5G STANDARDS DEVELOPMENT IN 3GPP – RELEASE 17 AND 18

Iain Sharp, ATIS (Moderator)
Greg Schumacher, T-Mobile USA
Puneet Jain, Intel
Wanshi Chen, Qualcomm

April 20th, 2022

ATIS' Value Driven Mission and Role as a 3GPP Founder

ATIS strategic initiatives and solutions/standards work progresses new business opportunities, solves common industry challenges, and creates a platform for collaboration with other industries:

- Members innovate and compete "on top of" ATIS' foundational work
- Collaborative efforts across industries can lead to greater scale and customer adoption

Identifying and defining *where and how* to align and collaborate; *sharing resources, effort and cost* to develop large-scale, interoperable solutions for a "common industry good" is both critical and beneficial to the industry. ATIS is the catalyst

ATIS advances international cooperation and is a founding partner of 3GPP

Agenda

Opening/Overview

Iain Sharp
Principal Technologist
ATIS

Services

Greg Schumacher
Global Standards
T-Mobile USA

Systems Architecture and Core Networks

Puneet Jain
Principal Engineer and Director of Technical Standards
Intel Corporation
3GPP SA2 Chairman

Radio Access Network

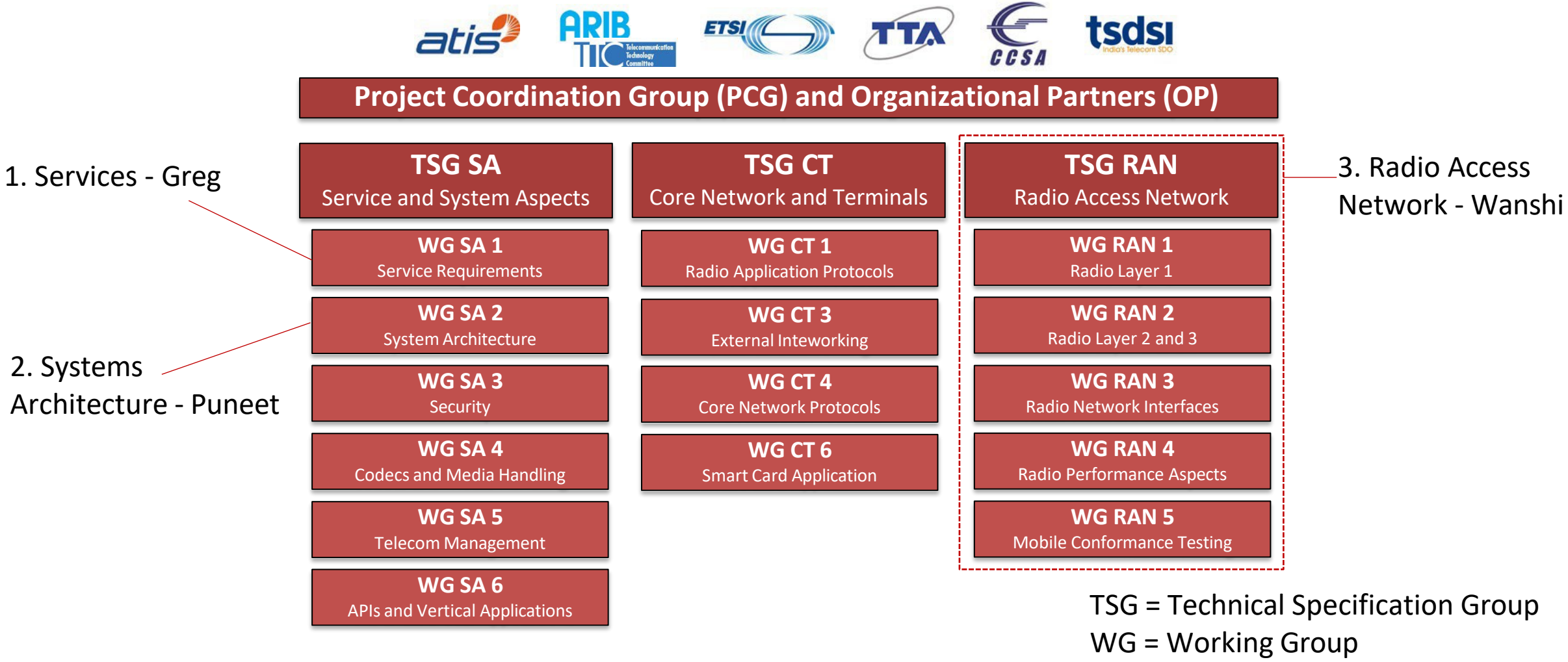
Wanshi Chen
Senior Director, Technology
Qualcomm
3GPP RAN Chairman

Long Term Outlook

Q&A: *Please submit questions via chat during the webinar*

3GPP Structure and Today's Agenda

Any organization that designs a system will produce a design whose structure is a copy of the organization's communication structure.
— Melvin E. Conway



3GPP Release Roadmap

2020	2021	2022	2023	2024

Rel. 16

Enhanced support for broadband and vertical use-cases

Rel. 17

Protocol Coding Freeze – June 2022

Advanced technologies and applications, e.g. AI/ML, XR, high frequency bands

Rel. 18

Content Package Agreed – Dec. 2021/March 2022

New vertical users, applications, deployment models, spectrum

Rel. 19

April 2022 - 3GPP Specifications Release Status

- Release 17
  - Most protocol work is frozen except for essential corrections
  - Protocol coding (“ASN.1”) freeze is on target for June 2022
  - **Focus moving from standardization to deployment**
  - The RAN and System Architecture presentations today will introduce Release 17’s technical capabilities

- Release 18 *5G-Advanced*
  - Package of work to define scope has been approved by 3GPP
  - Target freeze mid-2024
  - The services presentation today will introduce service topics in Release 18

- Release 19
  - Work stated on service definitions

RELEASE 17 SERVICE PERSPECTIVE ("SA1")

Greg Schumacher, T-Mobile USA

April 20th, 2022

3GPP SA 1's role - overview

- Develop new & enhanced services, features and capabilities for:
  - 3GPP specifications
  - Interworking with services defined by SDOs external to 3GPP
- 3GPP IM entry point for vertical market's 3GPP service, feature and capability needs
- Define corresponding stage 1 requirements for downstream 3GPP groups
- Study Items (SIDs) result in use cases and potential requirements
- Work Items (WIDs) result in normative (downstream) requirements

SA 1 Release 17

- Recap from previous ATIS presentation
- Majority of work areas
  - eCAV – Enhanced cyber-physical control (industrial/factory vertical)
  - AVPROD – AV service production (A/V production vertical)
  - ATRAC – Asset tracking (warehouse vertical)
  - CMED – Critical Medical Applications (medical vertical)
  - EAV – UAV enhancements (drone vertical)
  - 5GSAT – Satellites use in 5G (satellite vertical)
  - REFEC – Enhanced relays for coverage and energy efficiency (various verticals)
  - MUSIM – Support multiple USIMs per UE
  - NCIS – Network controlled interactive service

A complete overview of R17 enhancements can be found in TR 21.917 *Release `17 Description: Summary of Rel-17 Work Items* – finalization expected around end of 4Q22

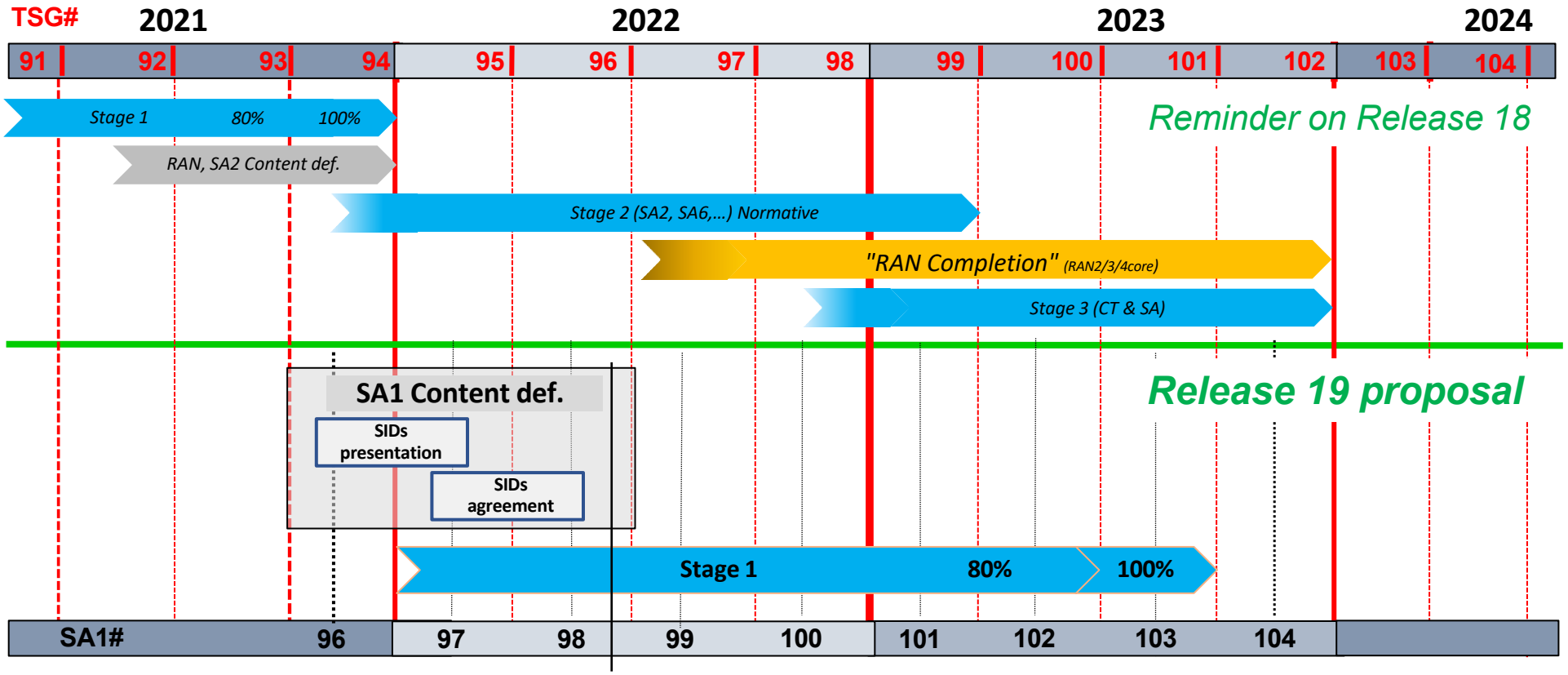
SA 1 Release 18 (1/2)

- SA 1 has completed R18 work and is onto R19 efforts
- Work areas for vertical markets
  - 5GSATB - Satellite backhaul (satellite vertical)
  - SVCS - Satellite access for video surveillance (satellite vertical)
  - EXPOSE - Service exposure for verticals (various verticals)
  - LPHAP - Low power high accuracy positioning (industrial/factory vertical)
  - SEI - Smart energy and infrastructure (power grid vertical)
  - 5TRS – Timing resiliency service (various verticals)

SA 1 Release 18 (2/2)

- Work areas (not vertical market specific)
  - PIN/Pirates - Personal IoT networks
  - Resident/Pirates - Residential 5G networks
  - Ranging – UE ranging service and sidelink positioning
  - AMMT – AI/ML model transfer (network – UE)
  - EASNS- Enhancements to network slicing
  - eMMTEL - IMS evolution
  - TACMM – UE tactile & multi-modal communication (gaming, robotic control)
  - VMR – Vehicle mounted relays
  - PALS – Access to localized network services
  - SFChain - Service function chaining

SA 1 R19


TSG#
2021
2022
2023
2024
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102
103
104
Stage 1
80%
100%
Reminder on Release 18
RAN, SA2 Content def.
Stage 2 (SA2, SA6,…) Normative
"RAN Completion" (RAN2/3/4core)
Stage 3 (CT & SA)
Release 19 proposal
SA1 Content def.
SIDs presentation
SIDs agreement
Stage 1
80%
100%
SA1#
96
97
98
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104

SA 1 R19

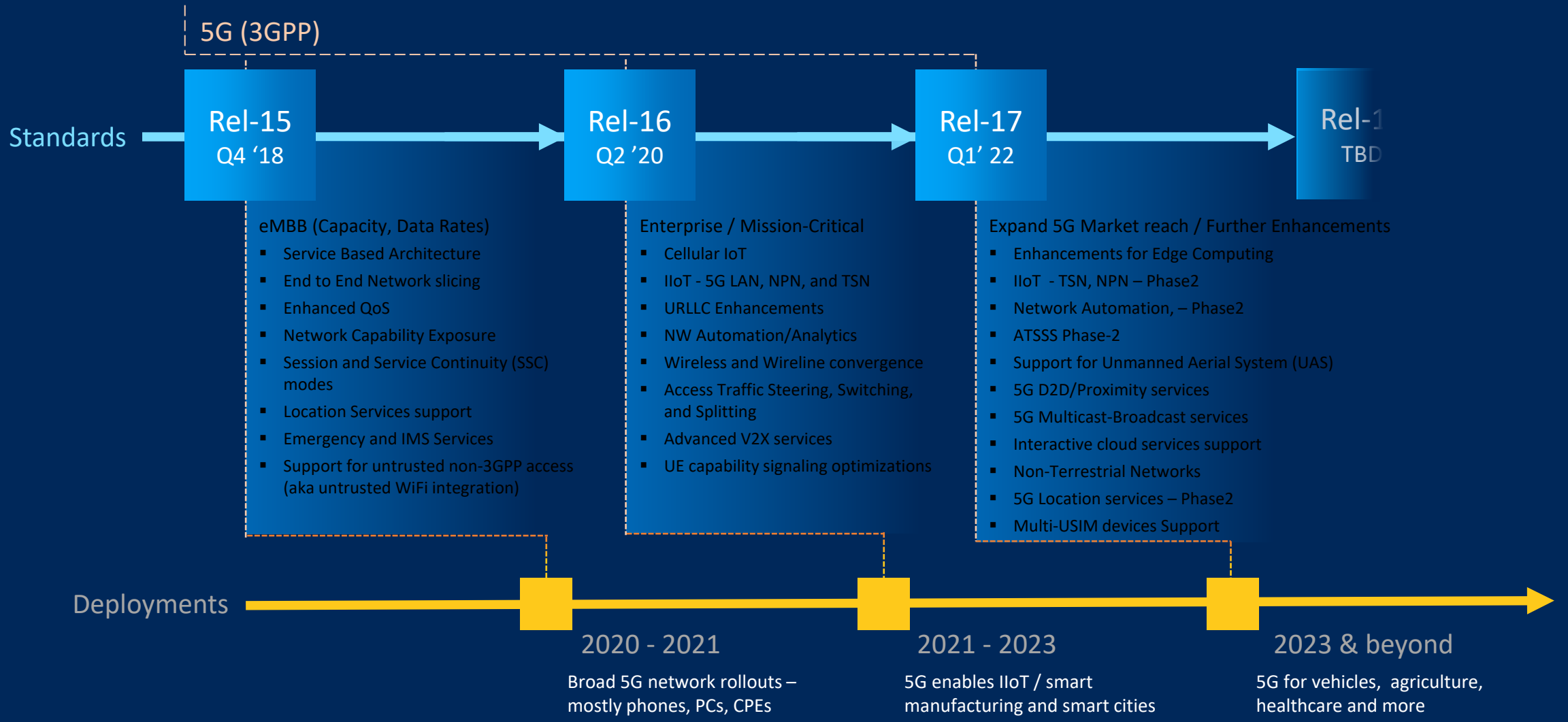
- R19 work in process
  - 26 SIDs have been presented, 6 agreed in 1Q22
  - SID discussion and agreement will continue in 2Q22
- Working schedule in SA 1 (subject to overall R19 schedule)
  - 2Q22 – R19 SID agreement + prioritization (if needed)
  - 2Q23 – R19 SID/WID 80% complete
  - 3Q23 – R19 SID/WID 100% complete

3GPP REL-17 SA2 FEATURES

Puneet Jain
3GPP SA2 Chair
Sr. Principal Engineer & Sr. Director, Intel Corporation

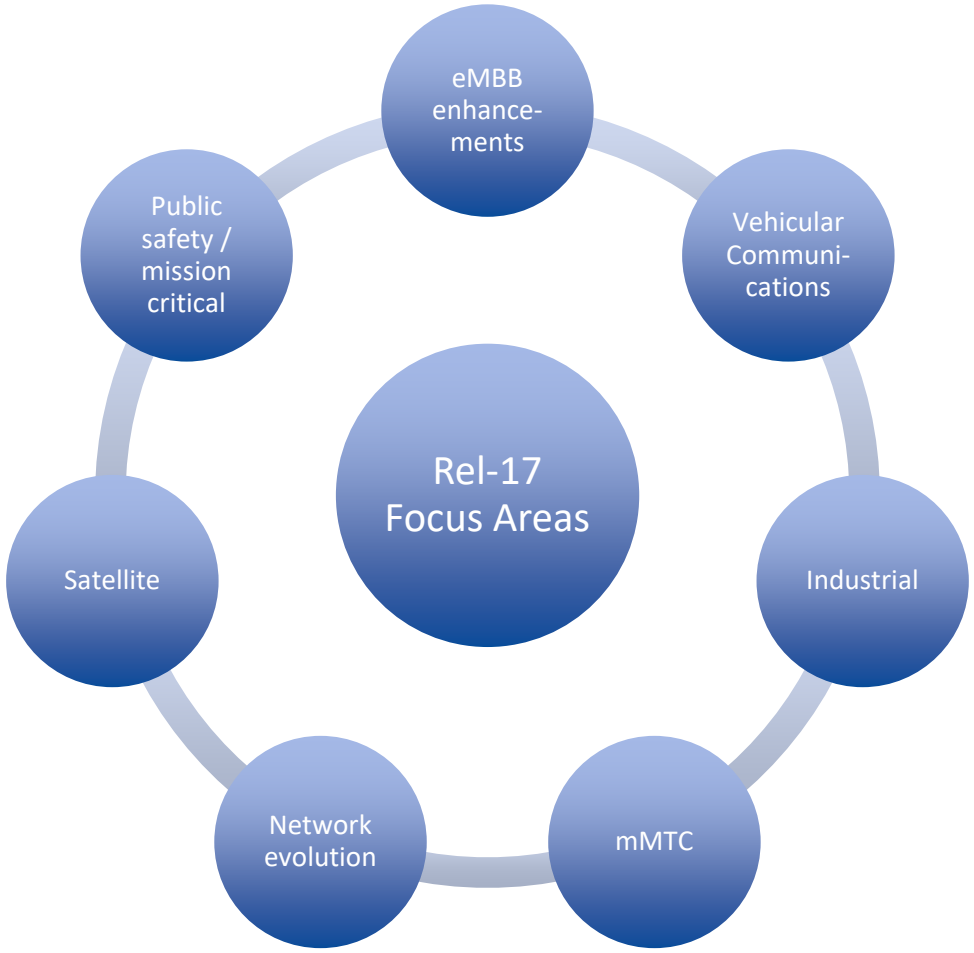
April 20, 2022

5G: Evolutionary and Revolutionary



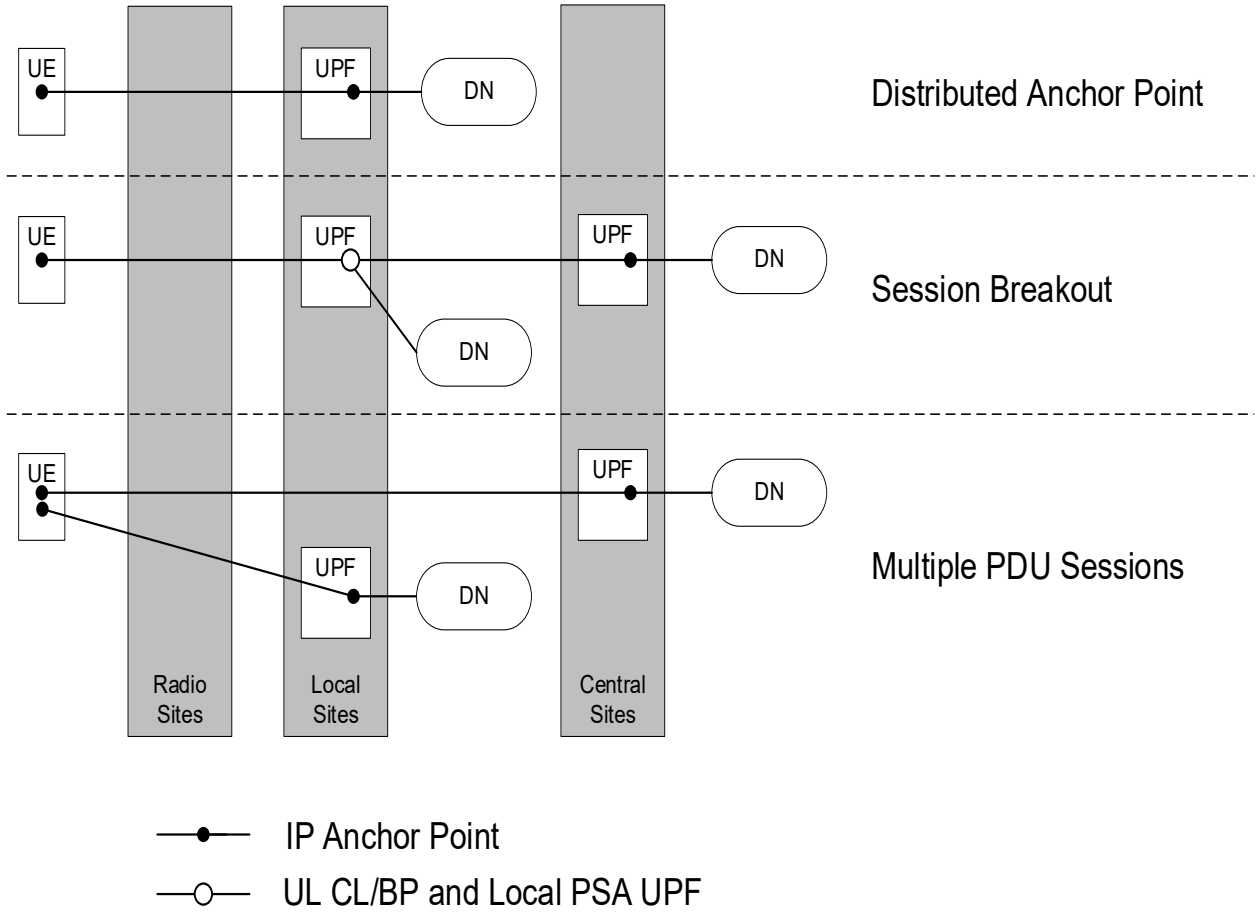
Release 17 - Overview

- **Rel-15**: Deliver baseline NR functionality to meet eMBB (enhanced Mobile Broadband) and URLLC (Ultra-Reliable Low Latency Communication) requirements of 5G technology
- **Rel-16 (aka 5G Phase 2)**: continuation of Rel-15 to fully address the original 5G vision
- **Rel-17 is more evolutionary in nature**
  - Expand the market reach of 5G technology
    - 5G for satellite; IoT services; Public safety and mission critical services, Support for Edge Computing and Interactive Cloud Services, Support for Unmanned Aerial Systems (UAS), etc.
  - Address additional requirements from mobile operators and verticals
    - Enhancements, performance and efficiency improvements targeting Industrial, V2X, mMTC, and eMBB uses cases
    - Network evolution (Network Slicing enhancements, IAB enhancements)



Enhancement for Support for Edge Computing

- Discovery of Edge Application Server
- Seamless Edge Relocation
- Network Exposure to Edge Application Server
- Support of 3GPP Application Layer Architecture
- DNAI based (I-)SMF selection

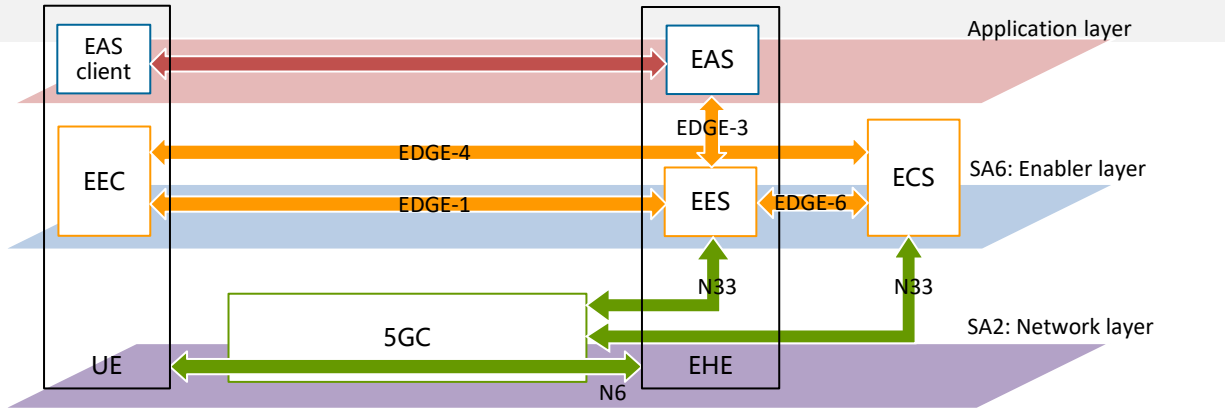


5GC Connectivity Models for Edge Computing

Relationship of SA2 and SA6 EC studies

SA2 FS_enh_EC SI: Define network layer solutions to support UE connectivity with EAS	SA6 EDGEAPP SI: Defines middle layer platform for edge computing	
EAS discovery via DNS	EAS registration/discovery via middle layer (ECS/EES)	Solutions for same issue but resolve in different layers
Edge relocation (focusing on user path relocation, session continuity, coordination with AF)	EAS relocation (focusing on application context relocation)	Complementary solutions
Network information exposure from 5GC to AF (e.g. EES/EAS) with low latency	Capability exposure from EES to EAS	Complementary solutions
Traffic local routing to EAS (I-SMF insertion/reselection)		

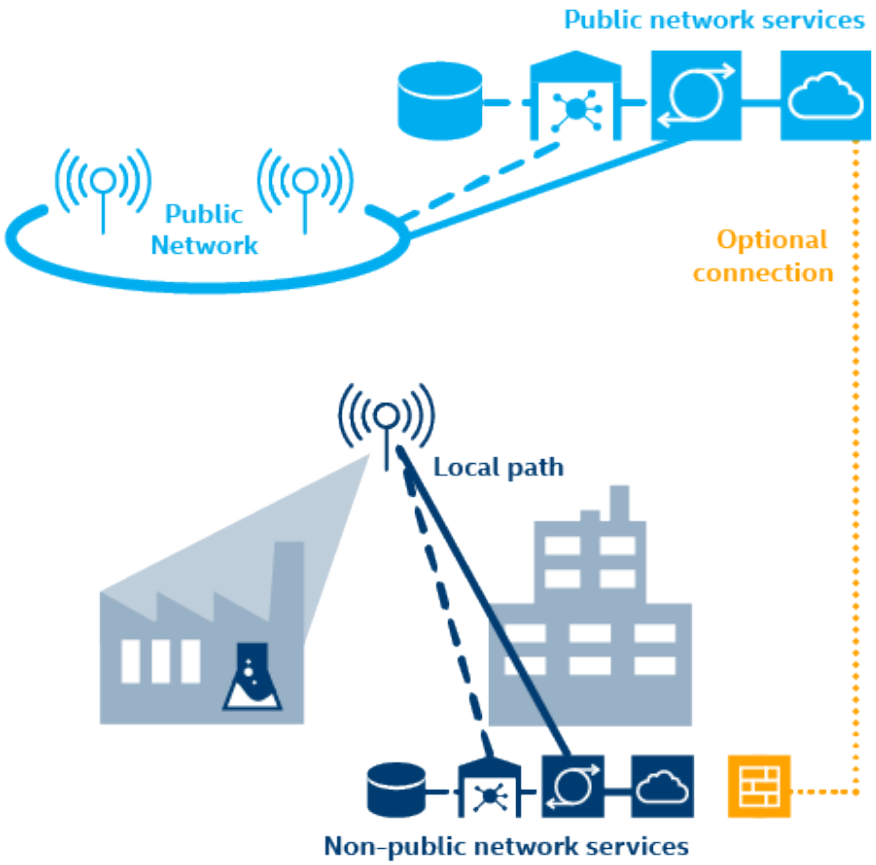
EAS: Edge Application Server
EES: Edge Enabler Server
ECS: Edge Configuration Server
EEC: Edge Enabler Client
EHE: Edge Host Environment



Different layer of edge computing

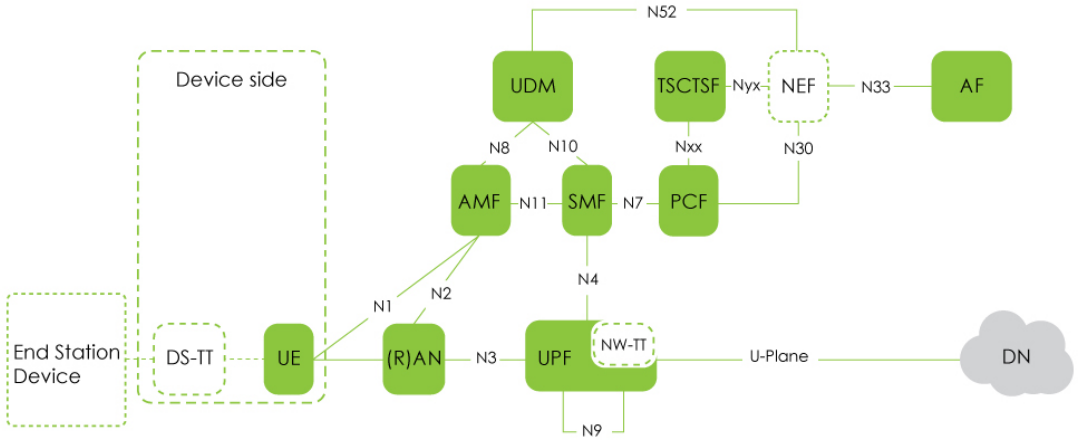
Enhanced support of Non-Public Networks

- Support SNPN (standalone private network) with subscription / credentials owned by an entity separate from the SNPN
  - Introduce the broadcast information (e.g. indication that a SNPN supports separate credentials etc.) to support network selection
  - support is uniform over the whole SNPN
    - No impact to idle mode mobility and connected mobility from Uu side
- Support UE onboarding and provisioning for SNPN
    - Devices connecting to the network for the first time are allowed at least the baseline connectivity and networking services for SNPN provisioning
- Support of IMS voice and emergency services for SNPN



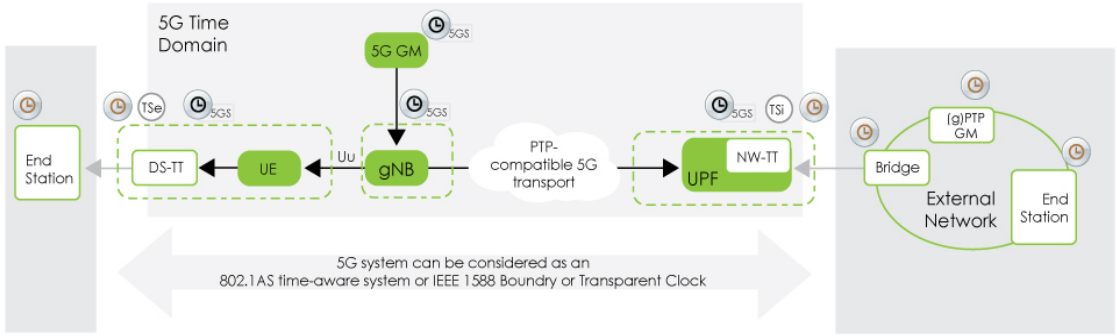
Enhanced support of Industrial Internet of Things

- Uplink Time Synchronization
- UE-UE TSC communication
- Exposure of deterministic QoS
- Exposure of Time Synchronization
- Use of Survival Time for Deterministic Applications in 5GS



Architecture to enable Time Sensitive Communication and Time Synchronization services

TS 23.501

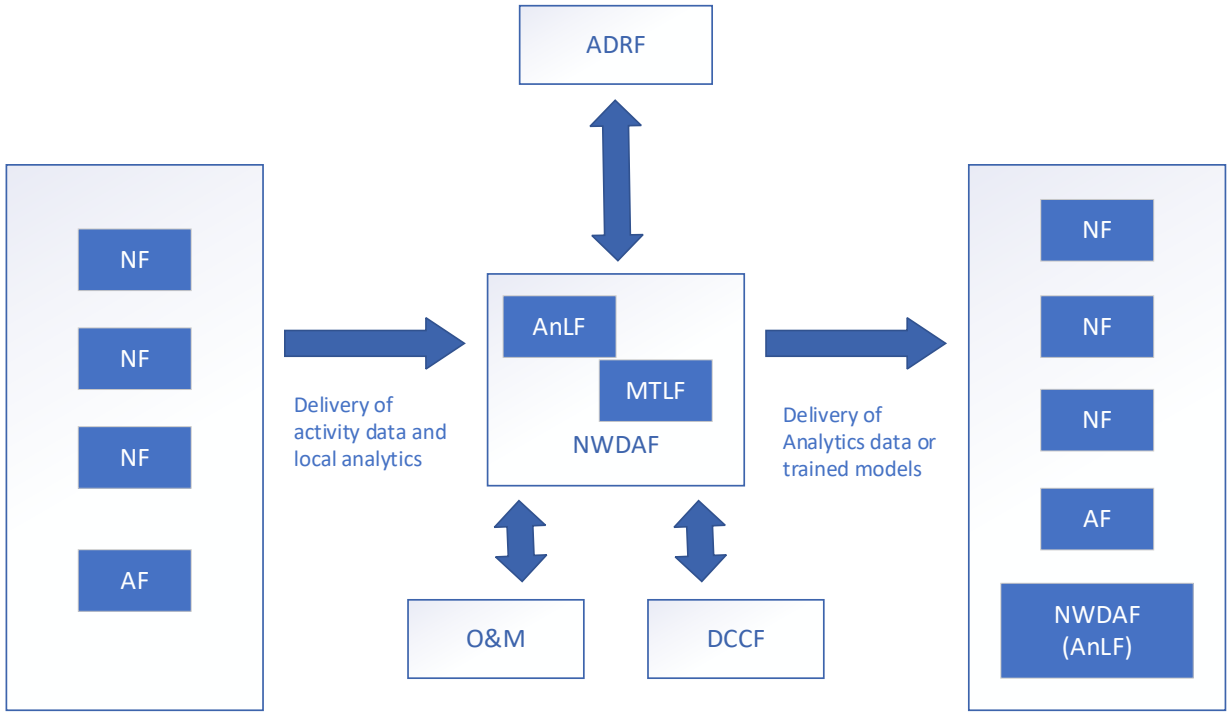


5G system is modelled as PTP instance for supporting time synchronization

TS 23.501

Enablers for Network Automation for 5G – Phase 2

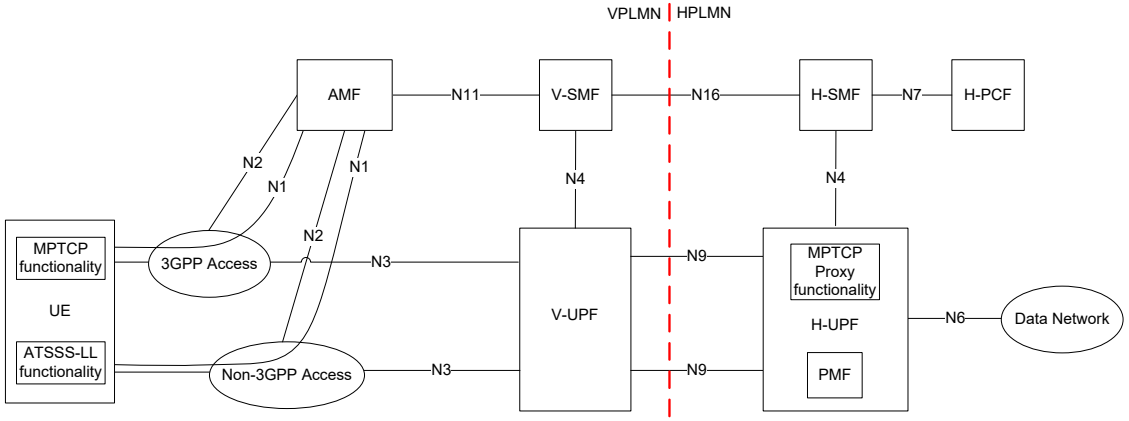
- **NWDAF is decomposed into**:
  - **Analytics logical function (AnLF):** The NWDAF provides analytics to 5GC NFs and OAM.
  - **Model Training logical function (MTLF):** NWDAF may provide trained models and exposes new training services to other NWDAFs.
- Pre-trained ML model storage and provisioning to NWDAF is out of the scope of 3GPP.
- The interactions between 5GC NF(s) and the NWDAF take place within a PLMN
- The service consumer (5GC NFs, OAM) decide how to use the data analytics provided by the NWDAF.



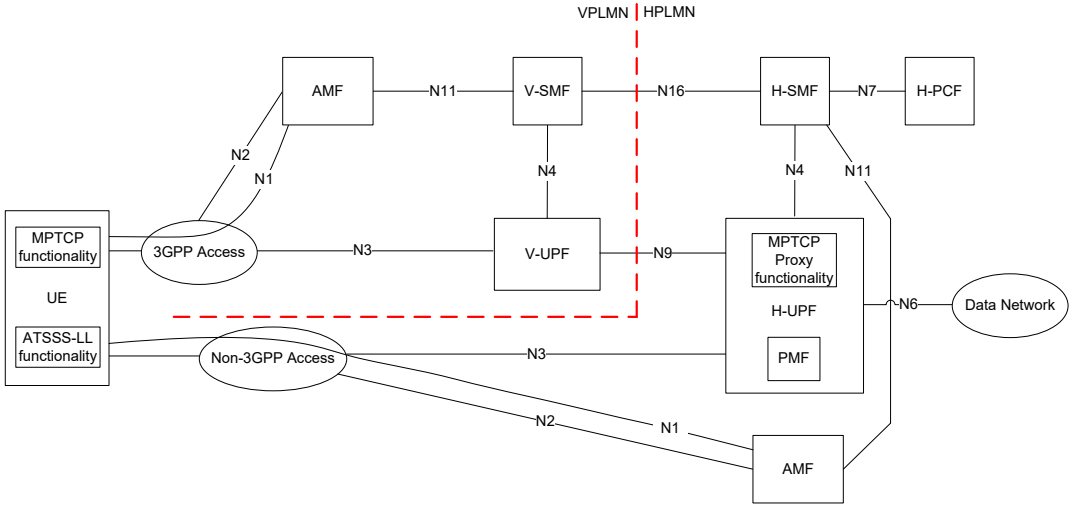
- **NF**: 5G Network Function (e.g., SMF, AMF, PCF)
- **AF**: Application Function
- **NWDAF**: Network Data and Analytics Function
- **ADRF**: Analytics Data Repository Function
- **DCCF**: Data Collection and Coordination Function
- **AnLF**: Analytics logical Function
- **MTLF**: Model Training logical Function

Access Traffic Steering, Switch and Splitting Support – Phase2

- Steering Modes
- Additional Steering Functionalities
- Supporting MA PDU with 3GPP access leg over EPC and Non-3GPP access leg over 5GC



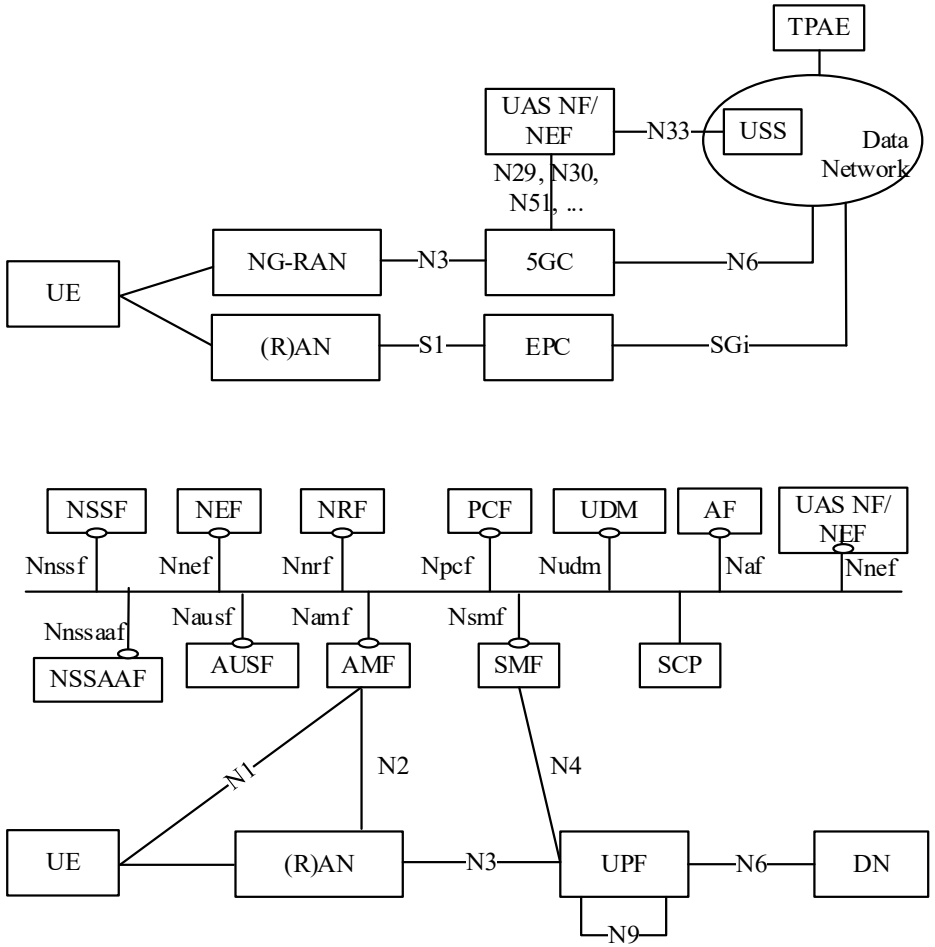
Roaming with Home-routed architecture for ATSSS support (UE registered to the same VPLMN)



Roaming with Home-routed architecture for ATSSS support (UE registered to different PLMNs)

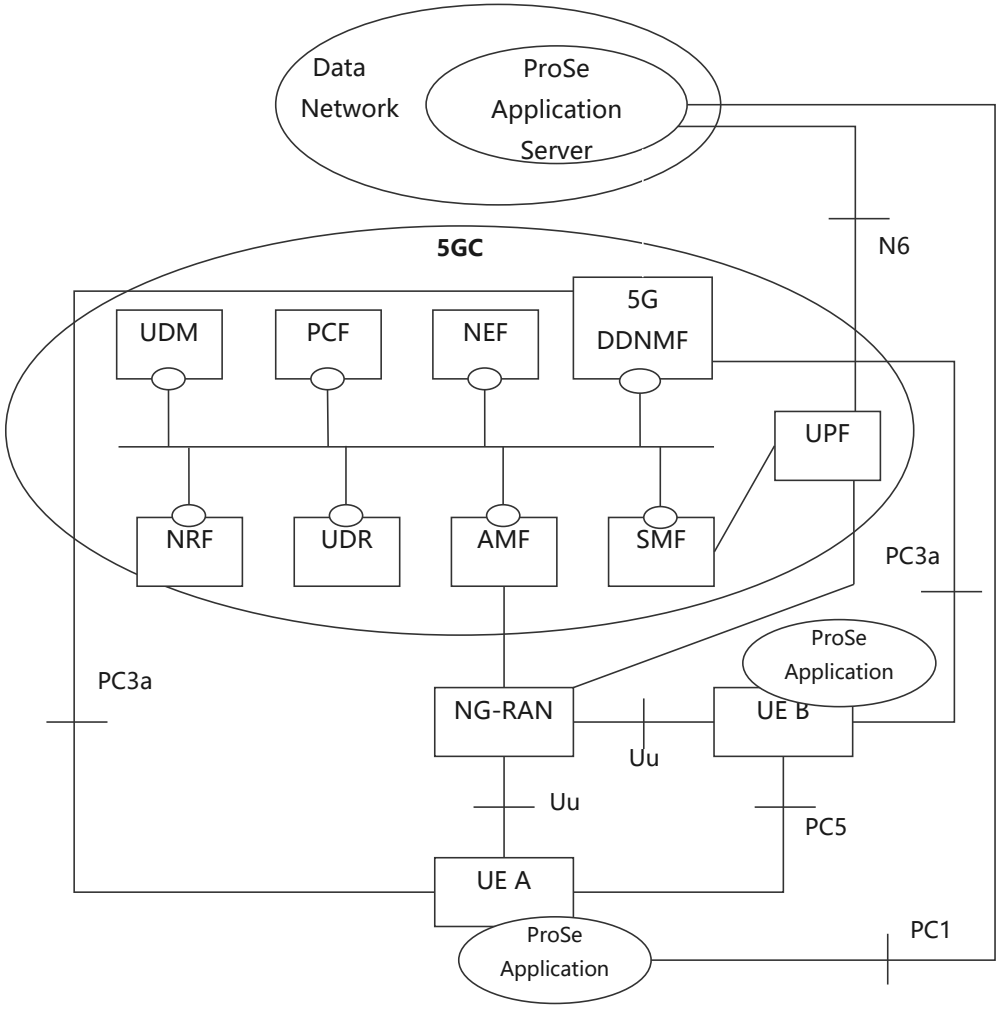
Support of Unmanned Aerial Systems Connectivity, Identification and Tracking

- UAV identification
- UAV authorization by UTM
- UAV and UAV Controller tracking
- UAV authorization revocation and (re)authorization failures
- UAV Controller and UAV association
- User Plane Connectivity for UAVs



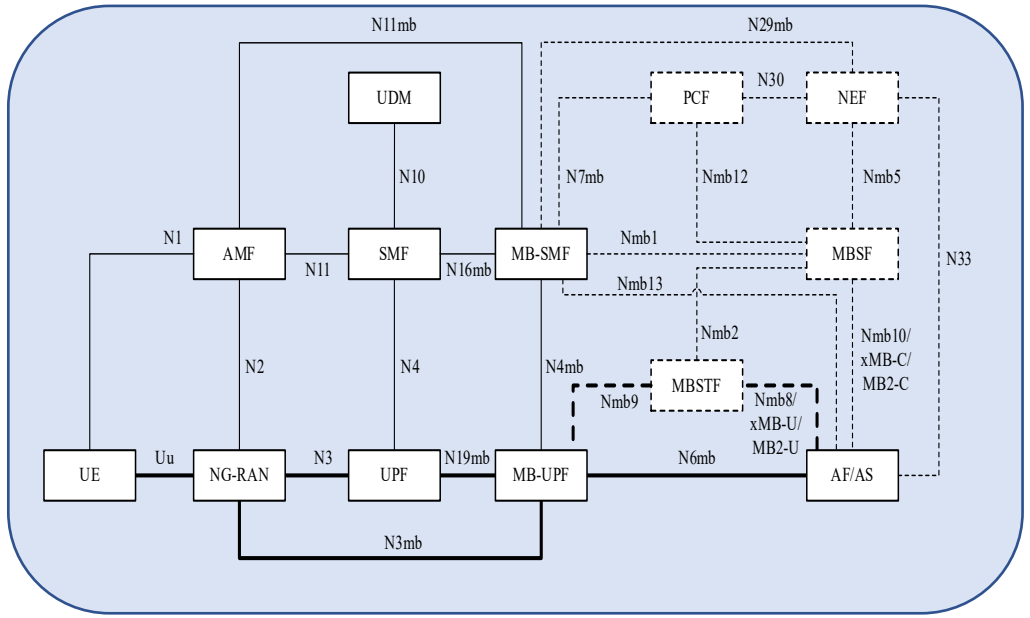
5G Proximity based Services

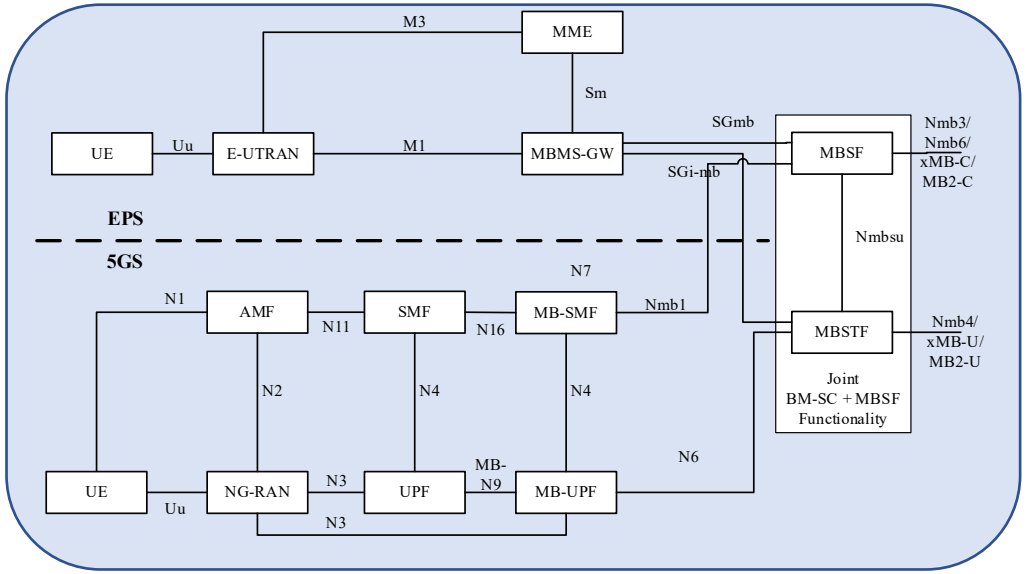
- ProSe Direct discovery
- Support of NR PC5 ProSe communication
- Support of UE-to-Network Relay
- Support direct communication path selection between PC5 and uu
- Support of PC5 Service Authorization and Policy/Parameter Provisioning



5G Multicast/Broadcast Services

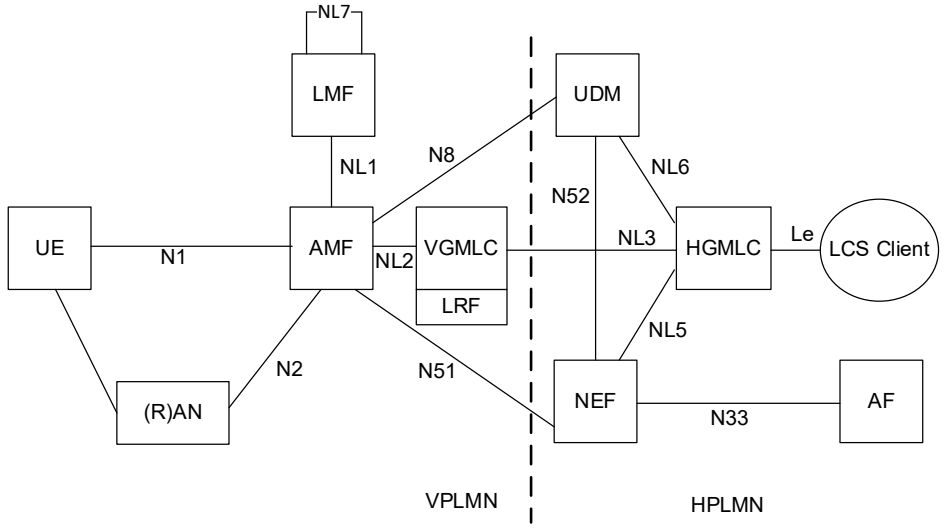
- MBS session management
- Definition of Service Levels
- Levels of authorization for Multicast communication services
- QoS level support for Multicast and Broadcast communication services
- Local MBS service
- Reliable delivery method switching between unicast and multicast
- Minimizing the interruption of public safety services upon transition between NR/5GC and E-UTRAN/EPC

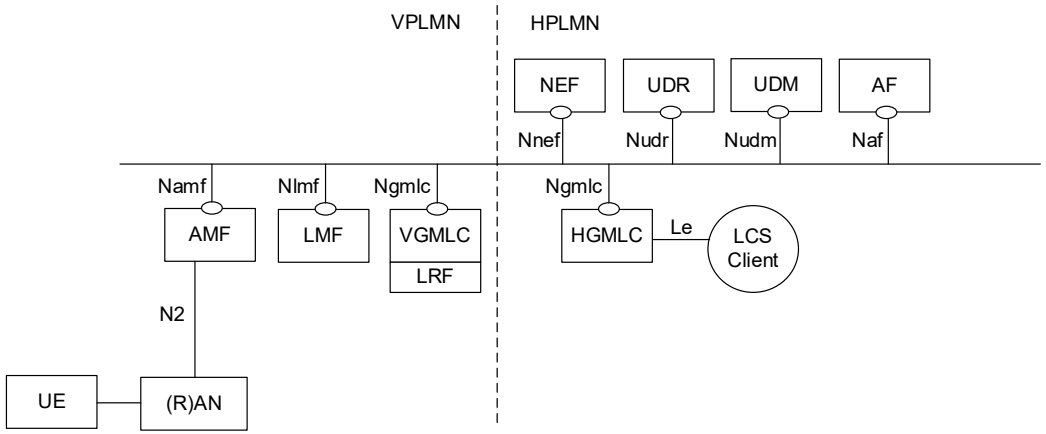




Enhancement to the 5GC LoCation Services – Phase 2

- UE Positioning Capabilities storage in AMF
- Multiple QoS Class
- Non-3GPP support for UE Position
- Scheduled Location Time
- Satellite RAT Type in LMF selection



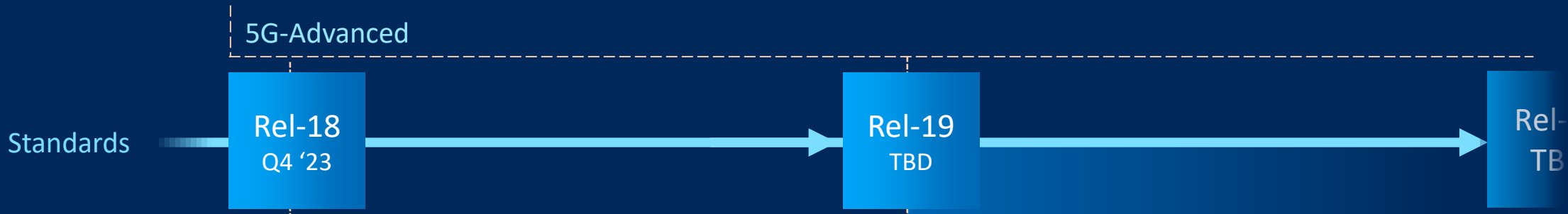


LRF: Location Retrieval Function
GMLC: Gateway Mobile Location Centre

Other Rel-17 enhancements

- 5G System Enhancement for Advanced Interactive Services (5G-AIS).
- Multimedia Priority Service (MPS) Phase 2:
- Support of advanced V2X services - Phase 2
- Architecture aspects for using satellite access in 5G.
- Efficient support of devices with Multi-USIM
- Enhancement of Network Slicing Phase 2
- Architecture Enhancement for NR Reduced Capability Devices
  - Aim to support devices with capability between NR-IoT/eMTC and eMBB
  - Targeting IoT use cases such as industrial sensors, video surveillance. Interest in wearable device use case growing.
  - Capability reduction encompassing complexity, size, bandwidths, antennas, power consumption, etc
- Minimization of Service Interruption (MINT)

5G-Advanced – Capabilities Still to Come



- Study on System Enabler for Service Function Chaining
- Study on Generic group management, exposure and communication enhancements
- Study on Access Traffic Steering, Switching and Splitting support in the 5GS; Ph3
- Study on enhanced support of Non-Public Networks - Ph2
- Study on Phase 2 for UAS, UAV and UAM
- Study on Extensions to the TSC Framework to support DetNet
- Study on 5G Timing Resiliency and TSC & URLLC enhancements
- Study on RedCap Phase 2
- Study on Vehicle Mounted Relays
- Study on 5GC LoCation Services Ph3
- Study on Edge Computing Ph2
- Study on 5G System with Satellite Backhaul
- Study on the support for 5WWC Ph3
- Study on Network Slicing Ph3
- Study on 5G AM Policy
- Study on Personal IoT Networks
- Study on evolution of IMS multimedia telephony service
- Study on 5G multicast-broadcast services Ph2
- Study on XR (Extended Reality) and media services
- Study on Ranging based services and sidelink positioning
- Study on System Support for AI/ML-based Services
- Study on Enhancement of 5G UE Policy
- Study on Enablers for Network Automation for 5G - Ph3
- Study on satellite access Ph2
- Study on UPF enhancement for Exposure And SBA
- Study on Proximity-based Services in 5GS Ph2
- Study on Seamless UE context recovery

Timing, features and enhancements TBD

For Rel-18, currently SA2 has 27 Study Items and 1 Work Item in progress

3GPP Release 17 RAN Features

Completing the first phase of the 5G evolution

To bring new system capabilities and expand 5G
to new devices, applications, and deployment

Wanshi Chen

3GPP TSG RAN Plenary Chair

Qualcomm Technologies Inc.

April 20th, 2020

Our presenter

Wanshi Chen

3GPP TSG RAN Chair

Sr. Director, Technology, Qualcomm Technologies, Inc.

Agenda

1. Where are we now with 5G?
2. What new 5G technologies are in Release 17?
3. How will 5G Advanced take us closer to 6G?
4. Questions?

5G Accelerating Globally

205+
Operators with 5G commercially deployed

280+
Additional operators investing in 5G

750M+
5G smartphones to ship in 2022

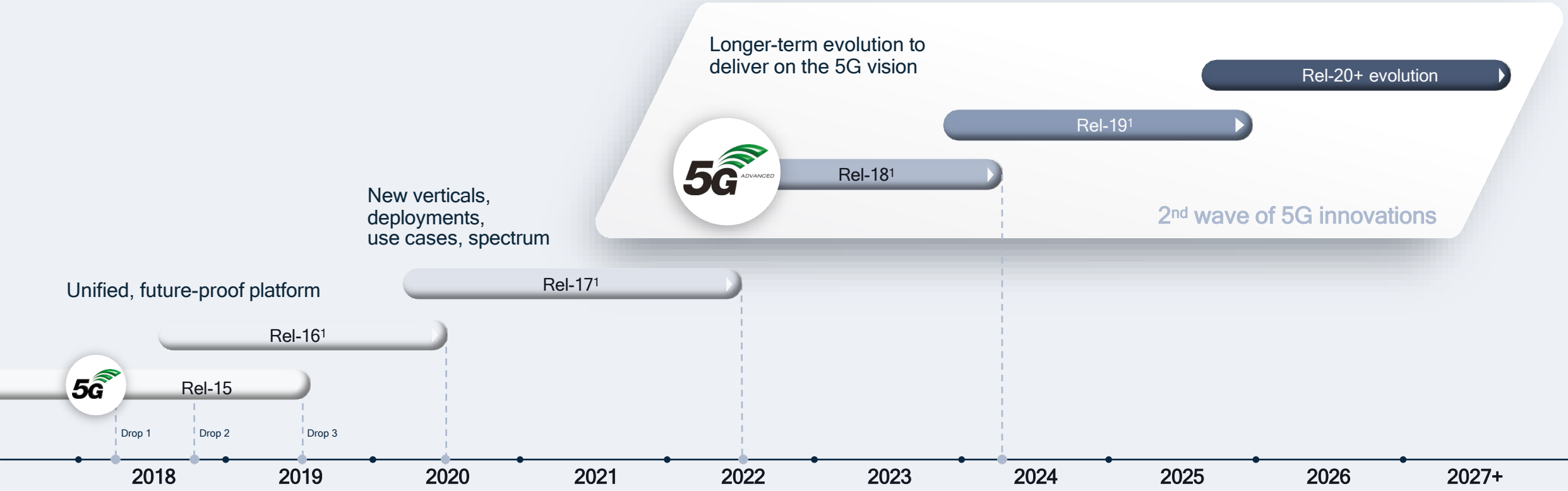
1B+
5G connections by 2023 – 2 years faster than 4G

5B+
5G smartphones to ship between 2020 and 2025

1275+
5G designs launched or in development

Sources – 5G commercial networks, operators investing in 5G: GSA, Feb '22. 5G device shipment projections: Qualcomm estimates, Feb '22. 2023 5G connection projections: average of ABI (Sep '21), Ericsson (Jun '21) and GSMA Intelligence (Sep 20=='21). 5G cum. smartphone shipments: average of CCS Insight (Sept '21), Counterpoint Research (Dec '21), IDC (Nov '21), Strategy Analytics (Oct '21); Launched / announced devices: GSA, Feb '22.

Driving the 5G technology evolution in the new decade



Rel-15 eMBB focus

- 5G NR foundation
- Sub-7 and mmWave
- Scalable & forward compatible
- Basic URLLC support
- mMTC via eMTC & NB-IoT

Rel-16 industry expansion

- Unlicensed spectrum (NR-U)
- Enhanced URLLC
- New functionalities: Sidelink (NR V2X), Positioning
- 5G broadcast
- eMTC/NB-IoT with 5G core
- Topology: IAB
- eMBB enh: MIMO, device power, CA/DC, mobility

Rel-17 continued expansion

- mmWave extended to 71GHz
- Lower complexity “NR-Light” (RedCap)
- Non-terrestrial communication (satellites): NR NTN and NTN IoT
- Improved IIoT, positioning, V2X
- Enhanced IAB, RF repeaters

Rel-18+ 5G-Advanced

- Next set of 5G releases (i.e., 18, 19, 20, …)
- Rel-18 scope decided in Dec ’21
- Rel-18 study/work to start in Q2-2022

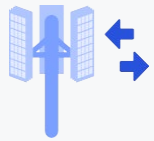
1. 3GPP start date indicates approval of study package (study item->work item->specifications), previous release continues beyond start of next release with functional freezes and ASN.1

3GPP Release 17

A key 5G milestone: 3GPP Release 17 Completion

Functional freeze in March 2022 and ASN.1 freeze expected in June 2022

New and enhanced 5G system capabilities

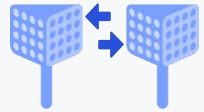


Further enhanced massive MIMO

Coverage enhancements

Device power savings

Spectrum expansion (60 GHz)



Enhanced IAB and RF repeater

Further enhanced URLLC, private networks, others…

Expansion to new 5G devices and applications

Sidelink expansion

Broadcast/ multicast expansion

NR-Light (RedCap), enhanced mIoT

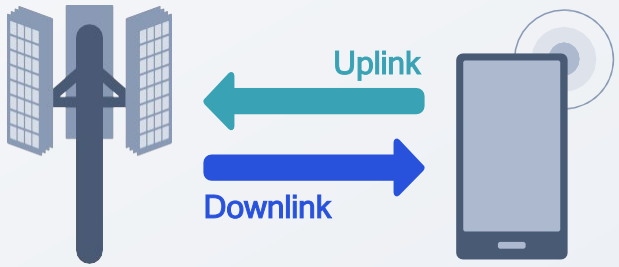
Non-terrestrial networks (NTN)

Enhanced precise positioning

Boundless XR study, others…

Strengthen the end-to-end 5G system foundation

Further enhancing
5G mobile broadband
and expanded use cases



Further enhancing 5G massive MIMO performance

Focus areas for Release 17 Work Item

Enhanced multi-beam operation

- Unified TCI[1] framework in DL/UL[2] to reduce latency and overhead
- UL beam selection for multi-panel devices
- More efficient L1/L2[3] intra-and inter-cell mobility

SRS[7] improvements

- More flexible triggering of aperiodic SRS and DCI[8] overhead reduction
- SRS switching for up to 8 antennas
- Improved SRS reliability such as repetitions and time bundling

Enhanced multi-TRP[4] deployment

- Improved reliability for DL control, UL control and data channels
- QCL[5] for inter-cell multi-TRP reusing L1/L2 mobility measurements
- Beam management for multi-panel Rx
- High-speed SFN[6] enhancements

CSI[9] measurement & reporting

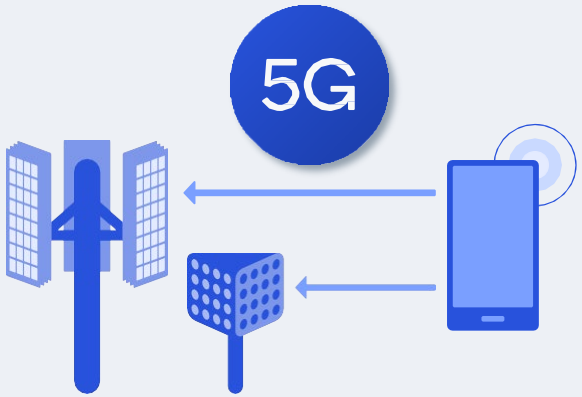
- DL/UL reciprocity of angle and delay for FDD[10]
- More dynamic channel/interference hypotheses for non-coherent joint transmission

Source: RP-212535 (Further enhancements on MIMO for NR)

1 Transmission Configuration Indicator; 2 Downlink/Uplink; 3 Layer-1/Layer-2;
4 Transmission and Reception Points; 5 Quasi Co-Location;
6 Single Frequency Network; 7 Sounding Reference Signal;
8 Downlink Control Information; 9 Channel State Information;
10 Frequency Division Duplex

Improving 5G uplink coverage

Targeting urban and rural deployments using sub-7 GHz and mmWave, also applies to satellites (NTN[1]) communication



Coverage enhancements Work Item

3GPP Release 17

- **Uplink data channel (PUSCH[2]) enhancements**
  Increasing the maximum numbers of repetitions, supporting transport block processing over multiple slots, and enabling joint channel estimation across multiple transmissions and frequency hopping
- **Uplink control channel (PUCCH[3]) enhancements**
  Supporting dynamic repetitions for better reliability, DMRS[4] bundling across repetitions based on similar mechanisms for enabling joint channel estimation for PUSCH
- **Message 3 enhancements**
  Supporting Type A PUSCH repetitions for capability signaling, barring, and early indication

Source: in RP-211566 (NR coverage enhancements)

1 Non-terrestrial Network; 2 Physical Uplink Shared Channel;
3 Physical Uplink Control Channel; 4 Demodulation Reference Signal

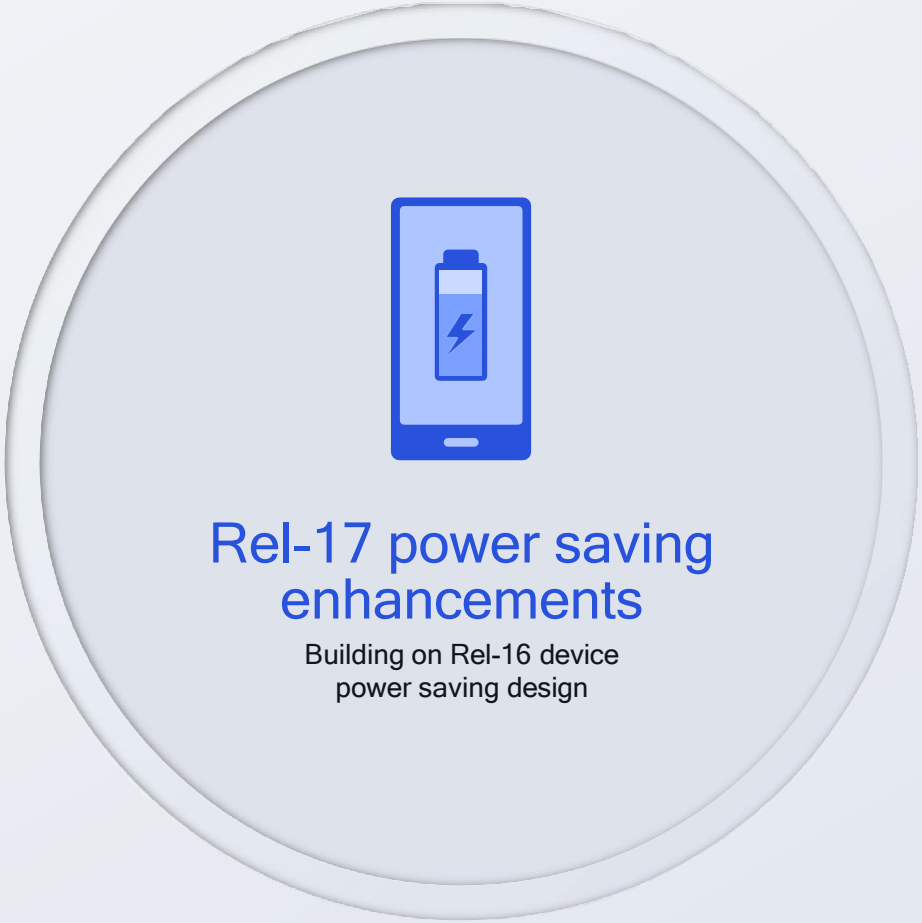
Further enhancing device power efficiency

For idle/inactive mode

Techniques to reduce unnecessary device paging reception (false alarms) without impacting legacy devices

Providing potential TRS[1]/CSI-RS[2] to devices in idle/inactive mode with minimized system overhead impact

Supporting PDCCH[3]-based permanent equipment identifier (PEI)



For connected mode

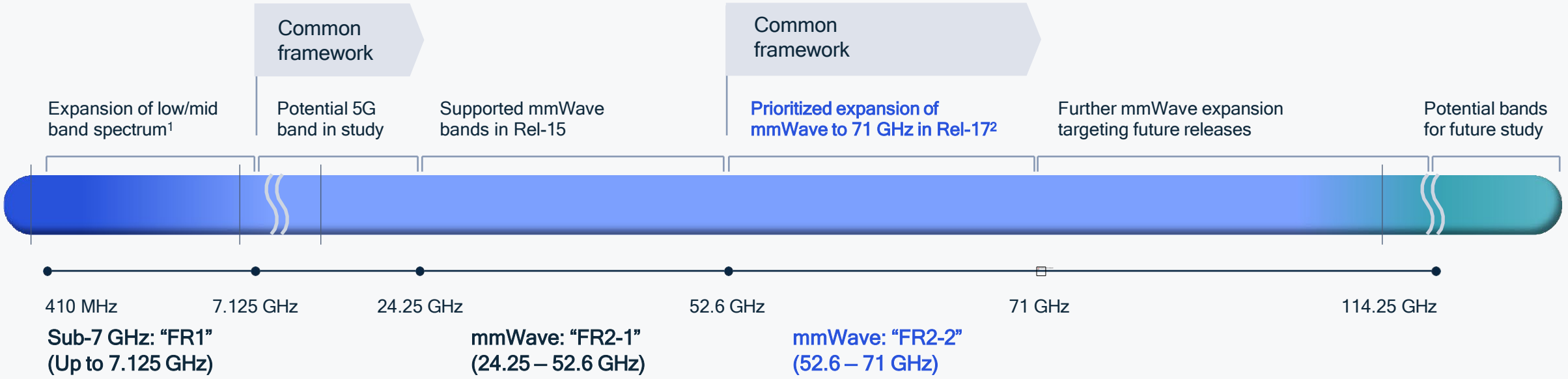
Extending to Rel-16 DCI[4]-based power saving adaptation for an active BWP[5], including PDCCH monitoring skipping during C-DRX[6]

Relaxing device measurement for RLM[7] and/or BFD[8] for low mobility devices with short DRX[9] cycle

Source: RP-212630 (UE Power Saving Enhancements)

1 Tracking Reference Signal; 2 Channel State Information Reference Signal; 3 Physical Downlink Control Channel; 4 Downlink Control Information; 5 Bandwidth Part; 6 Connected Discontinued Reception; 7 Radio Link Monitoring; 8 Bidirectional Forwarding Detection; 9 Discontinued Reception

Scaling 5G NR design to support 60 GHz unlicensed band



Design Principles

SCS[3] for control/data channels

Leveraging existing design of 120 kHz, and scaling to wider numerology of 480 kHz and 960 kHz

SSB[4] numerology

Supporting 120 kHz (480 kHz optional) for initial access, 120 kHz (480 kHz, 960 kHz optional) for non-initial access, and 64 SSB beams

Channel access mechanisms

Supporting flexible deployment in unlicensed spectrum utilizing LBT[5], directional LBT, or no LBT

Beam management

Reusing designs based on existing mmWave frequency range (FR2-1) established in Release 15 and 16

1. Rel-15 supported 450 MHz to 6 GHz; 2 To support global unlicensed 60 GHz bands, SCS scaling from 24.25-52.6 GHz band with same characteristics (e.g., waveforms);
3 Subcarrier Spacing; 4 Synchronization Signals Block; 5 Listen-Before-Talk

Further enhancing ultra-reliable, low-latency communications

Release 17 Work Item targeting to meet more stringent requirements of Industry 4.0 applications

Enhanced physical layer feedback

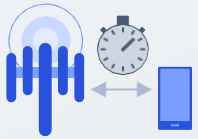
- Improved device feedback for HARQ-ACK[1]
- New mechanism triggered aperiodic CSI[2] and SRS[3] for more accurate MCS[4] selection
- Improved reliability with uplink control[5] on two carriers
- Subband CQI[6] with more granularity

Improved compatibility for unlicensed spectrum

- Supporting device-initiated COT[7] for FBE[8]
- Harmonizing uplink configured-grant enhancements in Rel-16 NR-U[9] and URLLC[10] to be applicable for unlicensed spectrum

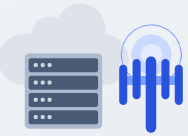
Intra-device multiplexing and prioritization

- Handling low-priority traffic on eMBB without impacting data flow in case of URLLC concurrency
- Parallel PUCCH and PUSCH[11] transmissions on different component carriers for inter-band CA[12]



Enhanced time synchronization

Supporting uplink RTT[13]-based method for TSN[14] and improved propagation delay compensation

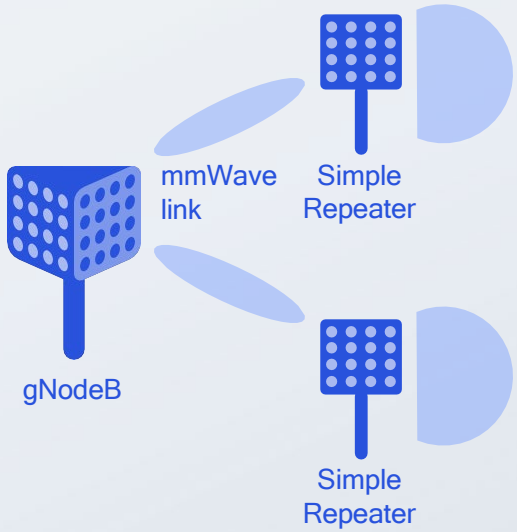


Network enhancements

Based on new QoS[15] related parameters such as survival time, burst spread

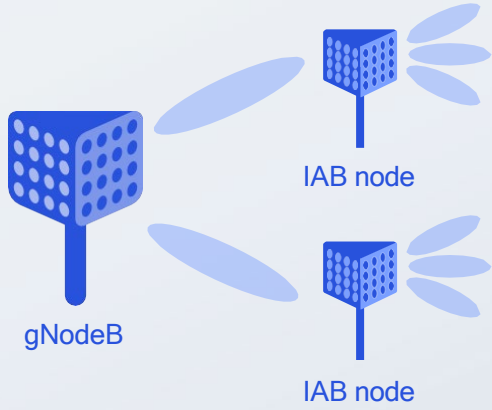
Source: RP-210854 (Enhanced Industrial Internet of Things and ultra-reliable and low latency communication support for NR)

1 Hybrid Automatic Repeat Request Acknowledge; 2 Channel State Information; 3 Sounding Reference Signal; 4 Modulation and Coding Scheme; 5 PUCCH - Physical Uplink Control Channel; 6 Channel Quality Indicator; 7 Channel Occupancy Time; 8 Frame Based Equipment; 9 NR Unlicensed; 10 Ultra Reliable Low Latency Communication; 11 Physical Uplink Shared Channel; 12 Carrier Aggregation; 13 Round Trip Time; 14 Time Sensitive Networking; 15 Quality of Service



RF Repeaters

Introduced RF repeaters (without adaptive beamforming) that can operate in sub-7 GHz (FDD/TDD) and mmWave, leveraging IAB and LTE repeaters work;
“Smart” network-controlled repeater in Rel-18



Integrated Access & Backhaul (IAB)

Enhanced Rel-16 IAB design by adding support for simultaneous Tx and Rx (spatially separated full duplex), inter-donor migration / handover, and multi-hop efficiency enhancements

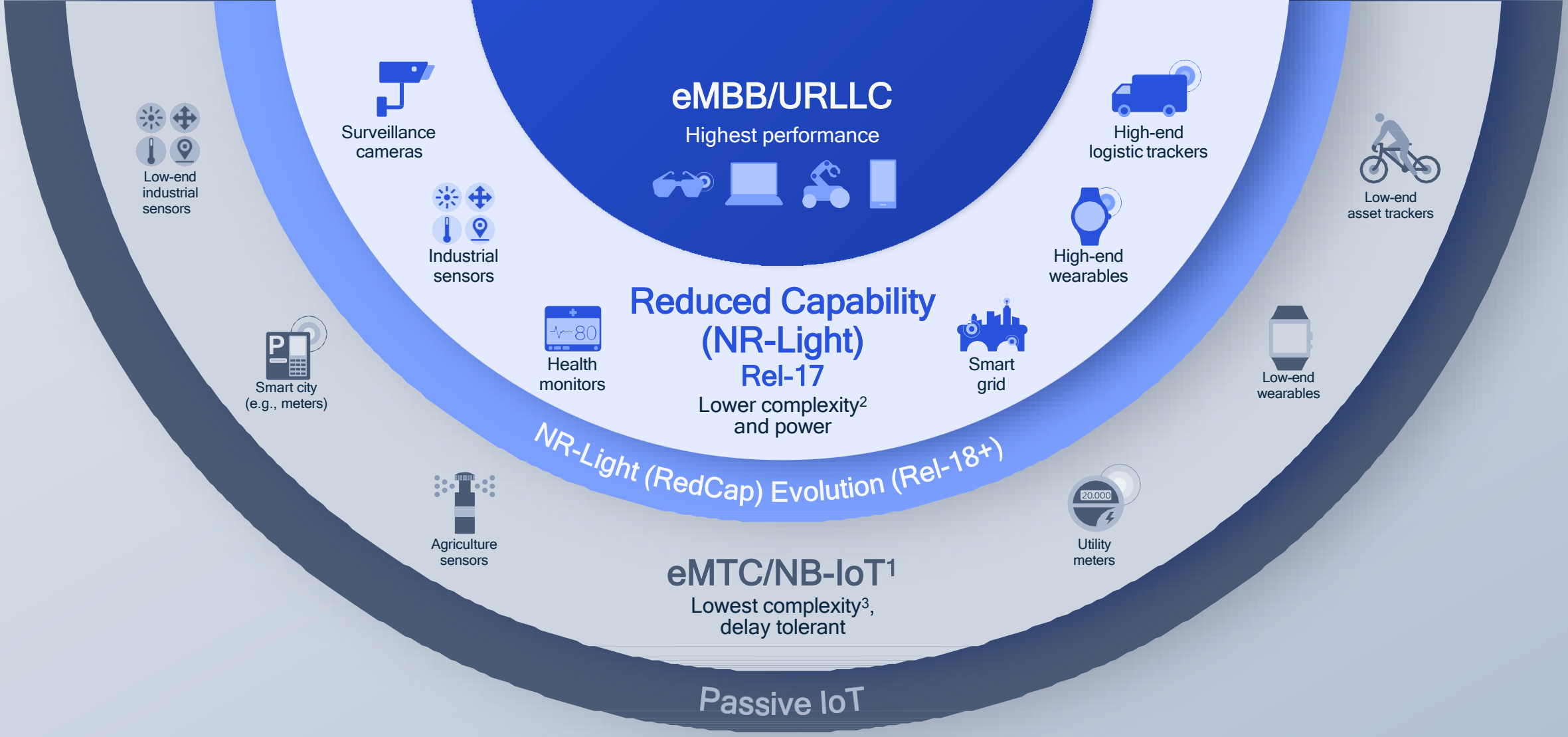
Efficiently expand 5G mmWave coverage

New mmWave infrastructure options introduced as part of Release 17

Source: RP-213514 (WID for NR Repeaters); RP-213668 (WID for IAB enh)

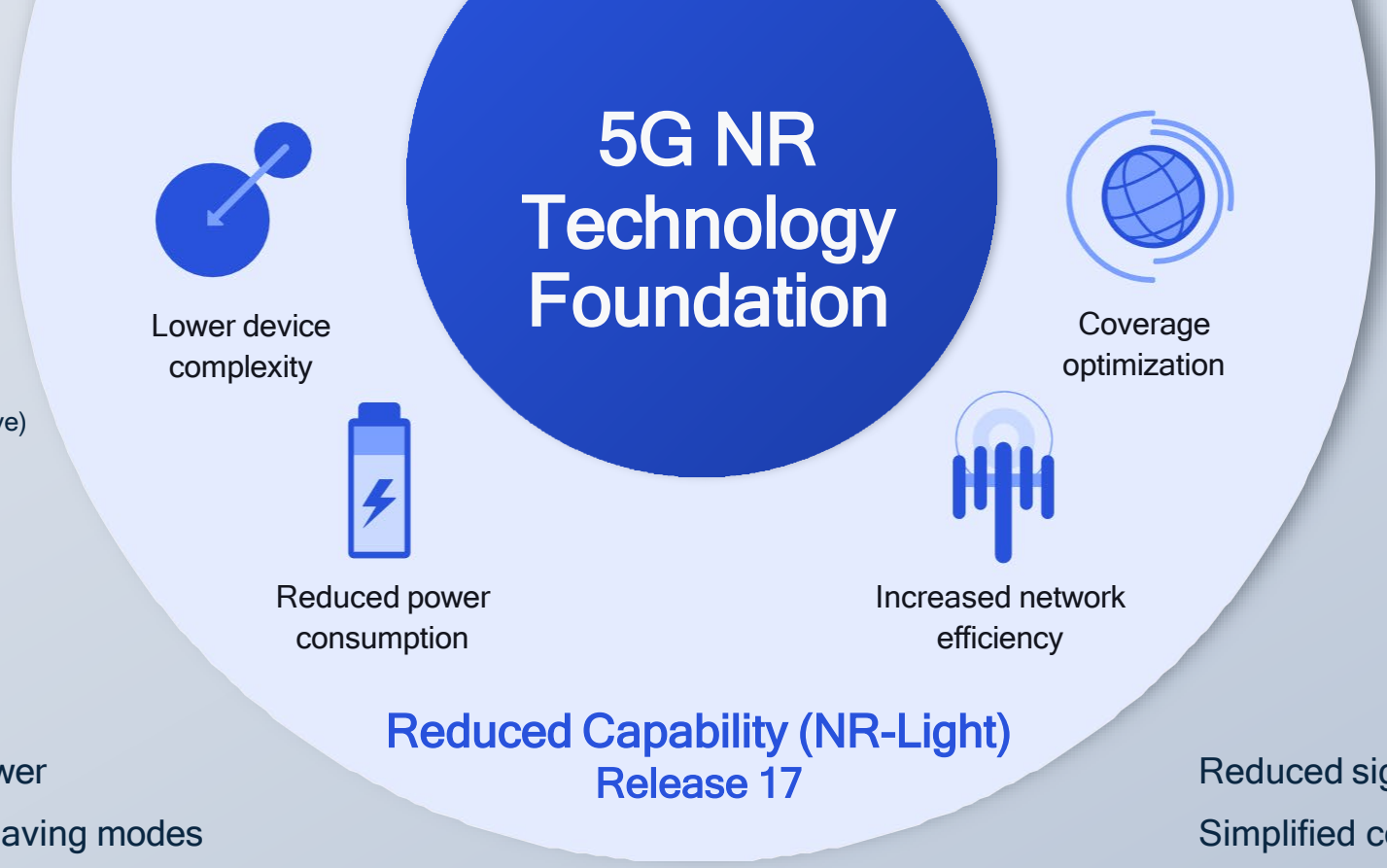
Proliferate 5G to virtually all devices and use cases

Continued expansion to new device types and tiers – fulfilling the 5G vision



5G NR: A unified, scalable air interface allowing coexistence of a wide range of 5G device classes

1 Also including satellite access; 2 Data rate of 150 Mbps DL / 50 Mbps UL, latency of 10-30 ms, 10-3 to 10-5 reliability, coverage MCL of 143 dB; 3 Data rate of 1Mbps, MCL of 155.7 dB (eMTC) and 164 dB (NB-IoT)



Narrower bandwidths
(20 MHz in sub-7, 100 MHz in mmWave)

Fewer receive antennas
(1 or 2 Rx)

Half duplex

Repetition and bundling

Lower order modulation
(256-QAM optional)

Sidelink or relays

Lower transmit power

Enhanced power saving modes

Limited mobility and handovers

Reduced signaling overhead

Simplified core network

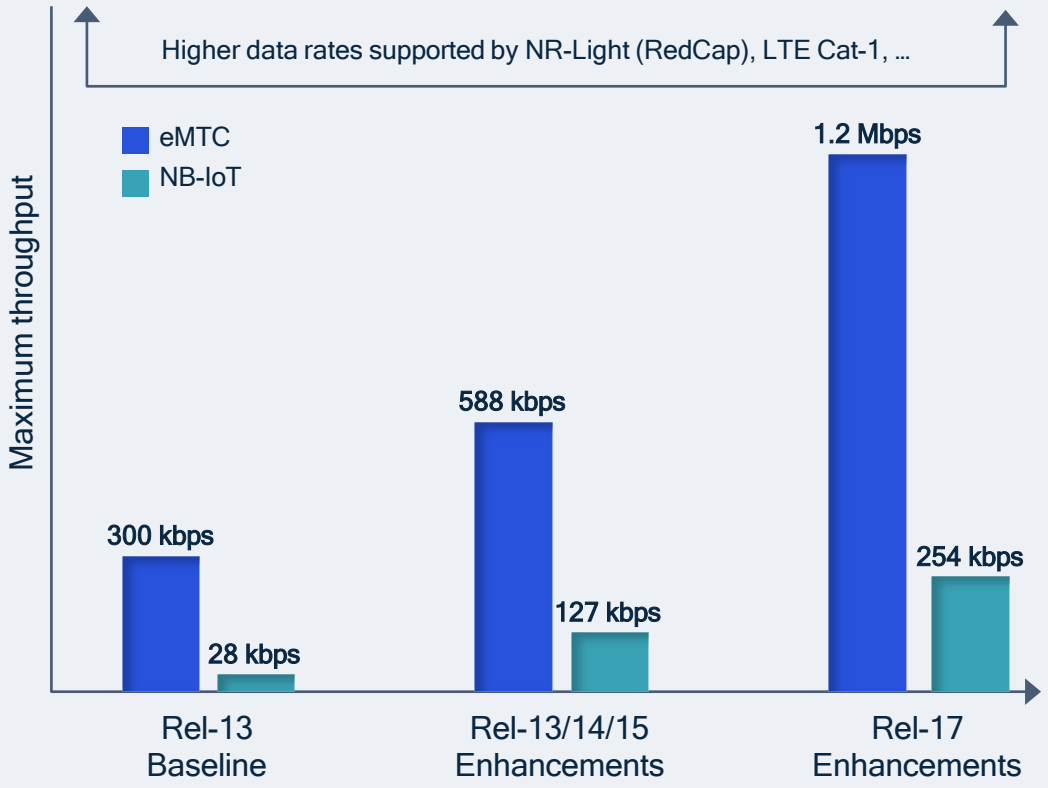
Better resource management

Scaling down 5G NR for lower complexity IoT devices

Source: RP-211574 (Support of reduced capability NR devices)

Continued 5G massive IoT evolution with eMTC/NB-IoT

Release 17 Work Item enhancements



eMTC enhancements

Supporting larger TBS[1] sizes and 14 HARQ[2] processes to increase data rate for half-duplex FDD[3] devices

Supporting power boosting for devices with PUSCH[4] sub-PRB[5] resource allocation

Adding an optional device capability to support a maximum DL TBS of 1,736 bits for half-duplex FDD devices

NB-IoT enhancements

Supporting 16-QAM for UL and DL unicast, increasing in maximum TBS sizes for DL compared to Rel-16 NB-IoT and extended channel quality reporting

Reducing the time taken to recover from RLF[6], with new signaling for neighbor cell measurements and triggering

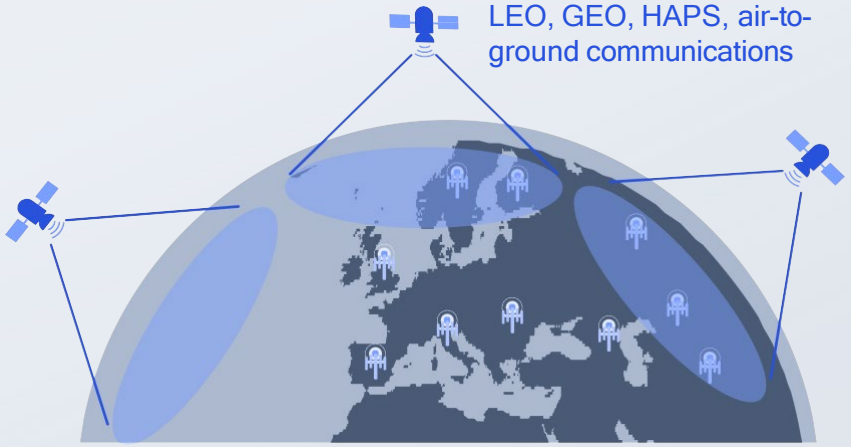
Introducing carrier selection based on coverage level and associated carrier specific configurations

Source: RP-211340 (Additional enhancements for NB-IoT and LTE-MTC)

1 Transport Block Size; 2 Hybrid Automatic Repeat Request; 3 Frequency Division Duplex; 4 Physical Uplink Shared Channel; 5 Physical Resource Block; 6 Radio Link Failure

5G NR for NTN

Complementing terrestrial networks in underserved areas



Supporting satellites backhaul communication for CPEs and direct link to handhelds (e.g., smartphones) for low data rate services

Utilizing sub-7 GHz S-band with additional bands added in the future (e.g., 10+ GHz in Rel-18 proposed)

5G IoT for NTN

Expanding addressable market for the 5G massive IoT

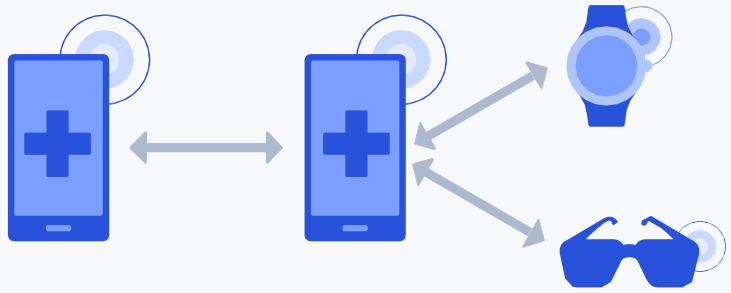
Supporting diverse use cases, including transportation, utilities (e.g., solar, oil/gas), farming, mining, environmental monitoring

Utilizing sub-7 GHz band for both eMTC and NB-IoT, with LTE EPC[1] only in standalone network

Release 17 establishes 5G NR support for satellites communication

Source: RP-210908 (NTN Enhancements); RP-211601 (NB-IoT/eMTC support for Non-Terrestrial Networks)
1 Enhanced Packet Core

Release 17 Work Item expands sidelink to new use cases



Release 17 Sidelink Enhancements

For public safety, IoT, commercial use cases and beyond

Updated sidelink evaluation methodology

Reusing existing evaluation assumption and performance metric[1], based on feedback from car manufacturers

Improved resource allocation

Reducing device latency, power consumption, and improving reliability (e.g., half duplex, collision detection indication, control forwarding, inter-device coordination)

Power saving enhancements

Defining sidelink DRX for broadcast, groupcast, unicast, and power-efficient resource selection for devices

New sidelink frequency bands

Ensuring sidelink and network communication coexistence in the same and adjacent channels in licensed spectrum

Geographic confinement

Limiting sidelink operations to be within a predetermined area for a given frequency range in non-ITS[2] bands

Sidelink relay

L2/L3 device to network relay for coverage extension,
Follow-up work Item for device-to-device relay in scope for Release 18

Source: RP-202846 (NR Sidelink enhancement); RP-212601 (NR Sidelink Relay)
1TR 36.843 and/or TR 38.840; 2 Intelligent Transport System

5G positioning evolution

5G Advanced

Release 16

Establishing foundation

Achieving accuracy of 3m/10m (indoor/outdoor) for 80% of time

Supporting RTT[1], AoA/AoD[2], TDOA[3], single-cell positioning

Including new evaluation scenarios, i.e., industrial IoT

Release 17

Enhancing capability and performance for a wide range of use cases[4]

Centimeter-level accuracy

Meeting accuracy requirements for commercial use cases (<1m) and IIoT (<0.2m within 100ms)

- Mitigating device and base station Rx/Tx timing delays
- Improving accuracy for UL AoA and DL-AoD positioning
- Enhancing information reporting for multipath & NLOS[5] mitigation

Reduced positioning latency

Optimizing positioning latency to as low as 10ms, related to the request / response of location, device measurement time and gaps

Improved efficiency

Scaling to higher capacity by supporting device positioning in inactive state and on-demand PRS[6], triggered by network or device

GNSS[7] enhancements

Improve the performance and efficiency for 5G positioning with assistance information from GNSS, supporting GNSS positioning integrity determination, BeiDou positioning signals (BDS B2a and B3I), and NavIC[8] for 5G NR

5G positioning evolution in Release 18+

Improving performance, expanding to new devices and deployments

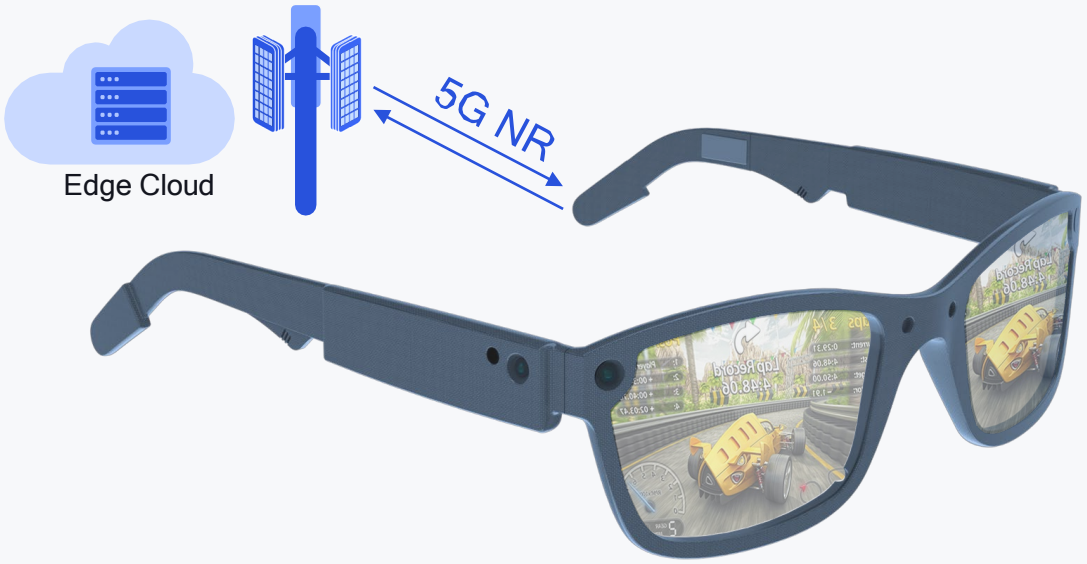
Pushing forward with the 5G positioning technologies

Source: RP-210903 (NR Positioning Enhancements); RP-201518 (Positioning use cases for V2X & PubS)

1 Roundtrip Time; 2 Angle of Arrival, Angle of Departure; 3 Time Difference of Arrival; 4 Including a Study for sidelink positioning for V2X and public safety; 5 Non-line-of-slight; 6 Positioning Reference Signal; 7 Global Navigation Satellite System; 8 Indian Regional Navigation Satellite System

Optimizing 5G NR for Boundless XR experiences

Release 17 Study Item for XR over 5G NR – Work Item in scope for Release 18



Use cases in scope

- Distributed computing
- Split rendering
- Viewpoint dependent streaming
- Conversational XR
- Cloud gaming

Traffic requirement

Identifying requirements for use cases in scope, such as roundtrip time, one-way packet delay budget, and packet error rate, taking different upper layer assumptions into consideration

Evaluation methodology

Assessing XR (including VR, AR) and cloud gaming performance along with identification of KPIs for relevant deployment scenarios

Performance evaluation

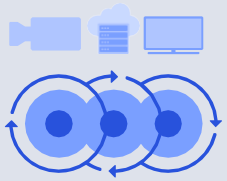
Carrying out characterization of XR system performance based on agreed upon evaluation methodologies

Source: RP-210460 (Study on XR Evaluations for NR)

UHF[1] broadcast frequencies

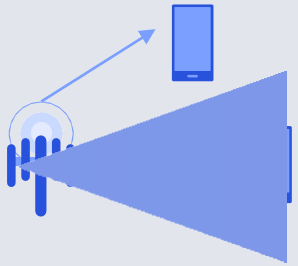
Adding support for 6/7/8 MHz carrier bandwidths[2] to support UHF bands

CMAF[3]-based streaming ecosystem



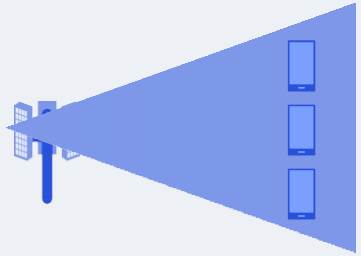
Targeting low-latency broadcast distribution and 5G media streaming

Simultaneous broadcast + unicast



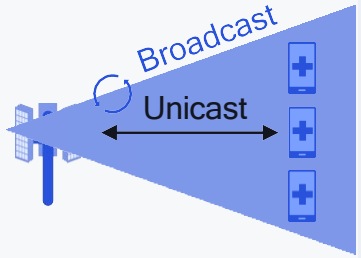
Optimizing modem resource usage and enabling fast broadcast service discovery

Multicast operation for 5G NR



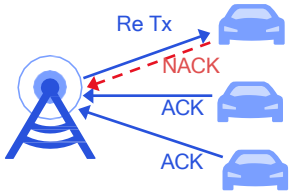
Supporting group scheduling, mobility, DRX[4], reception in idle and transparent SFN[5]

Broadcast and unicast dynamic switching



Enabling dynamic switching between unicast & broadcast (e.g., for public safety use cases)

Improved robustness and efficiency



Supporting uplink HARQ[6] feedback and retransmissions for link adaptation and reliability

5G Standalone Broadcast (Rel-17) → 5G Mixed-mode Multicast (Rel-17)

Continue to evolve the end-to-end design for 5G broadcast

Source: RP-211144 (New bands and bandwidth allocation for LTE based 5G terrestrial broadcast); RP-201038 (Revised Work Item on NR Multicast and Broadcast Services)
1 Ultra high frequency, i.e., 470 to 698 MHz; 2 In additions to currently support carrier bandwidths of 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz, 20MHz;
3 Common media application format; 4 Discontinued Reception; 5 Single Frequency Network; 6 Hybrid Automatic Repeat Request

Other RAN projects in 3GPP Release 17

DSS[1] enhancements

Enable PDCCH[2] cross-carrier scheduling from a SCell[3] to a P(S)cell[4] in sub-7 GHz

Enhanced multi-radio DC[5]

Support efficient activation/de-activation of one SCG[6] and SCells, and conditional PSCell change/addition

Multi-SIM[7]

Support dual-standby, 1 active and 1 idle SIM, device-indicating network switch, and SIM from different MNOs[8]

Higher-order modulation

Support 1024-QAM for downlink and 256-QAM for sub-7 GHz uplink communication

Small data transmission

Allow uplink data in inactive mode (in either 2-step or 4-step RACH[9]) with defined small data request message

High-speed train

Optimize 5G support for high-speed trains for both sub-7 GHz and mmWave

Uplink data compression

Utilize LTE procedure as baseline for 5G NR Standalone mode only

Enhanced data collection

Add new data categories for SON/MDT[10] (mobility, energy saving, capacity, coverage, …), and for RAN AI (use cases, types of input/output)

RAN[11] slicing

Support slice-based cell reselection, RACH configuration, service continuity, enforcement of slice maximum bit rate

Enhanced private network

Access to standalone private networks using credentials from a different entity, IMS voice, emergency services.

Quality of experience

Enable measurement collection in Standalone mode with mobility continuity and per-slice support.

User-plane integrity protection

Strengthen 5G security with integrity protection for user-plane in addition to control-plane using 5G NR PDCP[12]

Source: RP-211345 (NR Dynamic spectrum sharing); RP-201040 (Further Multi-RAT Dual-Connectivity enhancements); RP-213679 (Multi-SIM?); RP-202886 (NR DL 1024-QAM); RP-212594 (NR small data transmissions in INACTIVE state); RP-210833/210800 (NR High Speed Train); RP-211203 (NR Uplink Data Compression); RP-212534 (Enhancement of RAN Slicing for NR); RP-213574 (Data collection for SON/MDT); RP-201620 (Enhancement for data collection for NR and ENDC); RP-211406 (NR QoE management and optimizations for diverse services); RP-212585 (Enhancement of Private Network Support); RP-213669 (UPIP support for EPC connected architectures)

1 Dynamic Spectrum Sharing; 2 Physical Downlink Control Channel; 3 Secondary Cell; 4 Primary/Secondary Cell; 5 Dual Connectivity; 6 Secondary Cell Group; 7 Subscriber Identity Module; 8 Mobile Network Operator; 9 Random Access Procedure; 10 Self Organizing Network, Minimization of Drive Test; 11 Radio Access Network;12 Packet Data Convergence Protocol

How will 5G Advanced bring us a step closer to 6G?

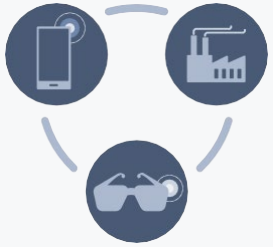
Continued evolution towards 6G

Leading the 5G Advanced technology evolution on the path to 6G

Creating new value across applications

Driving a balanced 5G evolution across key technology areas

Mobile broadband evolution vs. further vertical expansion

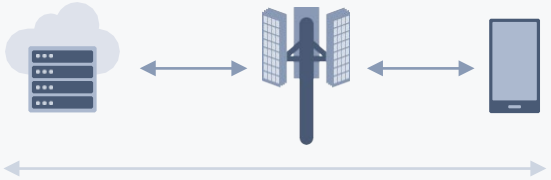


Deliver enhanced mobile broadband experiences and extend 5G's reach into new use cases

Immediate commercial needs vs. longer-term 5G vision

Drive new value in commercialization efforts and fully realize 5G's potential with future deployments

New and enhanced devices vs. network evolution



Focus on the end-to-end technology evolution of the 5G system to bring new levels of performance

Release 18 scope takes into consideration of the 5G Advanced evolution in Release 18, 19, and beyond (i.e., many Study Items defined to set up for Work Items in later releases)

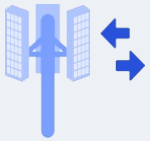
5G ADVANCED

Release 18

3GPP Release 18 sets off the 5G Advanced Evolution

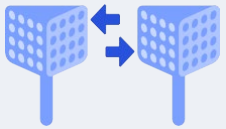
Approved package has a wide range of projects – nominal work to start in Q2 2022

Strengthen the end-to-end 5G system foundation



Advanced DL/UL MIMO

Enhanced mobility



Mobile IAB, smart repeater

Evolved duplexing

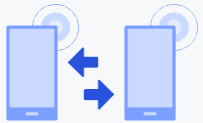
AI/ML data-driven designs

Green networks

Proliferate 5G to virtually all devices and use cases

Boundless extended reality

NR-Light (RedCap) evolution



Expanded sidelink

Expanded positioning

Drones & expanded satellites comm.

Multicast & other enhancements

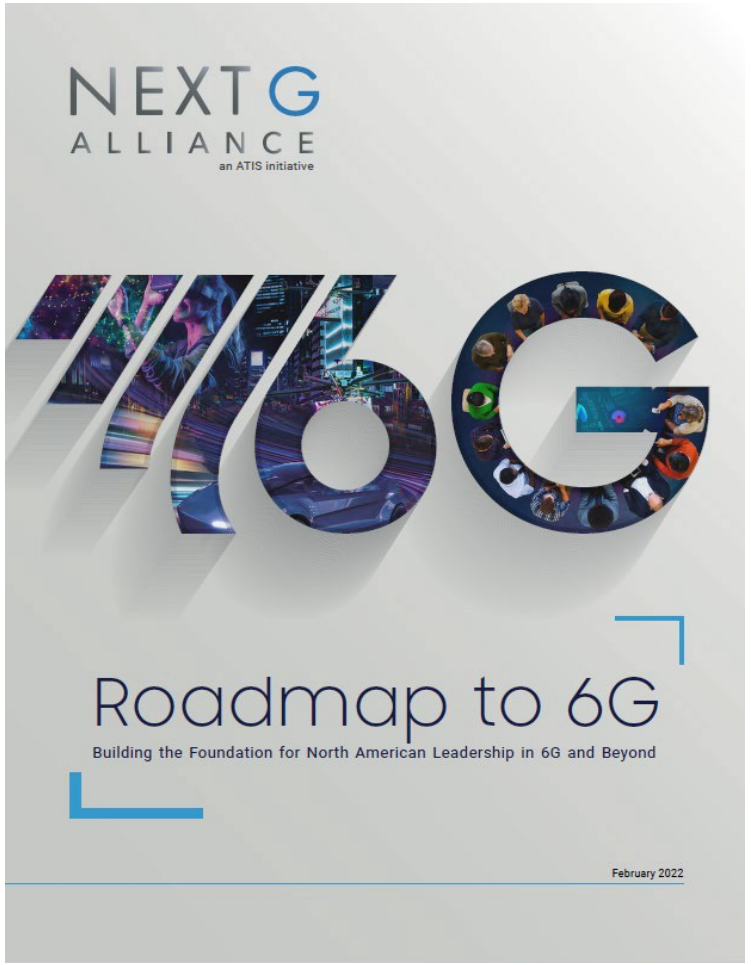
PROGRESS TOWARDS 6G AND CONCLUSION

Iain Sharp

Principal Technologist

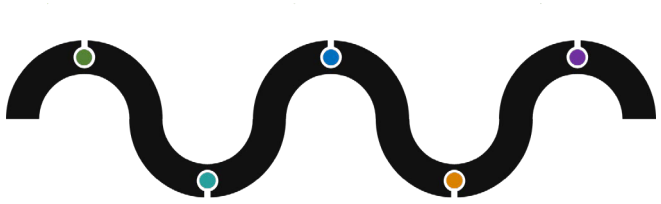
ATIS Next G Alliance – Building the Foundation for North American Leadership in 6G and Beyond

- Next G Alliance membership covers a broad ecosystem:
  - Operators, Vendors, Hyperscalers, Academia, Government, Research Labs
- Next G Alliance "*Roadmap to 6G*" report and presentations are available at:
  - roadmap.nextgalliance.org
- Foundation for North American 6G Vision and Leadership



Foundations for Next G Alliance 6G Vision

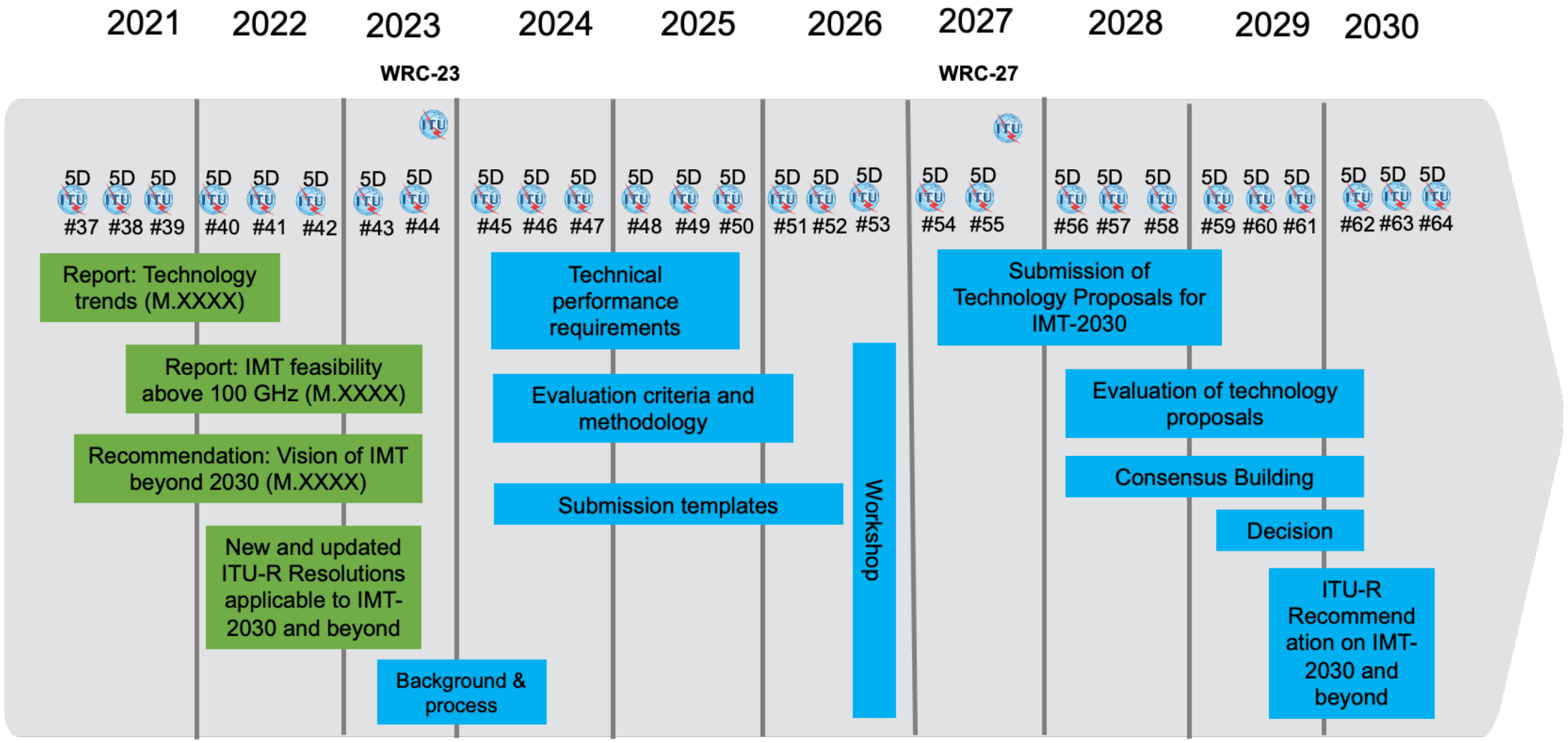
Audacious Goals create the framework for advancing North American leadership and positioning a robust 6G marketplace



North American 6G Roadmap defines the path for connecting every stage of the lifecycle and progressing to an end-of-decade 6G Vision

6G Leadership Priorities incorporate innovative applications, societal needs, economic goals, government actions and technology developments

ITU-R "IMT towards 2030 and Beyond"



Conclusion – Successfully Advancing 5G Goals and Preparing for 6G

- 3GPP is successfully evolving the 5G platform to enhance performance, efficiency and meet new use-cases
- Completing 3GPP Release 17 in the face of Covid-19 is a major achievement
- 3GPP Release 18 will herald the era of *5G Advanced*
- Industry and nations are preparing for the next generational transition:
  - 5G will dominate the market for another decade
  - For 6G, now is the time to define the vision and research priorities

ADVANCING INDUSTRY TRANSFORMATION

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