 5G Content Production group.

The FS_NPN4AVProd study is documenting its findings in TR 26.805, as well as identifying key issues that can optimize 5G networks to support the requirements of the media production community at all levels. The main challenges identified so far are related to the synchronization of multiple devices, device control and monitoring, traffic separation and prioritization, and the trade-off between quality and latency. Another issue is that media devices tend to be inherently multicast with a single camera or microphone being routed to several receivers simultaneously.

More about 3GPP WG SA4 and Multimedia Codecs, Systems and Services is at: www.3gpp.org/specifications-groups

CHINA STANDARDS IN SUPPORT OF INTERNATIONAL COOPERATION

An interview with WEN Ku, Secretary-General, CCSA

Highlights: Congratulations on your appointment to CCSA Secretary General. Can you tell us about your career and recent role in the Ministry of Industry and Information (MII)?

WEN Ku: In the Ministry, I successively served as the General-Director of the Department of Science and Technology and the General-Director of the Department of Information and Communication Development. During my government career, I have watched at close quarters the rapid development of the ICT industry, which has brought earth-shaking changes to productivity and to people's way of life. In this process, standards have played a vital role.

CCSA was established in 2002. I served as the Vice Chairman of the Board of CCSA for a long time, witnessing and being involved in the growth of the body as it played an important role in the development of China's ICT industry. I am now honored to also serve as Secretary-General of CCSA.

While feeling honored by my new mission, I also feel deeply the great responsibility that comes with it. Strengthening international exchanges and cooperation is the principle that CCSA has always adhered to. I would like to lead CCSA by facilitating our full participation in 3GPP activities and by helping our membership to better integrate into the international standardization ecosystem.

Highlights: What are the key standards related topics or themes that come up in conversations with the CCSA membership?

WEN Ku: Members are the foundation of CCSA, so responding to their concerns is my key task. Since April this year I have visited several member companies, including ZTE, Huawei, Tencent, Nokia Bell and Alibaba. Among these communication and Internet companies there are a variety of Chinese companies, but we also have several sino-foreign joint ventures, which are helping CCSA to fulfil its role of promoting in-depth cross-border cooperation.

CCSA General Assembly 2021

The members briefed me on the technical development trends affecting the ICT industry and outlined their own standardization priorities. They put forward constructive opinions about CCSA's work to strengthen international cooperation, on the China standards system and gave guidance on how we can improve the quality and efficiency of our standardization work.

Highlights: What do you feel the legacy of the Covid 19 Pandemic will be, for the technical work of 3GPP and our working methods?

WEN Ku: The epidemic has brought challenges to 3GPP, and the project has made great efforts to deal with the evolving situation. 3GPP has developed highly disciplined email and virtual meeting procedures, which are enabling 3GPP e-meetings to take place across all of the time-zones.

There are a couple of new features I would pick out, to show how the groups have adapted. A New Working Methods (NWM) online document editing system was developed, which has helped e-meetings to proceed efficiently. Also, for the recent elections of the technical leadership, 3GPP has successfully developed an online voting system, to further minimize the impact of not having face-to-face meetings. These are examples of measures that will continue to be evolved post-epidemic, as a positive legacy from the e-meeting era. The 3GPP Project Coordination Group (PCG) has now started the discussion on how to successfully restart 3GPP face-to-face meetings. CCSA believes that this work is very necessary and will actively participate in and contribute to the discussion.

Looking ahead, the future evolution of the 3GPP system will bring new challenges. In order to meet them face on 3GPP's existing principles of fairness and openness must remain at its foundation - while we study potential improvements, particularly on meeting efficiency, to allow us to meet the ever-increasing project needs. In terms of project setup, I believe one of the big challenges will be for us to balance the development needs of a variety of members, whether traditional telecommunications businesses, the vertical industries or the creators of future 'new technologies' as they seek to join us.

Highlights: We have recently agreed that we will have a new 5G marker, as the mid-point for the work. What are the most important features that will be in Release 18, the starting point for 5G-Advanced?

WEN Ku: 5G-Advanced will continue to enhance the success of 5G and play an increasing role in promoting the in-depth integration of 5G with various industries. Regarding the most important features of Rel-18, different experts may have different opinions, and the final solutions will be determined after full discussion and coordination among the experts. From my personal point of view, Rel-18 shall meet the following three characteristics:

- The first is to meet the application requirements of subdivided IoT, and provide more precise technical solutions for different application scenarios;
- the second is to adopt technologies such as full duplex and integration of communication and sensing to continuously improve the basic transmission efficiency of 5G systems;
- and the third is the deep integration of 5G and artificial intelligence, taking advantages of AI technologies to improve the efficiency of 5G networks and support 5G networks to carry AI applications more efficiently.

Highlights: These three characteristics are bringing in new ideas - New to 3GPP. How optimistic are you that the project will have the capacity to cope with such diverse needs as healthcare, transport, industrial automation and other 'smart' sectors?

WEN Ku: The evolution to the industrial Internet is a global trend and 5G shall meet the demands of these new applications and technologies. From the perspective of demand for new features, it is necessary to incorporate the needs of customers in medical, industrial and other industries at the research stage and to transform these needs into technical characteristics of the network and its subsequent technological evolution.

It is also necessary to pay attention to the differentiated technical requirements of these industries under the optic of a unified 5G technical architecture. To form a large-scale and reproducible industrial ecology, it is necessary to make differentiated partial customizations for different industries; to form a standards system for the private use of the public network, so as to enable 5G base stations, core networks, edge computing and networks and services management platform to adapt to these businesses.

Finally, because of these new needs and the evolving 3GPP system to meet them, it is necessary to establish close relationships with those new industry customers, so that the market can verify and inform future 3GPP work, forming a closed loop for decades of successful standardization work ahead.

Our thanks for this interview, to WEN Ku, Secretary-General, CCSA

CCSA is one of the seven 3GPP Organizational Partners - from Asia, Europe and North America – that determine the general policy and strategy of 3GPP and also transpose the approved 3GPP Technical Specifications into national and regional standards.

http://www.ccsa.org.cn/

"The evolution to the industrial Internet is a global trend and 5G shall meet the demands of these new applications and technologies"

ADDRESSING THE FUTURE

By Eduard Vasilenko and Latif Ladid, IPv6 Forum

Internet Protocol version 6 (IPv6) has made remarkable progress in the past five years, a period that has seen the Mobile network operators becoming its main adopters, due to 3GPP's specification of IPv6 for the mobile networks. Since the early days of 3GPP, the IPv6 Forum has taken part as a market partner in the project. In this short article for Highlights, we will share our vision on the current up-take and the prospect for the future deployment of IPv6.

Growing support brings market success

The mobile Internet is the driving force for market adoption, and user device IPv6 support has been greatly improved by mobile OS vendors effectively making IPv6 mandatory for all applications. The support of IPv6 on websites, with major content providers having deployed it, makes the whole ecosystem (user device – network – content) 'IPv6 ready' for the first time in history.

IPv6 is growing faster than IPv4 ever did, especially among mobile carriers, with 70% of IP traffic now IPv6 – increasing to a peak of 99% for some trail blazing operators. Major Standards development organizations (SDOs) have now prioritized IPv6 over version 4. The Internet Architecture Board of the IETF has reported the increase in both dual-stack (both IPv4 and IPv6) and IPv6-only deployments, as an accelerating trend - Concluding that networking standards need to fully support IPv6 and not assume IPv4 will do the job [1].

Many governments now consider the transition to IPv6 strategically crucial to support 'digital transformation', setting deadlines on when the progress should be completed. In France, the Regulator (ARCEP) mandated IPv6 readiness by end of 2020 in France's 5G spectrum auction [2], while the US and China both imposed deadlines for the transition to IPv6-Only. India has made IPv6 mandatory on all peering links, while Malaysia has requested mandatory IPv6 certification for all user's devices. These are examples that demonstrate a successful global direction of travel for IPv6.

New services for IPv6

There are three types of new services that push for IPv6 adoption:

- Services that need new IP addresses,
- Services that need end-to-end connectivity initiated in both directions,
- Services that need new functionality.

VoLTE and Vo5G are the best examples of services that need huge additional address space. IoT devices (including NB-IoT) and cloud services (especially with micro-services architecture) need additional address space too. In countries like India, subscriber base expansion is the primary reason for IPv6 adoption.

The End to end (e2e) connectivity model has been 'broken' on the Internet for more than a decade. In that time, it has not been possible to initiate a connection to a user that is, in many cases, hidden behind Network Address Translation (NAT). NAT was an industry workaround for multiple users and devices to work off one IPv4 address, creating issues now - particularly for IoT products.

The adoption of IPv6 allows such devices to be uniquely addressable without having to work around all of the traditional NAT issues – so re-establishing e2e real-time apps and services used for a variety of new use cases.

New services (VR, AR, IoT, security, and many others) demand new network functionality that is built in with IPv6-Only development. Low latency, ultra-high bandwidth, deterministic quality, ubiquitous connectivity, security, and automation are all pushing the need for further IP modernization.

IPv4 as a Service (IPv4aaS)

When IPv6 traffic becomes dominant, carriers may face the issue of how to deal with the remaining IPv4-based segment. Some well-established tools allow for the conversion to IPv6. There are two distinct cases here:

- About 20% of traffic is still directed to IPv4 websites. Carrier may translate them into IPv6 by NAT64 and represent it by DNS64 as IPv6 reachable.
- About 1% of traffic is originated as IPv4 despite the DNS64 proposition to use IPv6. It is primarily because of old devices connected by tethering. The major mobile OSes have NAT46 translation for such cases (Customer-side transLATor) that may be activated from the carrier's side. This way, the tethered traffic could be also converted into IPv6.

Addressing the Future *continued...*

These conversions will allow future IPv6-only configurations for primary Access Point Names (APNs), simplifying the Packet Core and improving the scalability of the network.

IPv6 migration challenges and solutions

The primary IPv6 migration challenge is the IPv6 support within current equipment. Typically, it hasn't been possible to justify replacing equipment just to introduce IPv6. The smoother upgrade solution has been to mandate IPv6 support for new devices that replace devices as they reach the end of their life cycle.

The next challenge is the lack of IPv6 knowledge and experience. IPv6 is not an IPv4 clone with just bigger IP addresses. These protocols are significantly different. Hence, some efforts to gain needed knowledge are mandatory. ETSI did a comprehensive analysis for potential gaps that may create challenges for IPv6 deployment [3]. The document also points out IPv6 Enhanced Innovations as the solutions.

The conclusion is that IPv6 is ready to go, especially for the mobile Internet and the mobile vertical ecosystems, helping unleash the full potential of 5G.

References:

[1] IAB Statement on IPv6 (2016, 11)

[2] ARCEP - Annual barometer of the transition to IPv6 in France (2020, 12)

[3] ETSI GR IPE 001 - IPv6 Enhanced Innovation (IPE); Gap Analysis (2021, 08)

The author: Eduard Vasilenko is a Senior Architect, Europe Standardization & Industry Development Department at Huawei Europe. The article was reviewed by Latif Ladid, IPv6 Forum President.

DRIVING DATA TO DELIVER CONNECTED VEHICLE SERVICES

By Said Tabet, AECC

The Automotive Edge Computing Consortium (AECC) white paper, Distributed Computing in an AECC System provides an overview of distributed computing and the mobility services requirements for connected vehicle service implementations.

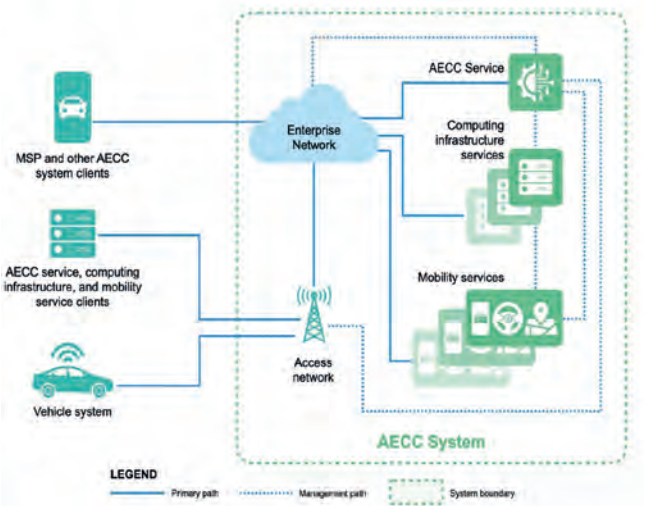
The document also provides initial solution profiling, to analyze existing technologies from standards organizations such as the 3GPP and open source communities. The process identifies candidate solutions that will satisfy AECC requirements and capture potential gaps to be addressed by connected vehicle stakeholders.

The AECC recommendations made to vehicle OEMs, MNOs and the service providers will provide ways to optimize service offerings.

'Distributed Computing in an AECC System' envisions scenarios within the AECC ecosystem – a collection of AECC systems (see Figure below). Each AECC system is composed of an AECC service, computing infrastructure services, mobility services and access networks, and gateway networks that provide access to vehicles and clients of the AECC and mobility services.

The white paper aligns AECC use case requirements from the AECC Use Case Development WG and reference architecture from the AECC Technical Solutions Development WG. In addition, it profiles global standards organizations' distributed computing approaches to enable selection of the best class solution to fulfill AECC service and architecture requirements and address gaps, such as the 5GS architecture from 3GPP WG SA2 Technical Specification (TS) 23.501 (Clause 5.13) and architecture for enabling edge application from WG SA6 TS 23.558 provide a set of foundational functional enablers for the integration of distributed computing in 5G networks.

As an MRP of 3GPP, the AECC will collaborate with the broader 3GPP membership to jointly identify future standards work and to conduct a gap analysis on what will be needed from 3GPP to ensure that connected vehicles benefit from best-in-class specifications.



www.aecc.org

CONNECTING THE CRITICAL COMMUNICATIONS COMMUNITY

By Nina Myren, TCCA Board member sponsored by DSB – the Norwegian Directorate for Civil Protection

Hopefully, some of you will be reading this having attended TCCA's Critical Communications World (CCW) event held in Madrid – perhaps some of you are reading it at the event, in which case, welcome! This is the event that was postponed from 2020, like so many others – and we are so delighted and relieved to be able to host events again where people can meet in person.

In the face of the pandemic, the proliferation of online events has proved successful across many sectors – not least our own. The Critical Communications Week online event in November 2020 attracted registrations from a huge number of people that had not attended our events before – in fact 90 per cent of the attendees had not been to a CCW physical event. That statistic is one of the reasons why elements of this year's CCW are available online as well as in Madrid – we want to continue to create collaboration opportunities for as many people as possible around the world, and disseminate information and knowledge as widely as possible.

However, while online collaboration is convenient, there is no doubting the value and importance of meeting in person. The pace of change, the innovation and the emergence of new solutions in our industry is increasing faster than, arguably, at any other time in its history.

The development of critical broadband standards and the enhancement of narrowband technologies to support hybrid networks are crucial to ensuring that end users are supported by the best possible technology, products and services.

To that end, there really is no substitute for events such as Critical Communications World, where the key manufacturers can showcase their products and services available today and engage with users to find out what is needed in the future to support their critical work. Visiting exhibition stands to see and test the hardware, having one-to-one meetings, attending conference sessions – these experiences cannot be 100 per cent replicated remotely.

> *"We are proud that TCCA is at the forefront of developments in the critical communications sector, working with key partners such as 3GPP and ETSI."*

Certainly the networking element of events, while of course available online, is so valuable: the knowledge exchange that takes place; meeting that unexpected person who provides huge value to your business; the conversations at social events that can catalyse new initiatives with positive impacts across the sector.

We are proud that TCCA is at the forefront of developments in the critical communications sector, working with key partners such as 3GPP and ETSI. TCCA is committed to ensuring that open standards continue to be the foundation of new advances as critical broadband and services become realities. 3GPP's willingness to include users' critical broadband requirements in their Releases and their support of our sector has been and continues to be essential to ensure that open standards remain the bedrock of the critical communications ecosystem.

www.critical-communications-world.com

"Beyond testing tools, manufacturers need to understand that the adoption of 3GPP standards means much more than just selecting a specific set of protocols and leveraging economies of scale."

STANDARDS COMPLIANCE - AN END TO UNPROVEN CLAIMS

By Bego Blanco Jauregi, Director of Quality Assurance and Institutional Assessment, University of the Basque Country

During the past few years, the mission-critical communications community has made a huge effort to develop new broadband solutions based on open standards. In this context, 3GPP provides a key framework developing technical specifications to ensure the evolution of mission-critical technology. However, using open standards is just not enough to break down traditional entry barriers and truly enable an open multi-vendor market. This is where conformance testing mechanisms and certification programs come into play. 3GPP has developed a comprehensive process to enable proper verification of conformance, from test cases definition in TSG RAN Working Group 5 (RAN5), to translation to neutral TTCN-3 testing language by TF160.

Beyond testing tools, manufacturers need to understand that the adoption of 3GPP standards means much more than just selecting a specific set of protocols and leveraging economies of scale. There needs to be a commitment to compliance in order to foster interoperability in multi-vendor deployments, which must be incorporated in the whole product development cycle as soon as possible.

Users must understand the added value of conformance testing and certification, which can be summarized as "ensuring you can just switch to another vendor client, server, or component and it should work". Only by including standard compliance requirements and verification mechanisms in their tendering processes will users free themselves from proprietary interfaces and long and costly integration processes.

But again, there is something of the chicken-and-egg situation here. Unless there is a validated mission critical services (MCS) test platform, certification programs cannot be launched. Meanwhile customers are forced to accept equipment supplied with unproven claims of standards compliance.

Currently, both the GCF (Global Certification Forum) and CTIA/PTCRB (the most prominent certification bodies) have MCS certification related Work Items waiting for test platforms availability. Only the availability of validated Test Platforms will trigger the activation of those Work Items in the certification bodies which is expected to happen in the next six months.

The MCS TaaSting project has been working intensively for the past two years to push all the certification program building stages and make the world's first validated MCS test platform available.

Furthermore, the testing-as-a-service mechanism proposed has been conceived to fit the needs of the niche MCS community in terms of cost efficiency and flexibility.

As a result, MCS TaaSting allows the industry to validate the 3GPP standards-compliance of their solutions and will encourage users and operators to trust that products and services are built on standards and will therefore be interoperable.

For more information visit www.mcstaasting.com

STATUS OF NTN & SATELLITE IN 3GPP RELEASES 17 & 18

By: Munira Jaffar & Nicolas Chuberre, Members of the ESOA Standards Working Group

The approval of normative activities on Non-Terrestrial Networks (NTN) in Rel-17 has generated growing interest in the topic. The Rel-17 NTN work items are supported by a wide range of vendors (terminal, chipset, network), as well as service providers from both the mobile and space industries and vertical user groups including ESOA.

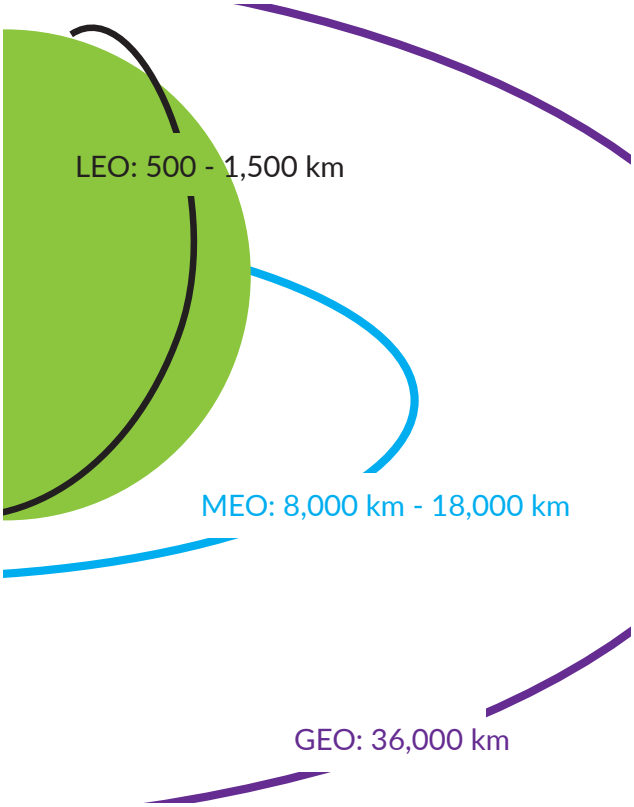
The Rel-17 NTN and satellite work items in Technical Specification Group (TSG) RAN and TSG SA have been progressing towards the goal of satellite inclusion in 3GPP technical specifications. The focus is on transparent payload architecture with FDD systems where all UEs are assumed to have GNSS capabilities. The normative phase includes adaptation to the physical & access layer aspects, radio access network and system architecture, radio resource management, and RF requirements for targeted satellite networks operating at LEO, MEO or GEO orbits.

With an expected completion date of March 2022, the 3GPP Rel-17 specifications will support New Radio (NR) based satellite access deployed in FR1 bands serving handheld devices for global service continuity. Equally exciting, the 3GPP Rel-17 specification will support NB-IoT and eMTC based satellite access to address massive Internet of Things (IoT) use cases in areas such as agriculture, transport, logistics and many more.

This joint effort between mobile and satellite industries will enable the full integration of satellite in the 3GPP ecosystem and define a global standard for future satellite networks. This will address the challenges of reachability and service continuity in unserved/underserved areas, enhance reliability through connectivity between various access technologies, and improve network resilience and dependability in responding to natural and man-made disasters.

Upon completion of Rel-17 the long-awaited standard for satellite networks serving handheld devices should be in place by 2022, with commercial product availability expected sometime in 2024. Including satellite as part of the 3GPP specifications will support the promise of worldwide access to 5G services and drive explosive growth in the satellite industry.

Looking ahead, ESOA members and other NTN stakeholders have started discussions during the 3GPP Rel-18 June workshop and are continuing to work on a further list of enhancements for both NR-NTN and IoT-NTN to be considered in Rel-18. Plans are also underway to further define the enablers for NR based satellite access in bands above 10 GHz to serve fixed and moving platforms (e.g., aircraft, vessels, UAVs) as well as building- mounted devices (e.g., businesses and premises). The goal of these efforts is to further optimize satellite access performance, address new bands with their specific regulatory requirements, and support new capabilities and services as the evolution of 5G continues.



About the co-authors:

Munira JAFFAR is the lead delegate representing EchoStar and Hughes, Nicolas CHUBERRE is the rapporteur of the NR_NTN_solutions work item (TSG RAN) and of the FS-5GET study item (WG SA1) from Thales Alenia Space. Both play an active part in the Standards Working Group of the EMEA Satellite Operators Association (ESOA).

www.esoa.net

NEW 3GPP MEMBERS IN 2021

A full list of the companies in 3GPP, who qualify through membership of one or more of the seven Organizational Partners (OPs) is available online at **www.3gpp.org/about-3gpp/membership.**

New members

3GPP has welcomed the following organisations* into the project during 2021. We currently have over 760 participating companies and organizations in 3GPP

3GPP MEMBERSHIP

ETSI	447
CCSA	138
ATIS	59
ARIB	28
TTA	28
TSDSI	54
TTC	10

New 3GPP IM 2020 - 2021	Partner	Country	New 3GPP IM 2020 - 2021	OP	Country
CERTH – Centre for Research and Tech. Hellas	ETSI	GR	Landis+Gyr	ETSI	CH
Apple R&D	CCSA	CN	Lekha Wireless Solutions Pvt Ltd	TSDSI	IN
ASR Microelectronics Technology Co., Ltd	CCSA	CN	Lynk Global	ATIS	US
Astrome Technologies Pvt Ltd	TSDSI	IN	Magister Solutions Ltd	ETSI	US
Baicells Technologies Co. Ltd	CCSA	CN	MediaTek korea Inc.	TTA	KR
BBA - BMW Brilliance Automotive Ltd.	CCSA	CN	MeitY	TSDSI	IN
Bharat Electronic Limited	TSDSI	IN	Mercedes-Benz	ETSI	DE
BSNL	TSDSI	IN	National Smart Grid Mission	TSDSI	IN
BTPDI - Beijing Telecom Planning & Designing Institute Co.,LTD.	CCSA	CN	National Spectrum Consortium	ATIS	US
Cambridge Consultants	ETSI	GB	Niral Networks Private Limited	TSDSI	IN
Cisco Systems India Pvt. Ltd.	TSDSI	IN	Perey Research & Consulting	ETSI	CH
Commsat - Beijing Commsat Technology Development Co.,Ltd.	CCSA	CN	PML - Purple Mountain Laboratories	CCSA	CN
CQUPT - Chongqing University of Posts and Telecommunications	CCSA	CN	Prasar Bharati	TSDSI	IN
CSA - Cyber Security Agency of Singapore	ETSI	SG	Puloli	ATIS	US
CU Digital Technology - China Unicom Digital Technology Co., Ltd.	CCSA	CN	Qualcomm Israel Ltd.	ETSI	IL
CUG - China Unicom Global Limited	CCSA	CN	Quanray - Shanghai Quanray Electronics Co., Ltd.	CCSA	CN
DanKook University'	TTA	KR	SAMEER	TSDSI	IN
DKK Co., Ltd.	ARIB	JP	Sensorise	TSDSI	IN
Dolby Technology India Pvt Ltd	TSDSI	IN	Signalchip Innovations Pvt. Ltd.	TSDSI	IN
EAST SA	ETSI	LU	SnT - University of Luxembourg	ETSI	CH, LU
ERNET India	TSDSI	IN	Sooktha Consulting Pvt Ltd	TSDSI	IN
ESSEN INNOVATION	CCSA	CN	Sterlite Technologies Ltd	TSDSI	IN
Eurofins Digital Testing Belgium NV	ETSI	BE	TATA Communications Ltd	TSDSI	IN
Ford	ETSI	US	Tata Motors	TSDSI	IN
GANPAT UNIVERSITY	TSDSI	IN	Tektronix GmbH	ETSI	DE
Honor Device Co., Ltd	CCSA, ETSI	CN	Telecommunications Consultants India Ltd	TSDSI	IN
IDRBT	TSDSI	IN	Tencent Cloud	CCSA	CN
IIIT Bangalore, Delhi, Hydrabad, Bhilai, Kharagpur, Kanpur, Mandi	TSDSI	IN	Tessares	ETSI	BE
IISc, Bangalore (Indian Institute of Science)	TSDSI	IN	UIET Panjab University Chandigarh	TSDSI	IN
INSPUR	CCSA	CN	UMA	ETSI	ES
InterDigital Finland Oy	ETSI	FI	Unicom Broadband Online - Unicom Broadband Online Co., Ltd.	CCSA	CN
Intersec	ETSI	FR	Unicompay Co., Ltd.	CCSA	CN
IPLOOK Networks Co., Ltd.	CCSA	CN	Vodafone Idea Ltd	TSDSI	IN
Juniper Networks	ATIS	US	VSENS - Unicom Vsens Telecommunications Co., Ltd	CCSA	CN
Kepler	ETSI	CA	Wipro Limited	TSDSI	IN
Korean Register	TTA	KR	Xcape, Inc.	ATIS	US
Kyonggi University	TTA	KR	ZEKU	CCSA	CN

Source: 3gppmembership@etsi.org

*NB. The list above may represent an evolution of an existing membership, or a change of company name, in addition to being a list of new members.

COLLABORATIVE DRAFTING TOOL FOR 3GPP

By Sebastian Müller, ETSI Centre for Testing & Interoperability

In itself, drafting is not a difficult endeavour, it is simply taking a document from one content state to another.

Of course, in the case of standardization, drafting is a highly complex activity due to the need for deep technical discussion, transparency and the desire to reach consensus, often among many hundreds of players, meeting remotely and in a highly market-sensitive context.

While Microsoft Word and Google Docs are good for writing, they are not optimal when it comes to workflow, submission of modifications, getting feedback and making decisions.

Today, industry generally, and many 3GPP members in particular, are looking at novel ways of collaborative working, especially the effective drafting of documentation.

The New Working Methods (NWM) project has been set up for this purpose.

> *"The first use case is currently under trial in 3GPP TSG RAN."*

The first use case of the NWM platform streamlines the way 3GPP works with Discussion Summary Documents. It allows moderators to create documents in order to summarize email discussions. These documents may contain headings, figures, rich text, tables and feedback forms. The feedback forms are used to collect company statements on specific questions. The workflow foresees that the moderator creates and updates documents, as well as inserts feedback forms inside the documents. Delegates post their company's opinion in these feedback forms.

The benefits of this approach are:

- 3GPP's work on Discussion Summary Documents is no longer scattered around lots of different Word files.
- Feedback can be provided simultaneously and at any time of the day.
- Moderators can lock feedback forms and thus steer the document over a finish line.
- Moderators no longer have to compile a master document out of multiple versions. They get one single document out of the process.
- Delegates can focus on providing their company statement, rather than struggling with ftp uploads and Word formatting.

The first use case is currently under trial in 3GPP TSG RAN and its working groups, with more than 2000 users having created 400 documents. This trial-approach allows the users to get an impression of the new tooling and to provide feedback to the NWM team. Likewise, the NWM team can evolve the NWM platform based on the users' feedback, monitor under real conditions, and fix bugs and performance issues.

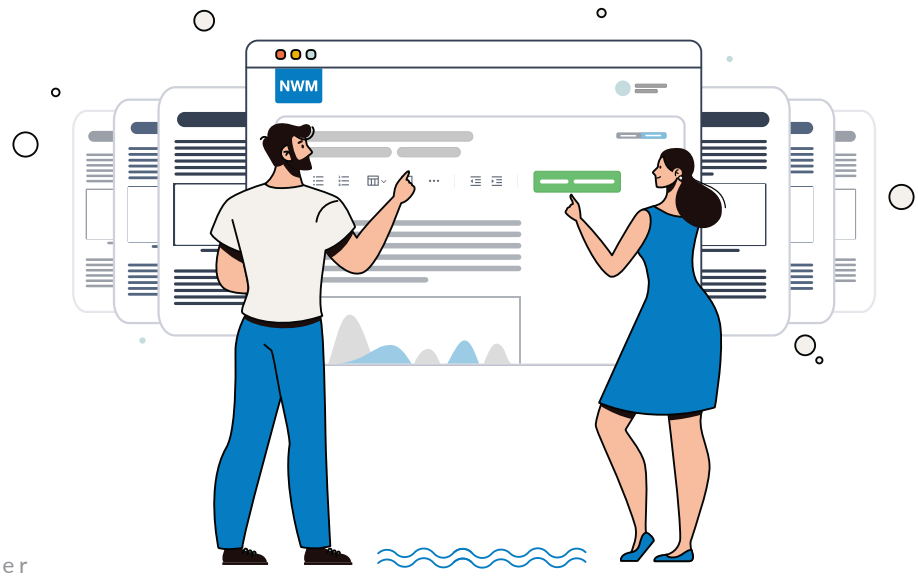
The NWM platform is developed in parallel to the ongoing trial sessions, with the focus to stabilize and enhance the performance and the existing features, as well as adding new features to prepare for the next use case which will be the Collaborative Drafting of Documents. This use case encompasses the following features:

- Submission, review and decision of proposed modifications.
- Integration of the (accepted) modifications into the baseline.
- Traceability of actions, decisions and proposed modifications.

In conclusion, the focus currently is on enabling new drafting processes and adaptive workflows. However, the final goal of this specification editing platform is to provide more added-value features such as cross-document navigation, consistent references, quality checks, comments/discussion threads, configurable stylesheets and data mining, to name a few.

Interested to learn more? Visit https://nwmwiki.etsi.org/docs/index.html

This article was co-authored by Alexandre Berge of the ETSI Centre for Testing & Interoperability.



CALENDAR OF MEETINGS

A selection of the major meetings for the period October 2021 – September 2022

WG	SA3#83-LI-e-a	2021-10-04	2021-10-05
WG	CT1#132-e	2021-10-11	2021-10-15
WG	CT3#118-e	2021-10-11	2021-10-15
WG	CT4#106-e	2021-10-11	2021-10-15
WG	RAN1#106-bis-e	2021-10-11	2021-10-19
WG	SA5#139-e	2021-10-11	2021-10-20
WG	SA6#45-bis-e	2021-10-11	2021-10-19
WG	SA2#147-e	2021-10-18	2021-10-22
WG	RAN3#114-e	2021-11-01	2021-11-11
WG	RAN2#116-e	2021-11-01	2021-11-12
WG	RAN4#101-e	2021-11-01	2021-11-12
WG	SA3#83-LI-e-b	2021-11-01	2021-11-05
WG	SA1#96-e	2021-11-08	2021-11-18
WG	RAN5#93-e	2021-11-08	2021-11-19
WG	SA3#105-e	2021-11-08	2021-11-19
WG	SA4#116-e	2021-11-10	2021-11-19
WG	CT1#133-e	2021-11-11	2021-11-19
WG	CT3#119-e	2021-11-11	2021-11-19
WG	RAN1#107-e	2021-11-11	2021-11-19
WG	SA2#148-e	2021-11-15	2021-11-19
WG	CT1#133-tbc	2021-11-15	2021-11-19
WG	CT4#107-e	2021-11-15	2021-11-23
WG	SA5#140-e	2021-11-15	2021-11-24
WG	SA6#46-e	2021-11-15	2021-11-23
WG	CT6#109-e	2021-11-16	2021-11-19
TSG	RAN#94-e	2021-12-06	2021-12-17
TSG	CT#94-e	2021-12-13	2021-12-15
TSG	SA#94-e	2021-12-14	2021-12-20
TSG	CT#95	2022-03-14	2022-03-15
TSG	RAN#95	2022-03-14	2022-03-17
TSG	SA#95	2022-03-16	2022-03-18
TSG	CT#96	2022-06-06	2022-06-07
TSG	RAN#96	2022-06-06	2022-06-09
TSG	SA#96	2022-06-08	2022-06-10
TSG	CT#97	2022-09-12	2022-09-13
TSG	RAN#97	2022-09-12	2022-09-15
TSG	SA#97	2022-09-14	2022-09-16

https://www.3gpp.org/3gpp-calendar

3GPP A GLOBAL INITIATIVE

REL-17 A PRIORITY AS F2F TIME PROVES ELUSIVE

The September Technical Specification Group (TSG) e-meetings (#93-e) have agreed that the freeze date for the Release-17 set of features will remain the major focus in the working groups until the end of the first quarter of 2022.

Release 18 will soon come under the spotlight, with agreement on its content due in December (TSG#94-e). However, apart from that prioritization process, the TSG#93-e meetings have agreed that the start of full-on Release 18 work can only begin once Release 17 has reached its functional freeze date – the date from which only essential corrections to the specifications are permitted - in March 2022.

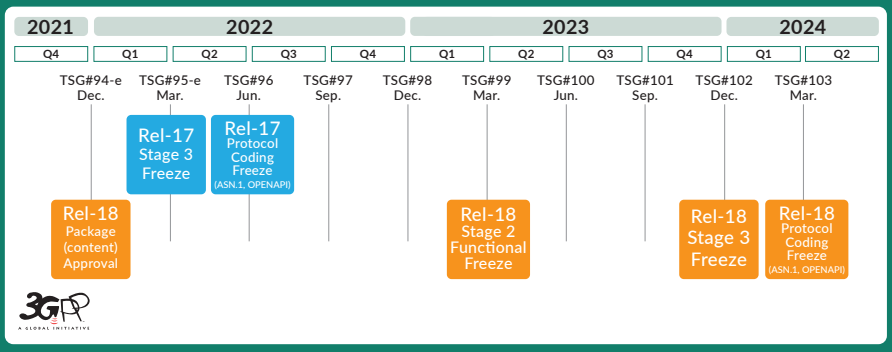
With the Release 18 work ramping up from Q2 2022 onwards, a clear timeline is approved for a functional freeze date of the first 5G-Advanced release, in December 2023.

During TSG#93-e, the conditions and timing for a return to physical meetings were discussed and the decision taken that all 3GPP meetings will continue to be held remotely, extending to the first quarter of 2022.

Although e-meetings are not the ideal environment for the delegates to work together, they are proving to be effective.

Release 17 has been the Covid-19 release, produced in the middle of a worldwide pandemic. With its completion now in sight, it will stand as a tribute to how we can adapt and flourish in such challenging times.

This article is adapted from a 3GPP website news story, September 22, 2021



LIFETIME ACHIEVER GETS HIS AWARD

Stephen Hayes has been granted the 3GPP Lifetime Achievement Award, nominated by his peers and approved by the Project Coordination Group (3GPP PCG), the leadership group in the project.

The award serves not only as recognition of Stephen Hayes' contribution to 3GPP, but it is also a tribute to his natural empathy and ability to motivate his colleagues towards the fulfilment of common goals.

He accepted the award, to the collective delight of the 500+ delegates attending a Joint 3GPP TSG plenary e-session, on September 16, 2021.

The full story is online here: **www.3gpp.org/news-events**

3GPP's MRPs:

Thanks to the 3GPP Market Representation Partners for their continued support and generous inputs to each edition of 3GPP Highlights.