

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



Project Coordination Group (PCG) and Organizational Partners (OP)

1. Services - Greg

2. Systems
Architecture - Puneet

3. Radio Access
Network - Wanshi

TSG SA

Service and System Aspects

WG SA 1

Service Requirements

WG SA 2

System Architecture

WG SA 3

Security

WG SA 4

Codecs and Media Handling

WG SA 5

Telecom Management

WG SA 6

APIs and Vertical Applications

TSG CT

Core Network and Terminals

WG CT 1

Radio Application Protocols

WG CT 3

External Interworking

WG CT 4

Core Network Protocols

WG CT 6

Smart Card Application

TSG RAN

Radio Access Network

WG RAN 1

Radio Layer 1

WG RAN 2

Radio Layer 2 and 3

WG RAN 3

Radio Network Interfaces

WG RAN 4

Radio Performance Aspects

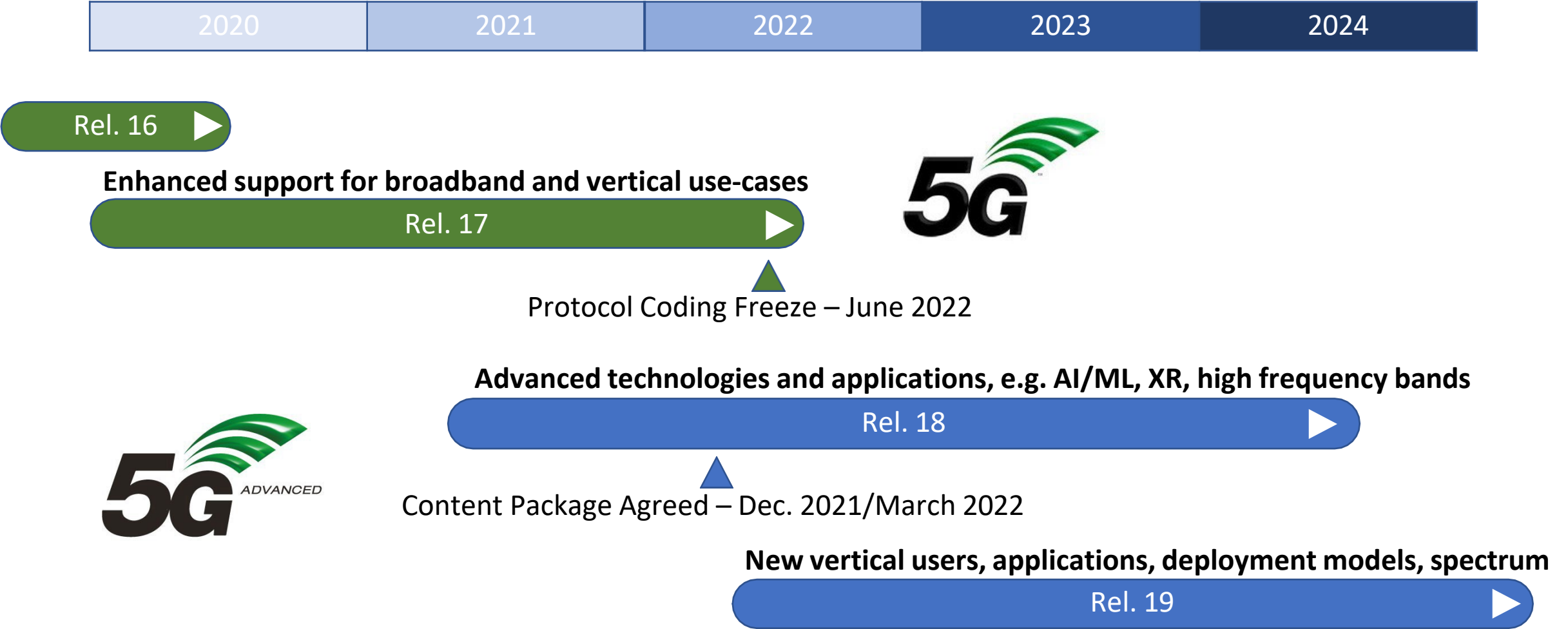
WG RAN 5

Mobile Conformance Testing

TSG = Technical Specification Group

WG = Working Group

3GPP Release Roadmap



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

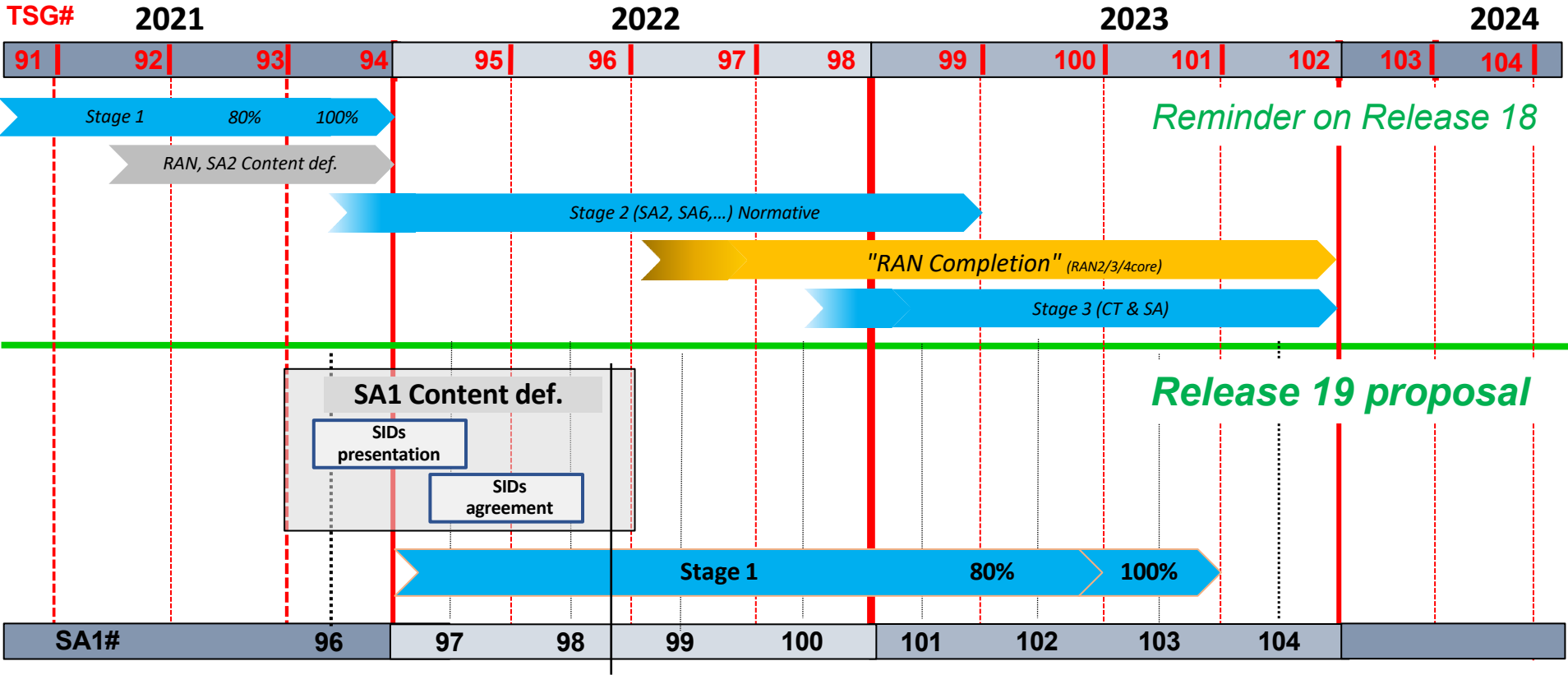
SA 1 Release 18 (1/2)

- 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



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

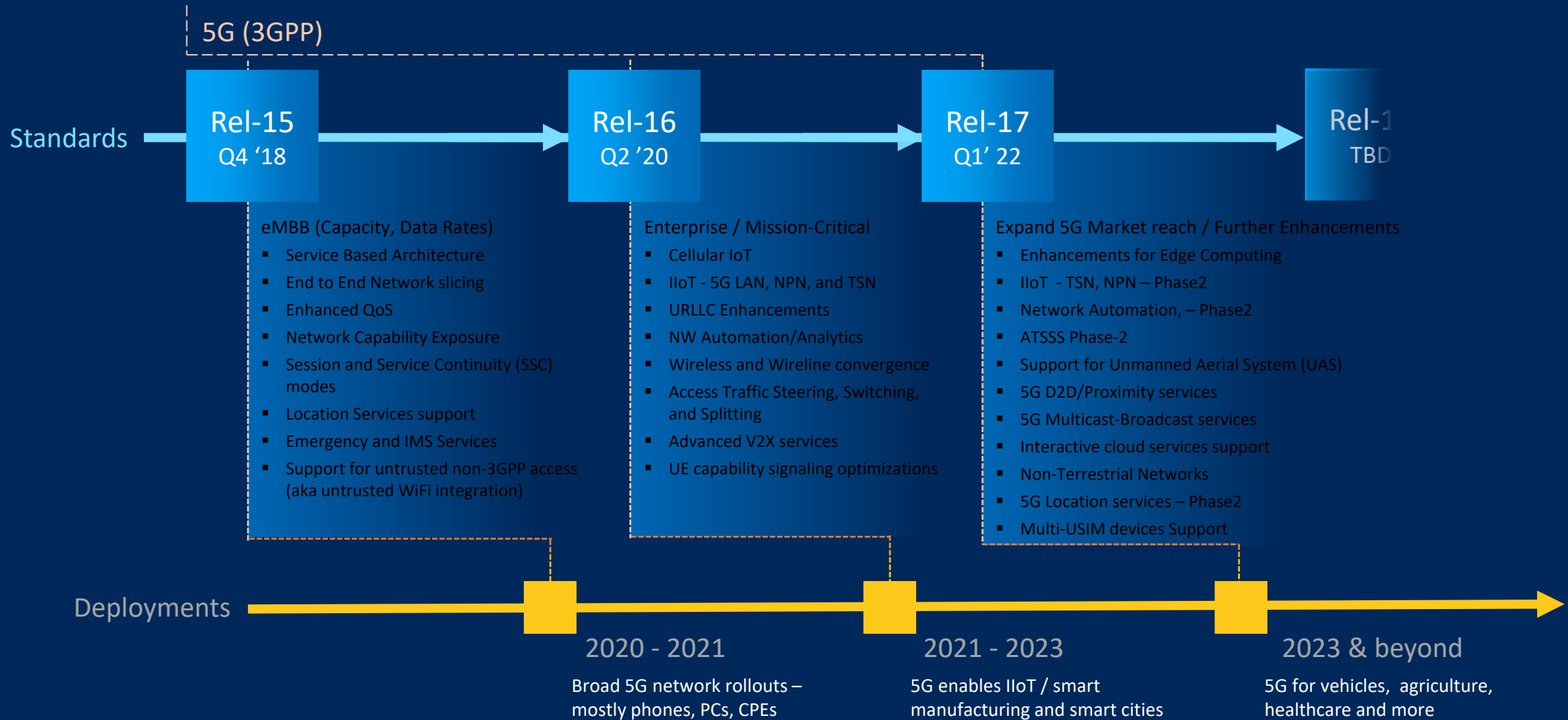
3GPP SA2 Chair

Sr. Principal Engineer & Sr. Director, Intel Corporation

April 20, 2022

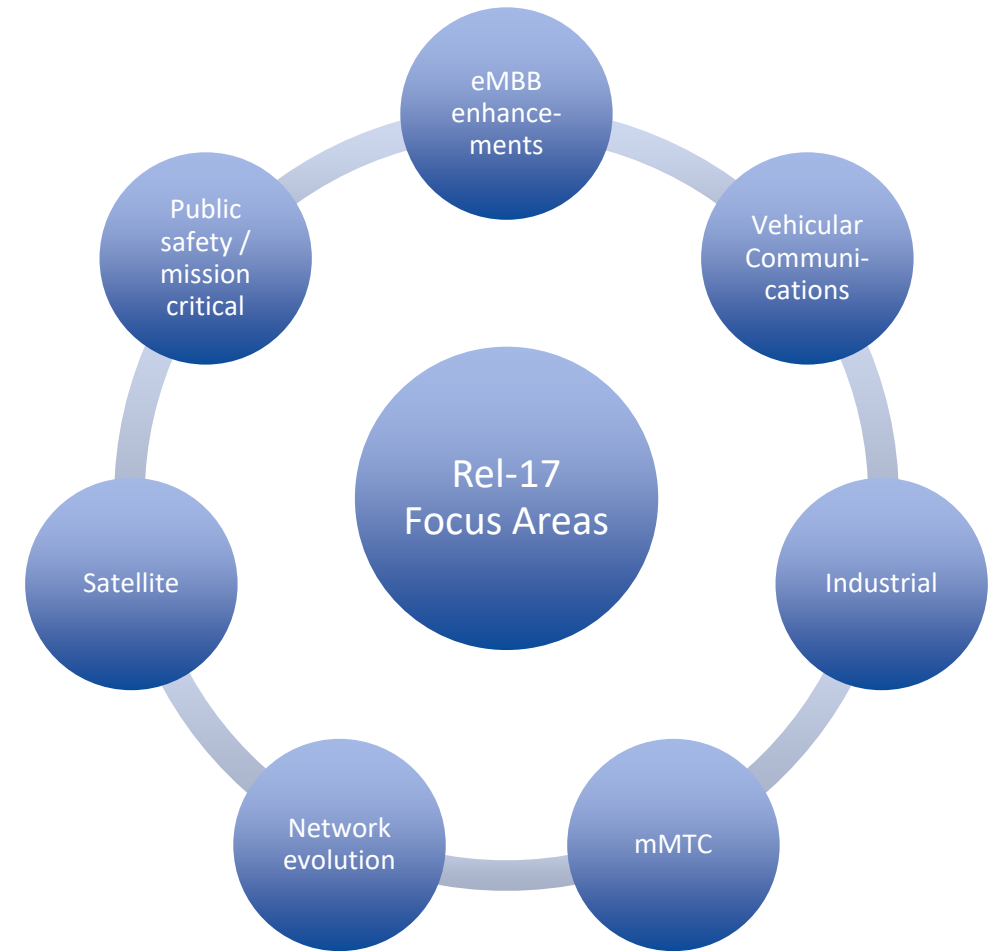


5G: Evolutionary and Revolutionary



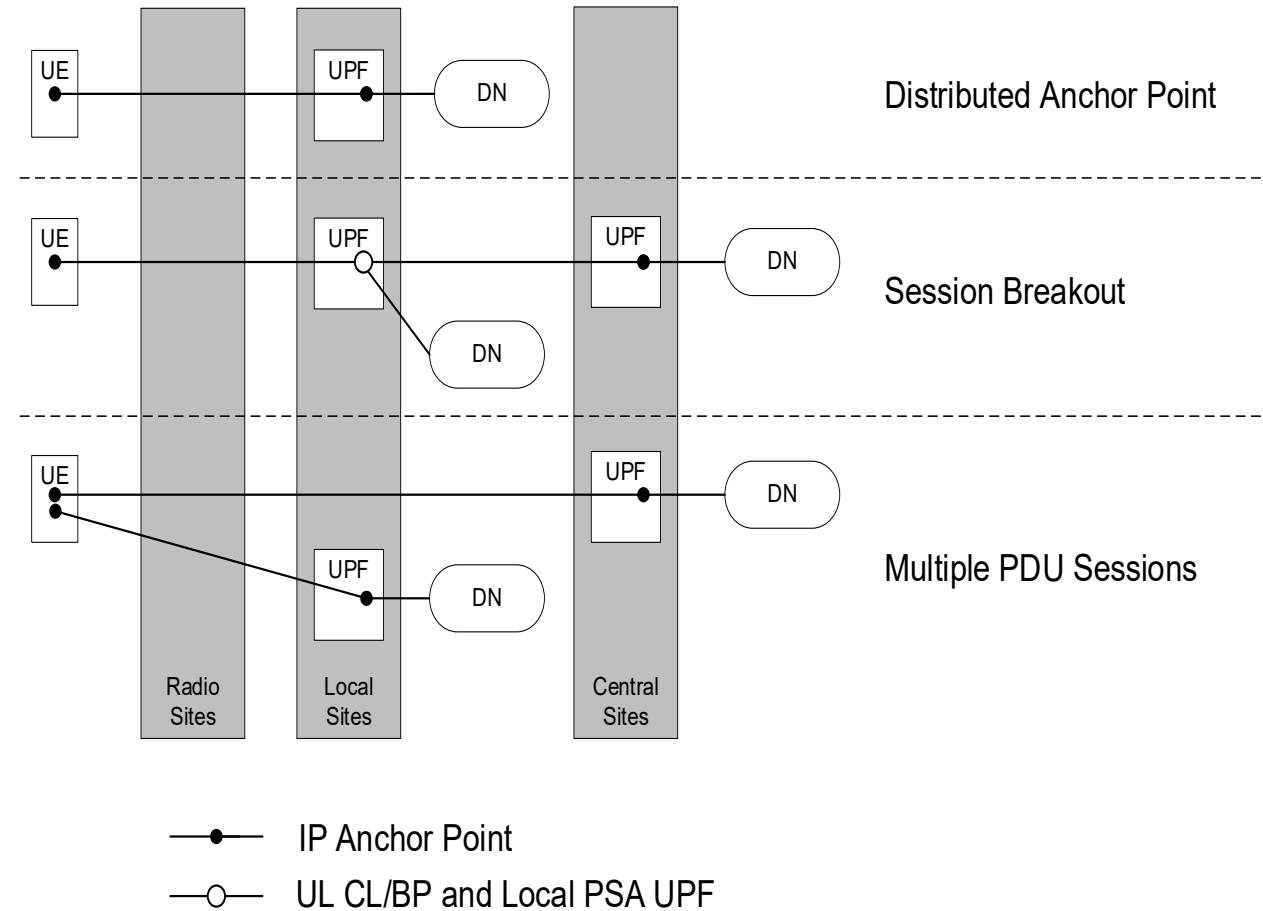
Release 17 - Overview

- **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)



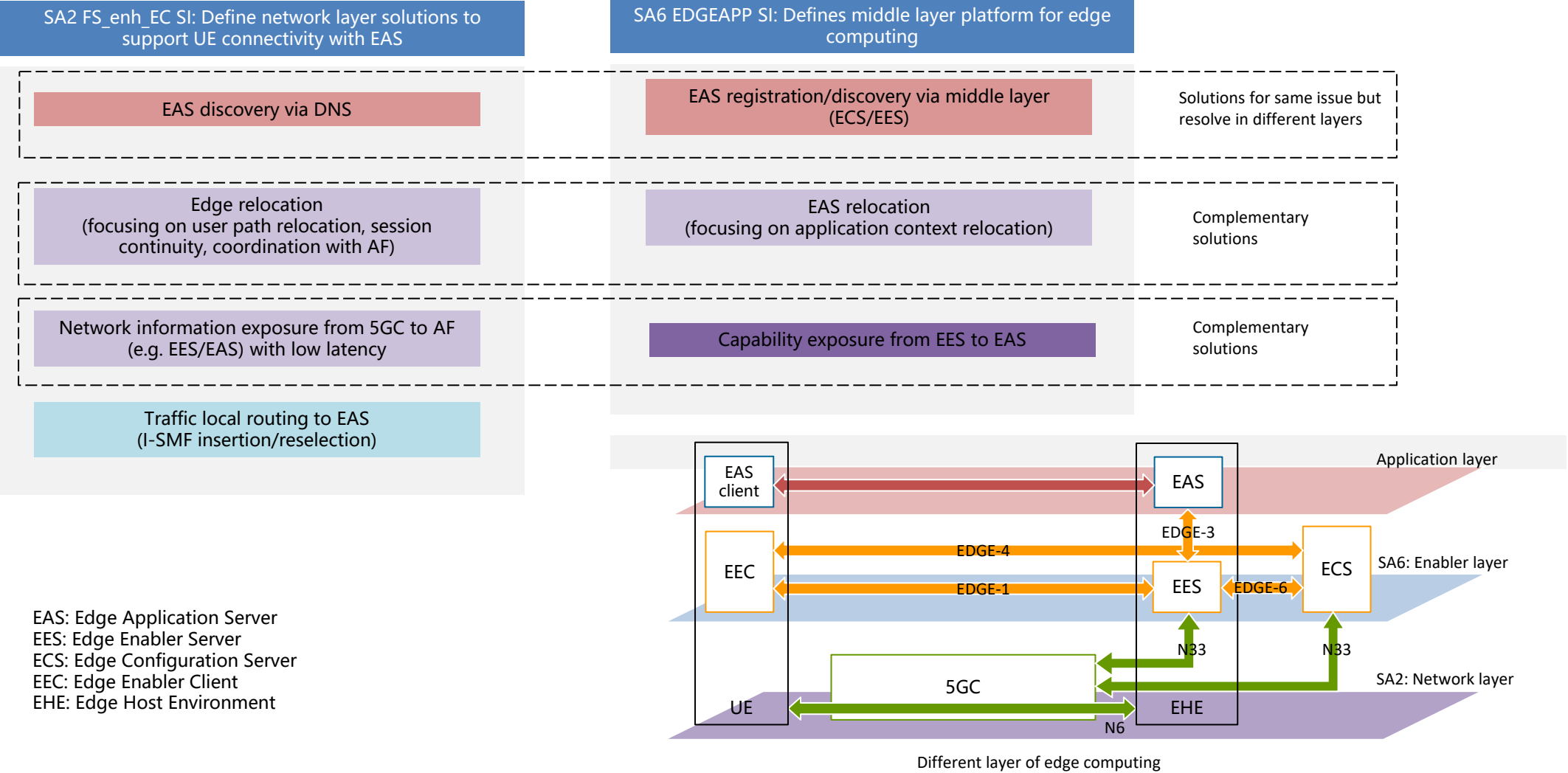
Enhancement for Support for Edge Computing

- 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



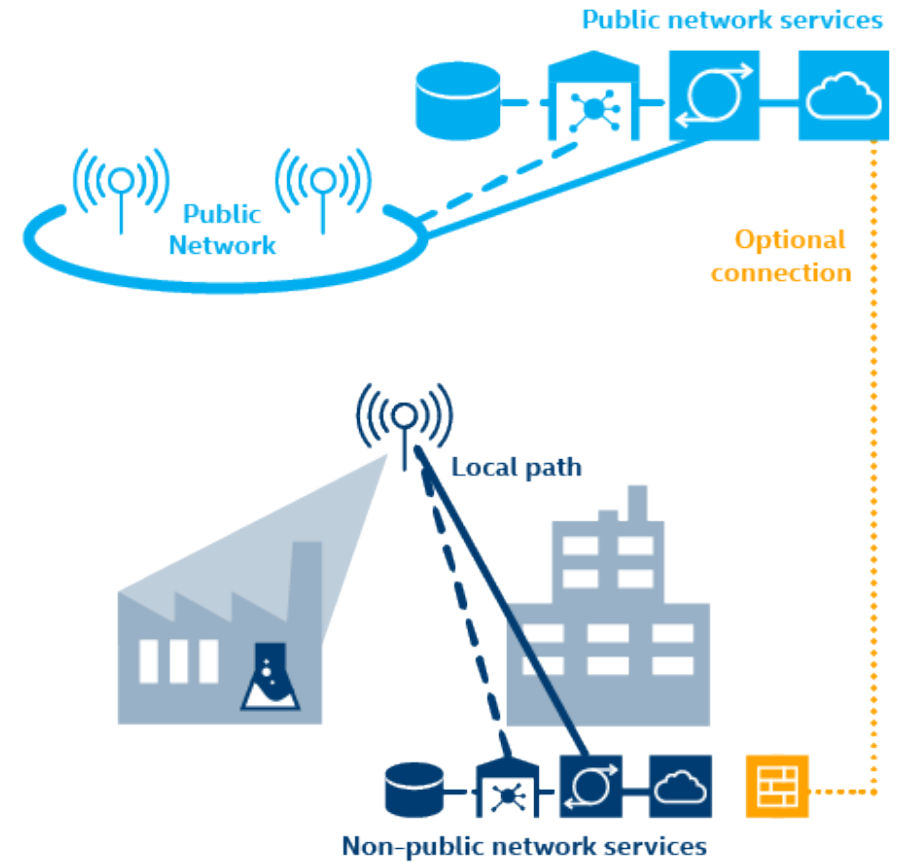
5GC Connectivity Models for Edge Computing

Relationship of SA2 and SA6 EC studies



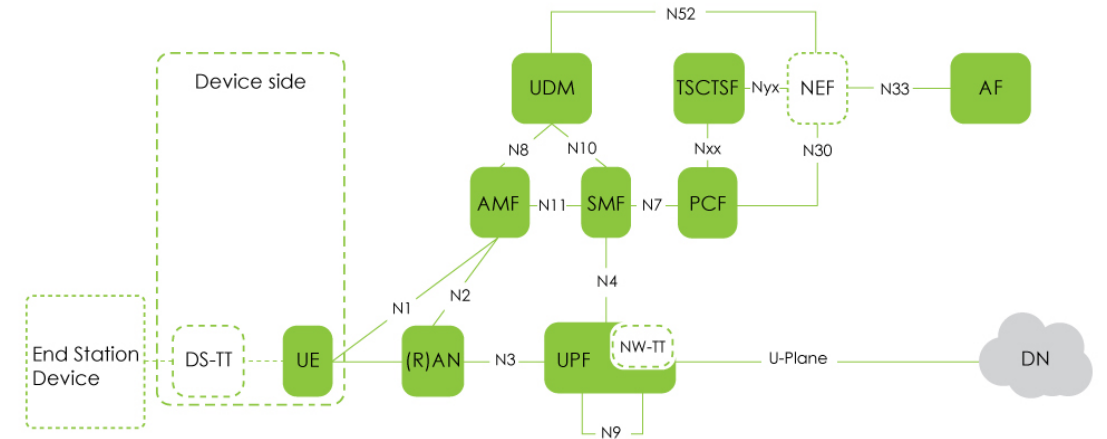
Enhanced support of Non-Public Networks

- 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



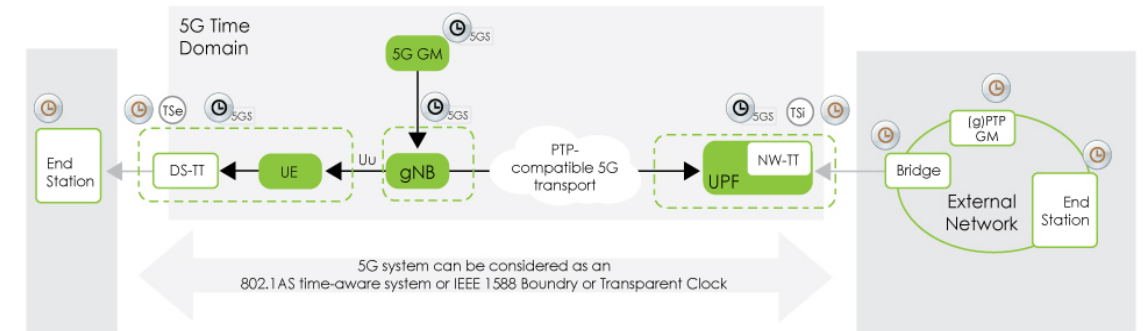
Enhanced support of Industrial Internet of Things

- 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

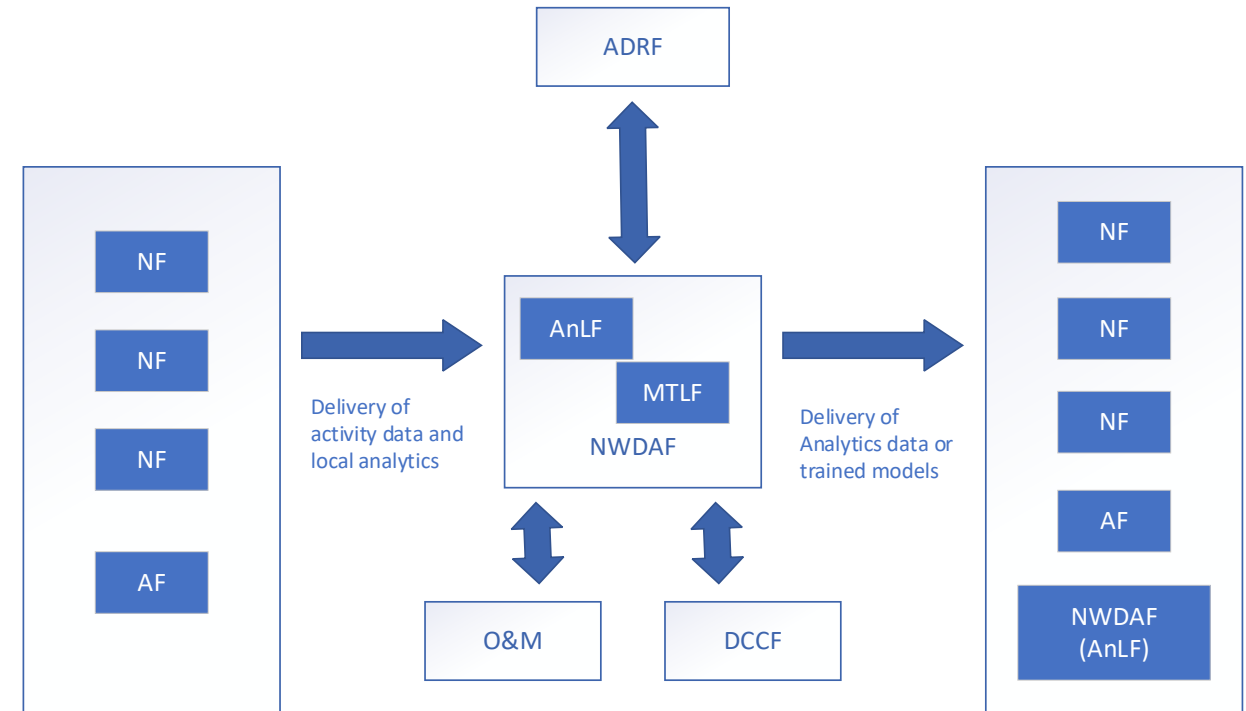
TS 23.501

→ : 5GS timing direction
→ : (g)PTP timing direction

⌚ : 5GS time synchronization
⌚ : (g)PTP time synchronization

Enablers for Network Automation for 5G – Phase 2

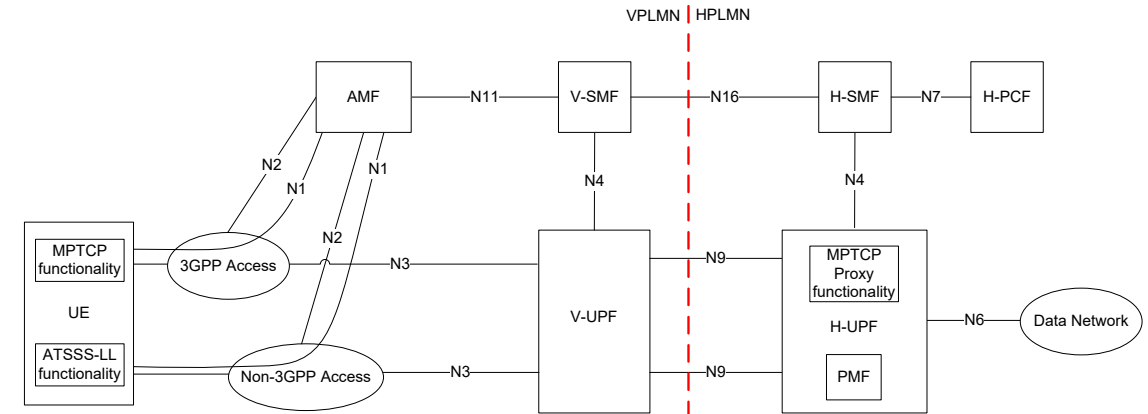
- **NWDAF is decomposed into:**
 - **Analytics logical function (AnLF):** The NWDAF provides analytics to 5GC NFs and OAM.
 - **Model Training logical function (MTLF):** NWDAF may provide trained models and exposes new training services to other NWDAFs.
- Pre-trained ML model storage and provisioning 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.



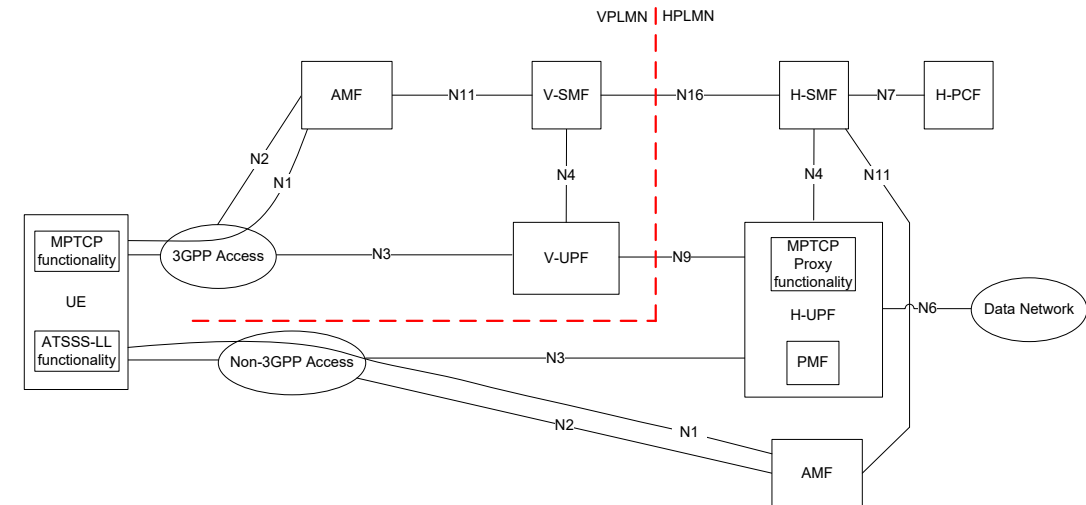
- **NF:** 5G Network Function (e.g., SMF, AMF, PCF)
- **AF:** Application Function
- **NWDAF:** Network Data and Analytics Function
- **ADRF:** Analytics Data Repository Function
- **DCCF:** Data Collection and Coordination Function
- **AnLF:** Analytics logical Function
- **MTLF:** Model Training logical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



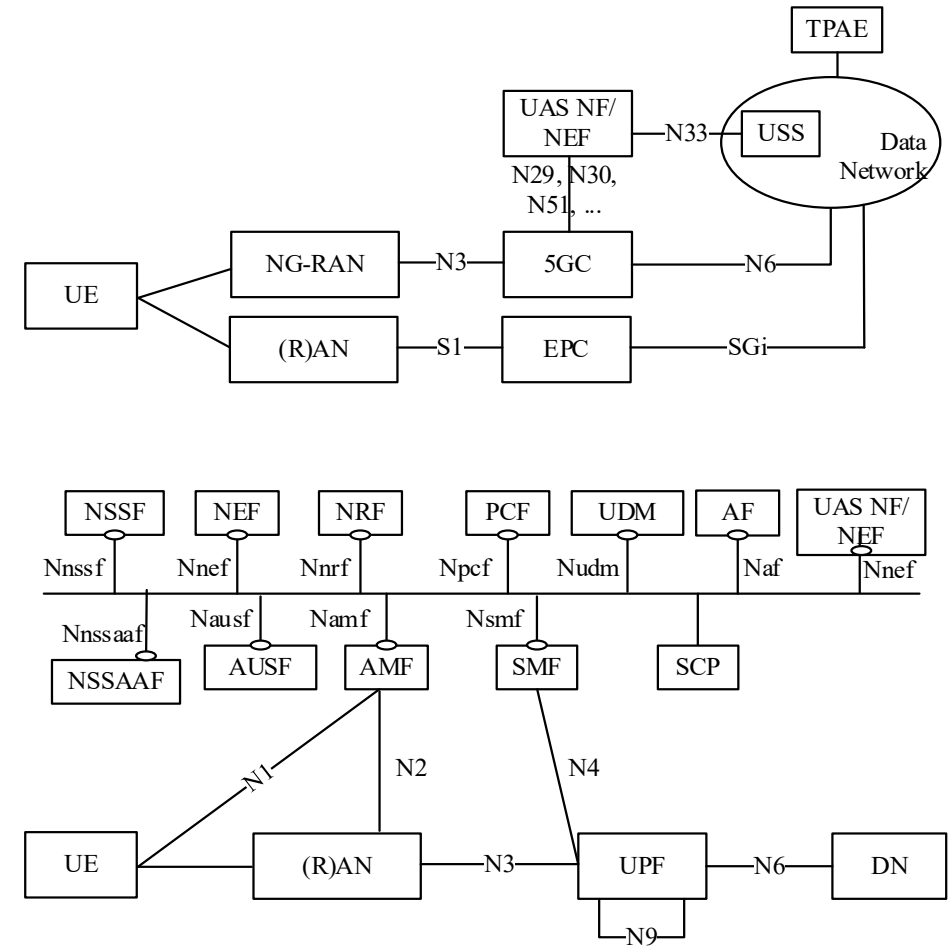
Roaming with Home-routed architecture for ATSSS support (UE registered to the same VPLMN)



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

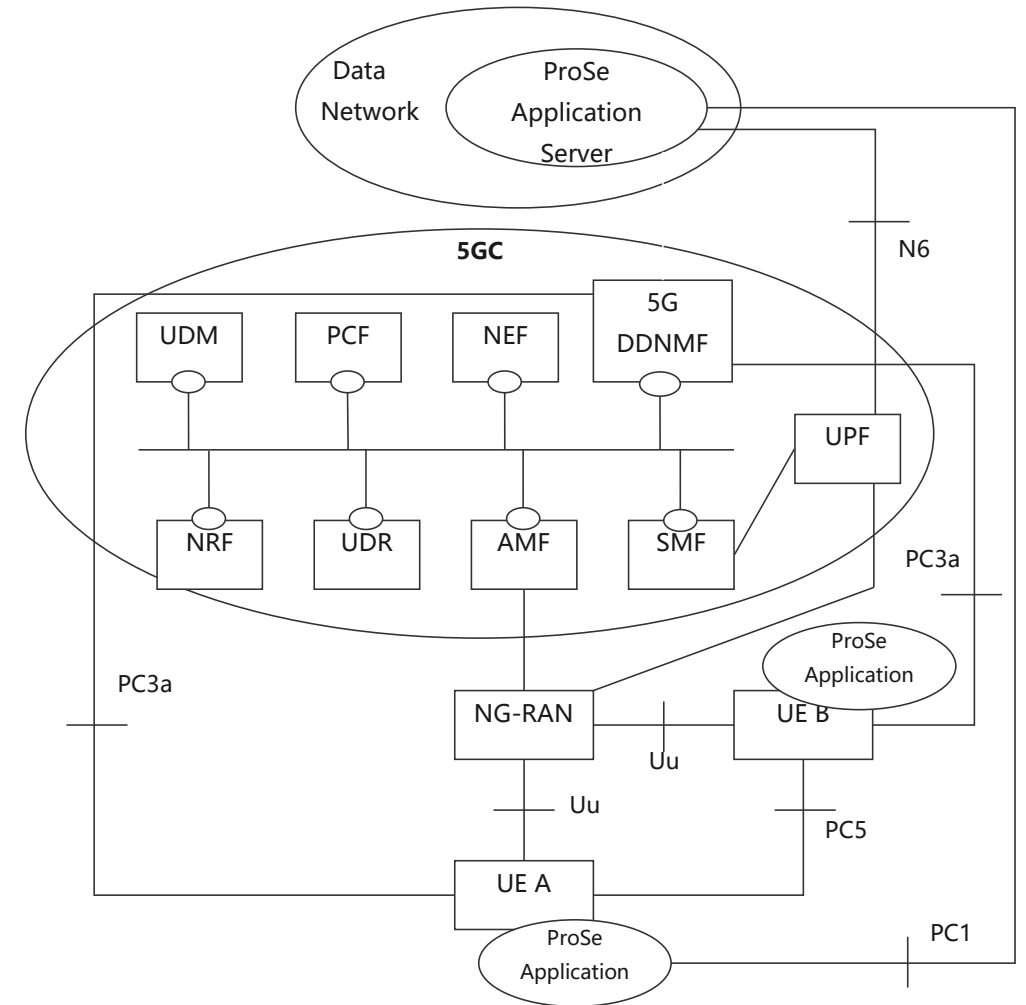
Support of Unmanned Aerial Systems Connectivity, Identification and Tracking

- 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



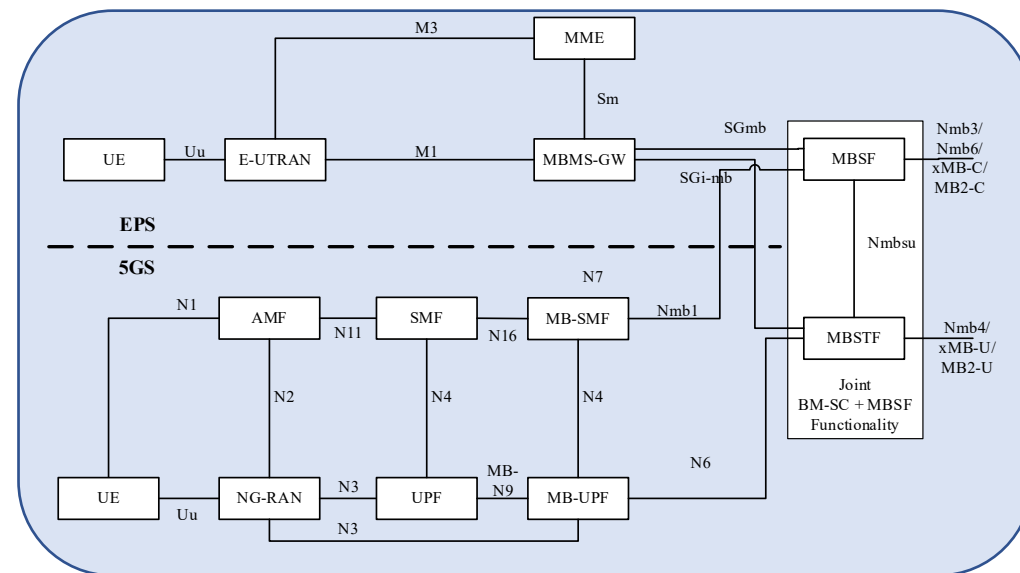
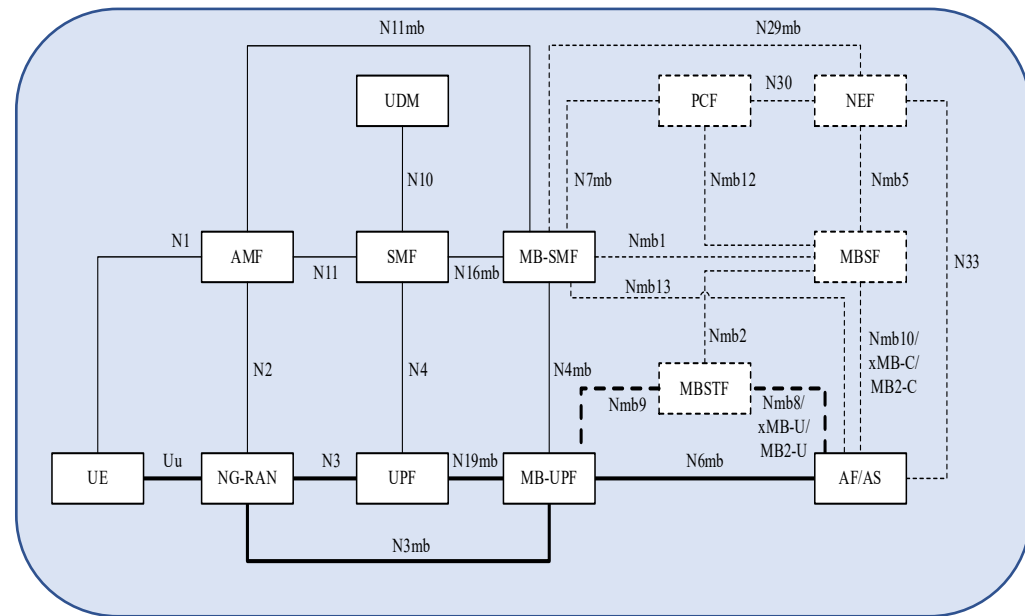
5G Proximity based Services

- 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



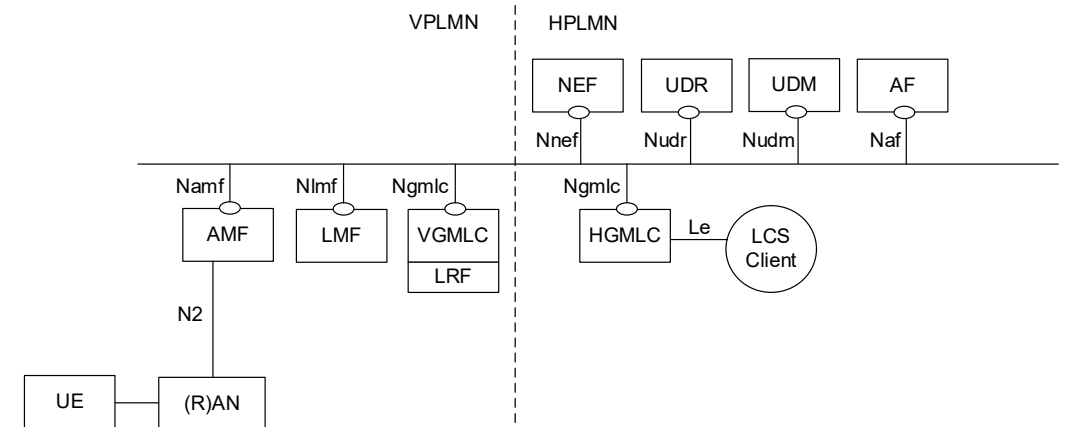
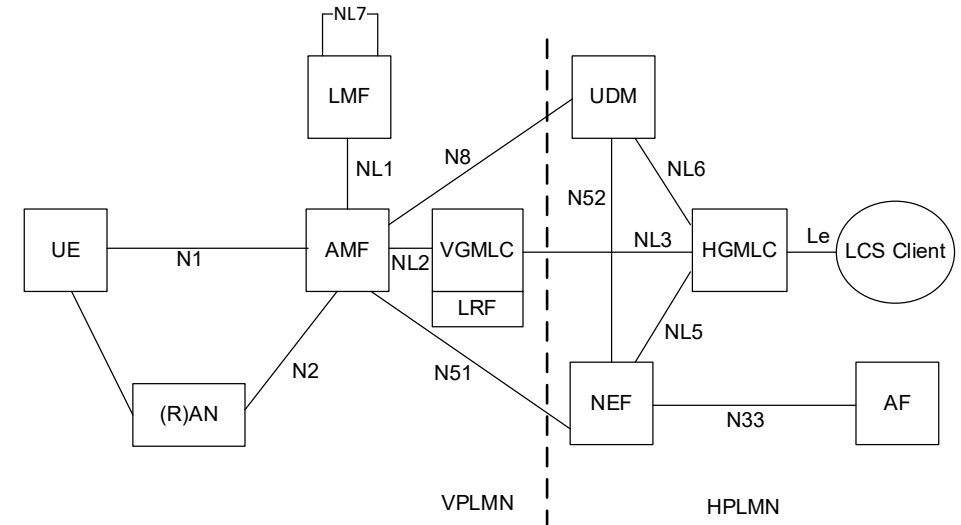
5G Multicast/Broadcast Services

- 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

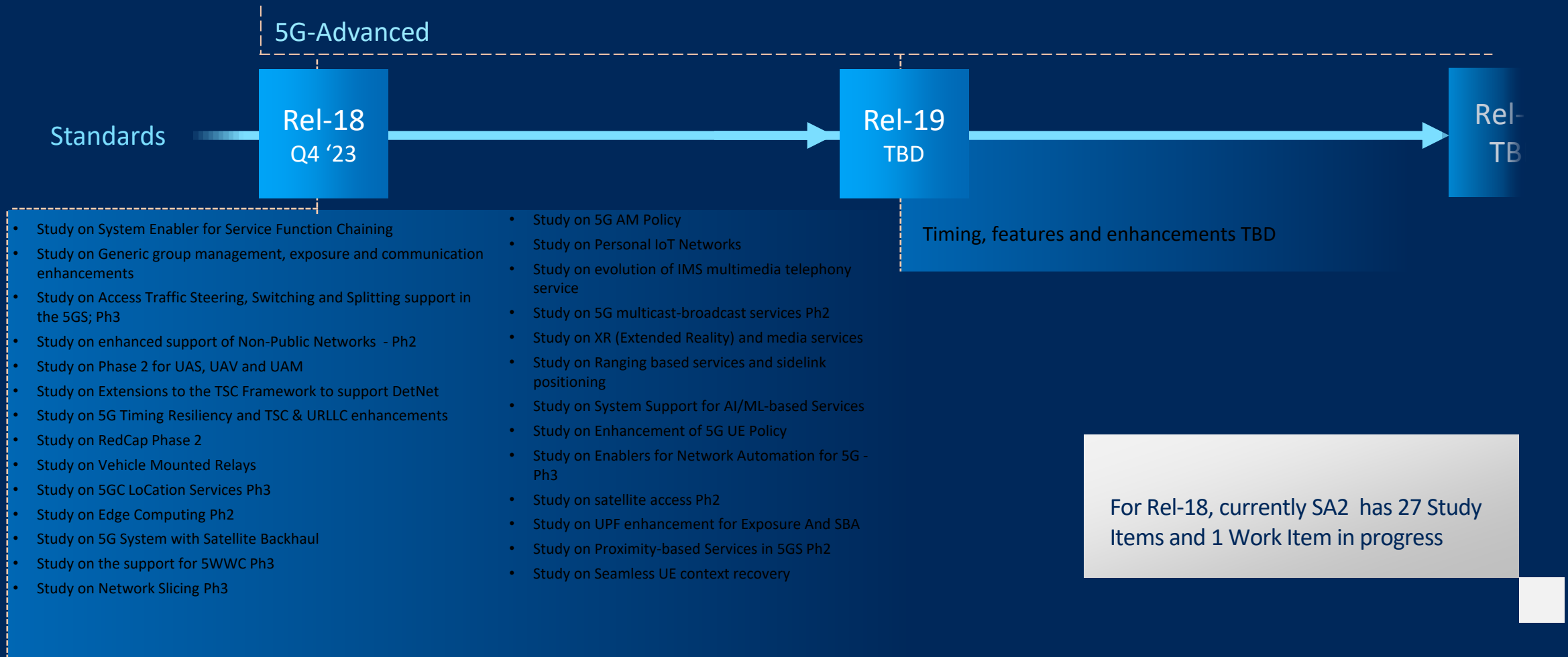


LRF: Location Retrieval Function
GMMLC: Gateway Mobile Location Centre

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



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+

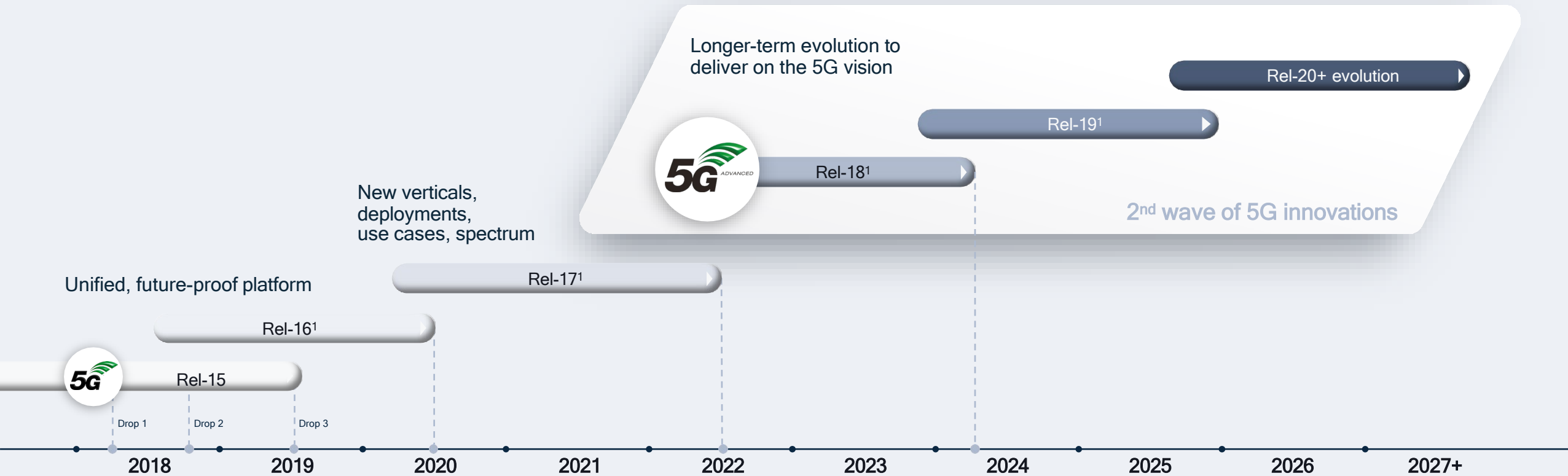
5G smartphones
to ship between
2020 and 2025

1275+

5G designs
launched or in
development



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

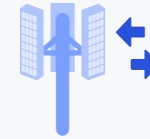


3GPP Release 17

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



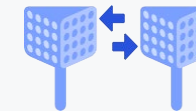
Coverage
enhancements



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 mMTC



Non-
terrestrial
networks
(NTN)



Enhanced
precise
positioning

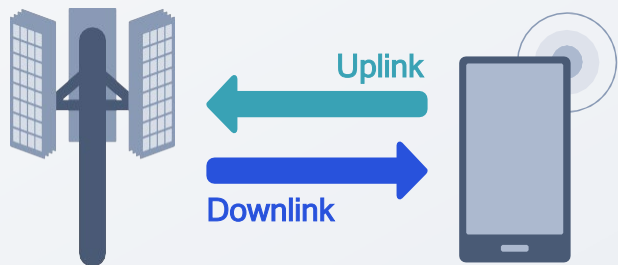


Boundless XR study,
others...

Strengthen the end-to-end 5G system foundation

Further enhancing
5G mobile broadband
and expanded use cases





Further enhancing 5G massive MIMO performance

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

Focus areas for Release 17 Work Item

Enhanced multi-beam operation

- Unified TCI¹ framework in DL/UL² to reduce latency and overhead
- UL beam selection for multi-panel devices
- More efficient L1/L2³ intra-and inter-cell mobility

SRS⁷ improvements

- More flexible triggering of aperiodic SRS and DCI⁸ overhead reduction
- SRS switching for up to 8 antennas
- Improved SRS reliability such as repetitions and time bundling

Enhanced multi-TRP⁴ deployment

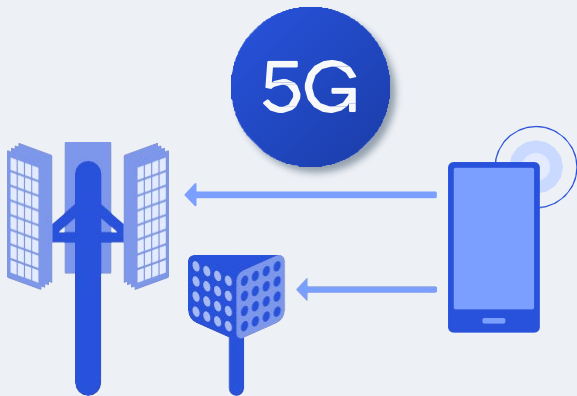
- Improved reliability for DL control, UL control and data channels
- QCL⁵ for inter-cell multi-TRP reusing L1/L2 mobility measurements
- Beam management for multi-panel Rx
- High-speed SFN⁶ enhancements

CSI⁹ measurement & reporting

- DL/UL reciprocity of angle and delay for FDD¹⁰
- More dynamic channel/interference hypotheses for non-coherent joint transmission

Improving 5G uplink coverage

Targeting urban and rural deployments using sub-7 GHz and mmWave, also applies to satellites (NTN¹) communication



Coverage enhancements Work Item 3GPP Release 17

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

- **Uplink data channel (PUSCH²) 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 (PUCCH³) enhancements**
Supporting dynamic repetitions for better reliability, DMRS⁴ 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

Further enhancing device power efficiency

For idle/inactive mode

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

Providing potential TRS¹/CSI-RS² to devices in idle/inactive mode with minimized system overhead impact

Supporting PDCCH³-based permanent equipment identifier (PEI)



Rel-17 power saving enhancements

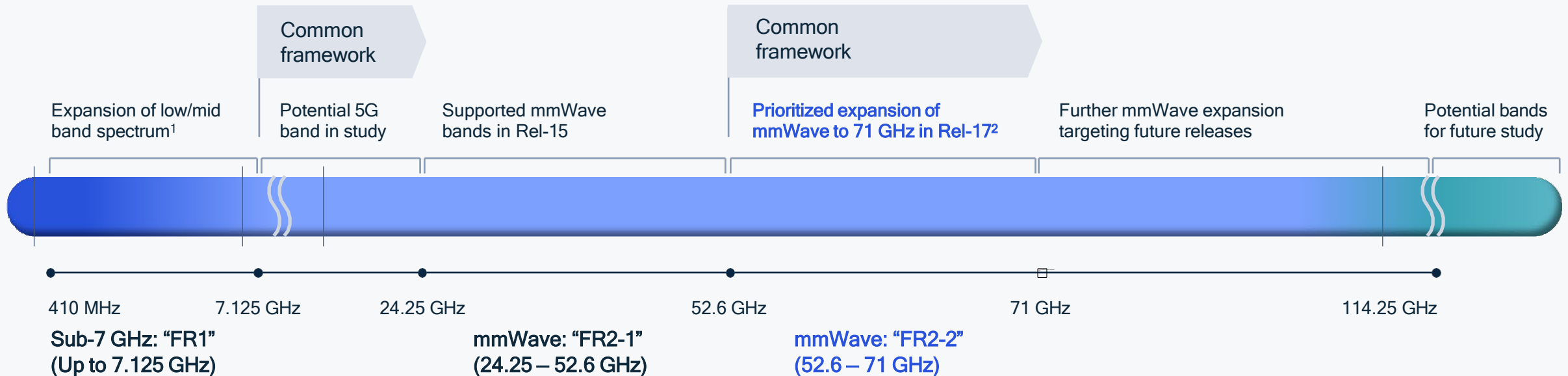
Building on Rel-16 device power saving design

For connected mode

Extending to Rel-16 DCI⁴-based power saving adaptation for an active BWP⁵, including PDCCH monitoring skipping during C-DRX⁶

Relaxing device measurement for RLM⁷ and/or BFD⁸ for low mobility devices with short DRX⁹ cycle

Scaling 5G NR design to support 60 GHz unlicensed band



Design Principles

SCS³ for control/data channels

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

SSB⁴ 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 LBT⁵, 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-ACK¹
- New mechanism triggered aperiodic CSI² and SRS³ for more accurate MCS⁴ selection
- Improved reliability with uplink control⁵ on two carriers
- Subband CQI⁶ with more granularity



Improved compatibility for unlicensed spectrum

- Supporting device-initiated COT⁷ for FBE⁸
- Harmonizing uplink configured-grant enhancements in Rel-16 NR-U⁹ and URLLC¹⁰ 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 PUSCH¹¹ transmissions on different component carriers for inter-band CA¹²



Enhanced time synchronization

Supporting uplink RTT¹³-based method for TSN¹⁴ and improved propagation delay compensation

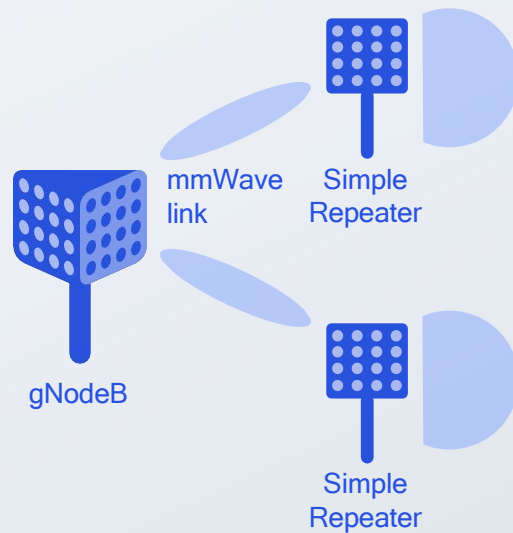


Network enhancements

Based on new QoS¹⁵ related parameters such as survival time, burst spread

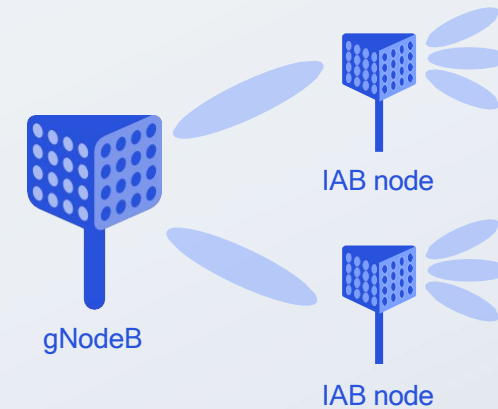
Source: RP-210854 (Enhanced Industrial Internet of Things and ultra-reliable and low latency communication support for NR)

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

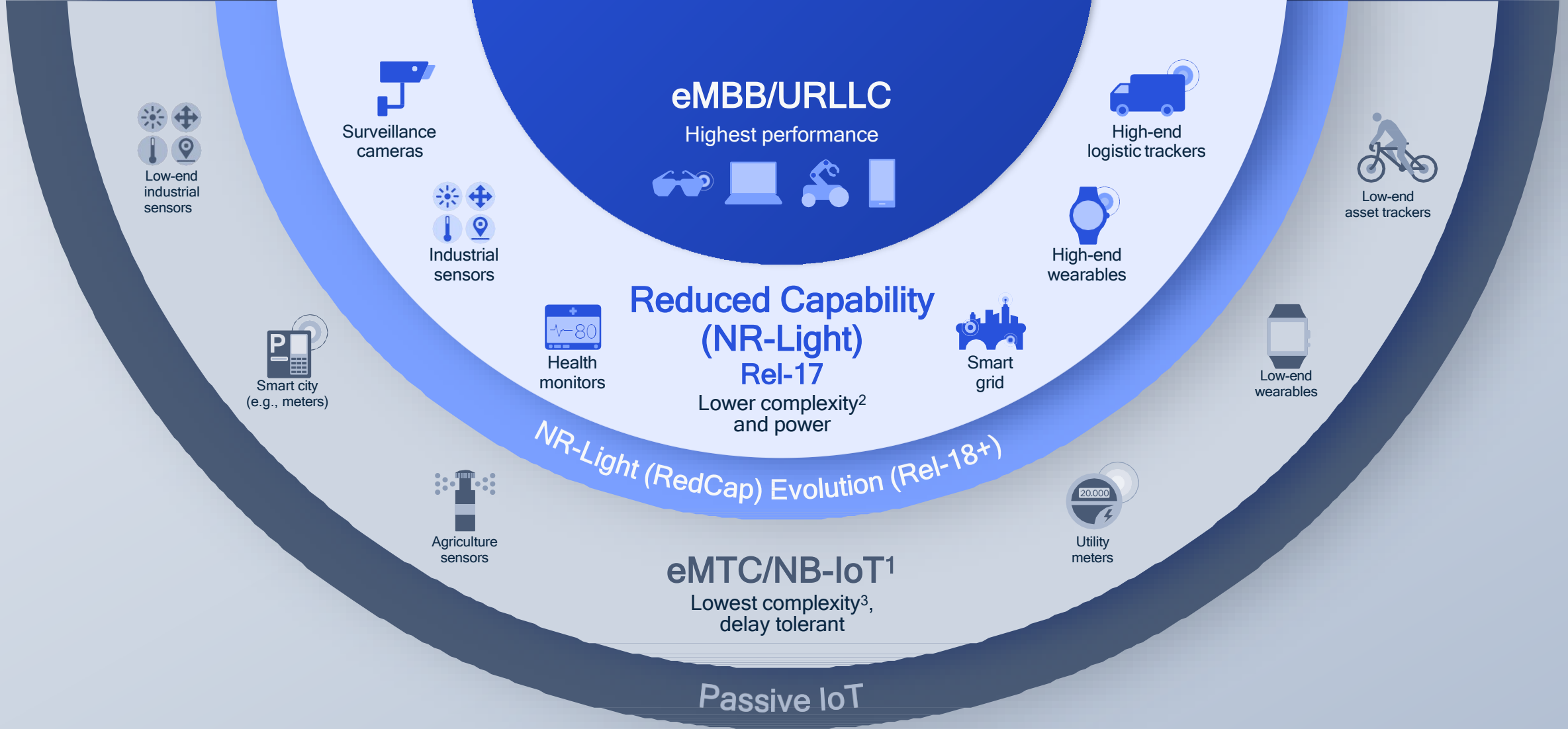
Efficiently expand 5G mmWave coverage

New mmWave infrastructure options introduced as part of Release 17

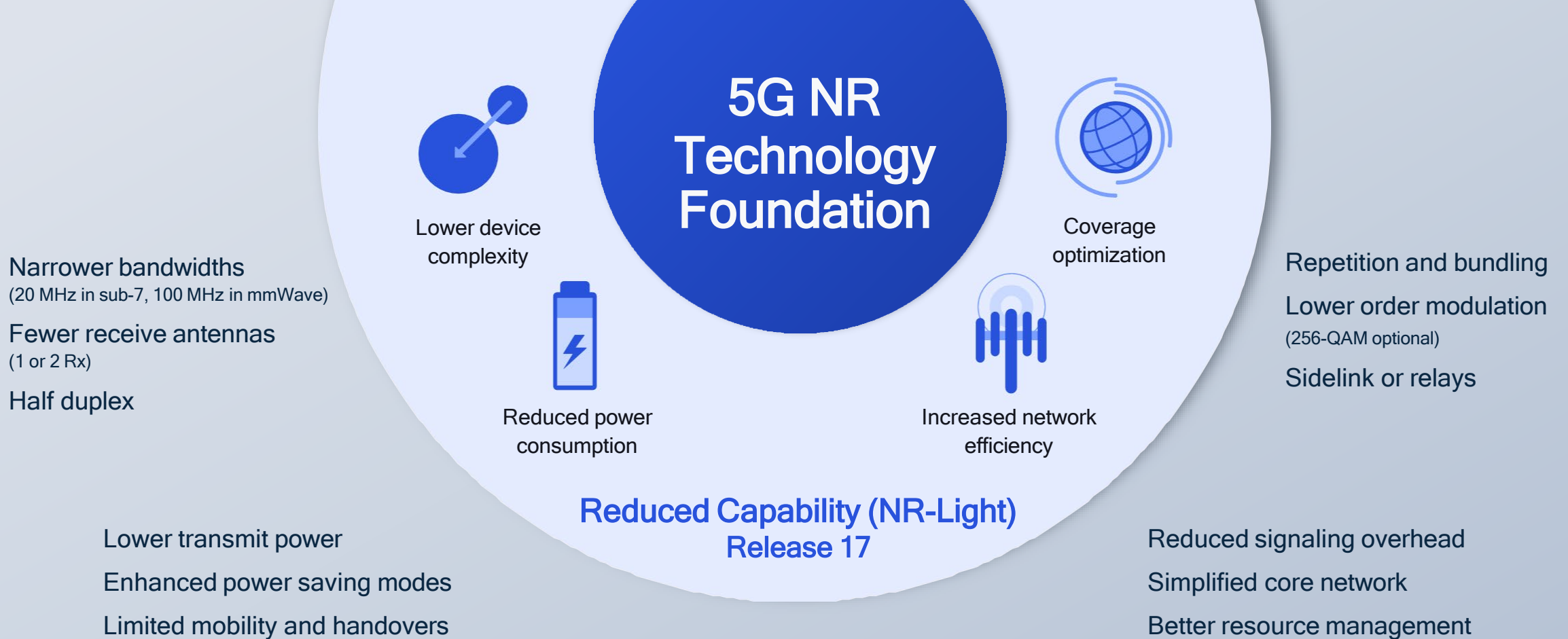
Proliferate 5G to virtually all devices and use cases

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





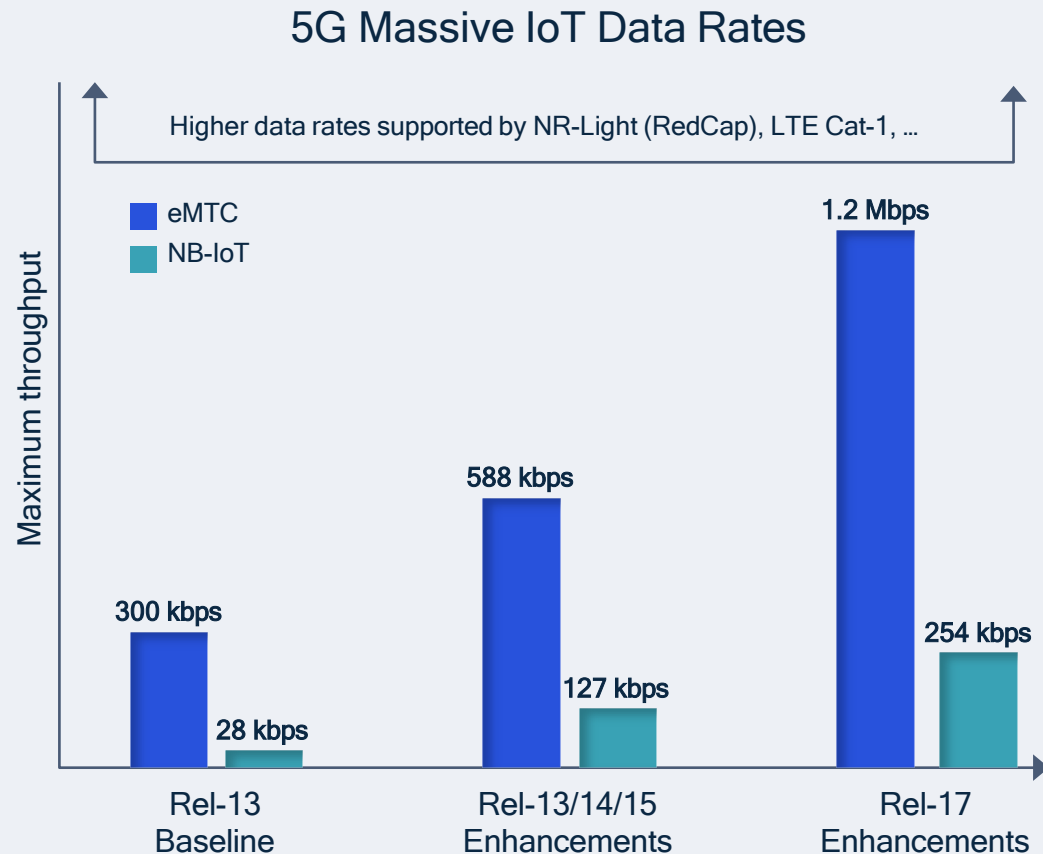
5G NR: A unified, scalable air interface allowing coexistence of a wide range of 5G device classes



Scaling down 5G NR for lower complexity IoT devices

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

Release 17 Work Item enhancements



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

eMTC enhancements

Supporting larger TBS¹ sizes and 14 HARQ² processes to increase data rate for half-duplex FDD³ devices

Supporting power boosting for devices with PUSCH⁴ sub-PRB⁵ 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

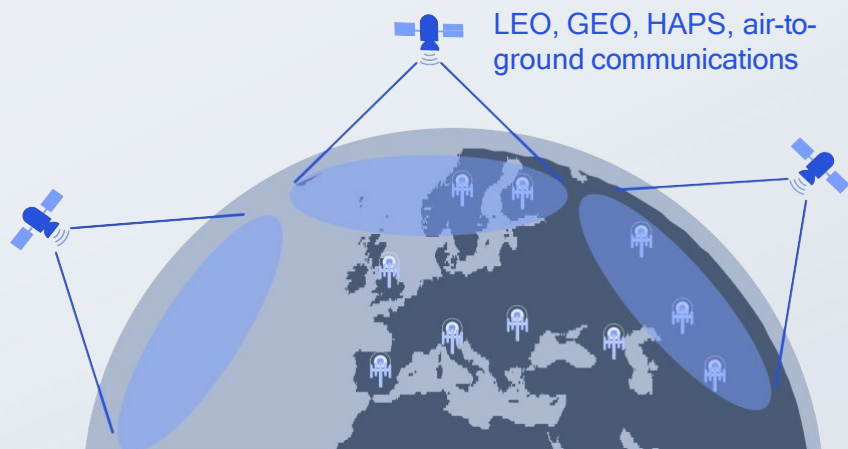
Supporting 16-QAM for UL and DL unicast, increasing in maximum TBS sizes for DL compared to Rel-16 NB-IoT and extended channel quality reporting

Reducing the time taken to recover from RLF⁶, with new signaling for neighbor cell measurements and triggering

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

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

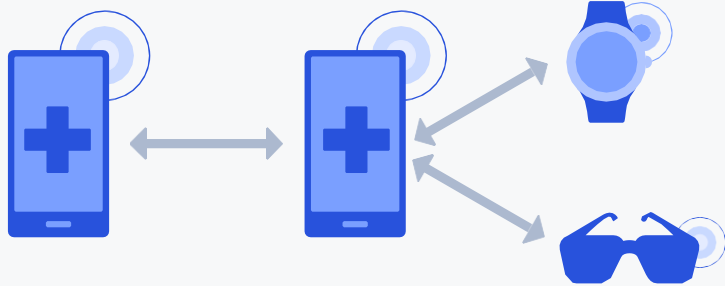


Supporting diverse use cases, including transportation, utilities (e.g., solar, oil/gas), farming, mining, environmental monitoring

Utilizing sub-7 GHz band for both eMTC and NB-IoT, with LTE EPC¹ only in standalone network

Release 17 establishes 5G NR support for satellites communication

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 metric¹, 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-ITS² 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



5G positioning evolution

5G Advanced

Release 16

Establishing foundation

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

Supporting RTT¹, AoA/AoD², TDOA³, single-cell positioning

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

Release 17

Enhancing capability and performance for a wide range of use cases⁴

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 & NLOS⁵ 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 PRS⁶, triggered by network or device

GNSS⁷ 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 NavIC⁸ for 5G NR

5G positioning evolution in Release 18+

Improving performance, expanding to new devices and deployments

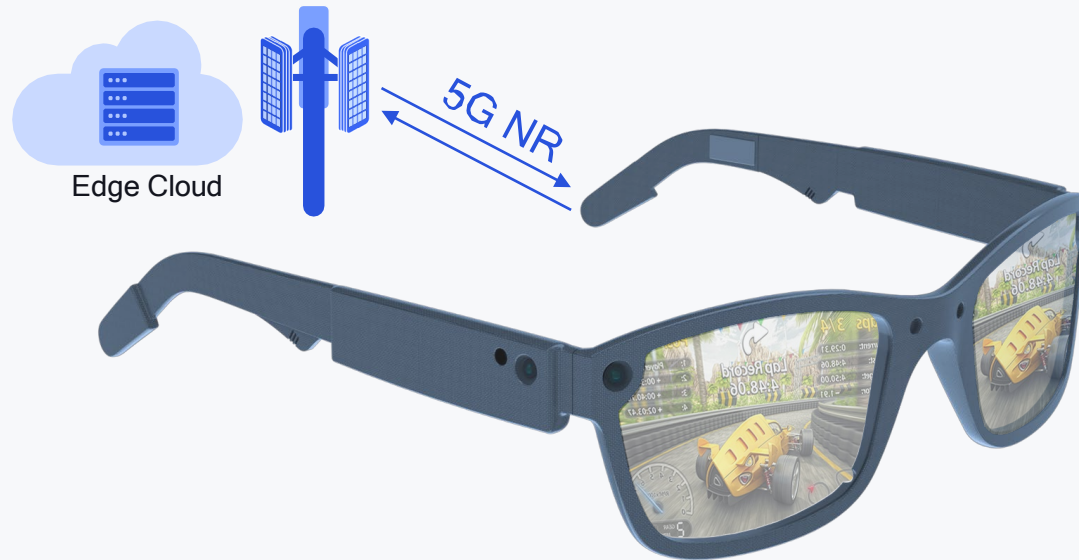
Pushing forward with the 5G positioning technologies

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-sight; 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

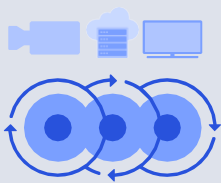
Carrying out characterization of XR system performance based on agreed upon evaluation methodologies

UHF¹ broadcast frequencies



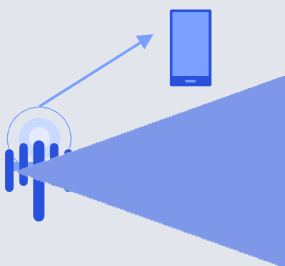
Adding support
for 6/7/8 MHz
carrier
bandwidths²
to support
UHF bands

CMAF³-based streaming ecosystem



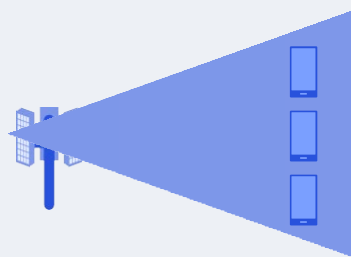
Targeting low-
latency broadcast
distribution
and 5G media
streaming

Simultaneous broadcast + unicast



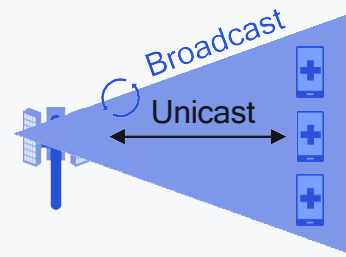
Optimizing modem
resource usage
and enabling
fast broadcast
service discovery

Multicast operation for 5G NR



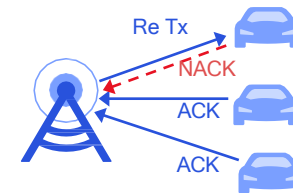
Supporting group
scheduling, mobility,
DRX⁴, reception in
idle and transparent
SFN⁵

Broadcast and unicast dynamic switching



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

Improved robustness and efficiency



Supporting uplink
HARQ⁶ 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

DSS¹ enhancements

Enable PDCCH² cross-carrier scheduling from a SCell³ to a P(S)cell⁴ in sub-7 GHz



Enhanced multi-radio DC⁵

Support efficient activation/de-activation of one SCG⁶ and SCells, and conditional PSCell change/addition



Multi-SIM⁷

Support dual-standby, 1 active and 1 idle SIM, device-indicating network switch, and SIM from different MNOs⁸



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 RACH⁹) with defined small data request message



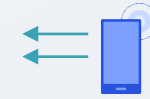
High-speed train

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



Other RAN projects in 3GPP Release 17

5G



Uplink data compression

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



Enhanced data collection

Add new data categories for SON/MDT¹⁰ (mobility, energy saving, capacity, coverage, ...), and for RAN AI (use cases, types of input/output)



RAN¹¹ 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 PDCP¹²

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 (UIIP 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?



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

Creating new value across applications

5G

5G Positioning

Advanced MIMO

Mobile mmWave

Green Networks

Industrial 5G Networks
Industrial Precise Positioning

AI-enabled Air Interface

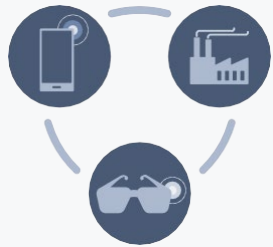
Automotive

Enabling the Metaverse

Wide-area IoT

Driving a balanced 5G evolution across key technology areas

Mobile broadband evolution vs. further vertical expansion



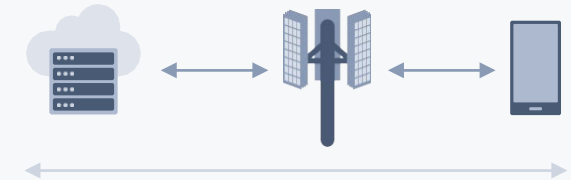
Deliver enhanced mobile broadband experiences and extend 5G's reach into new use cases

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)

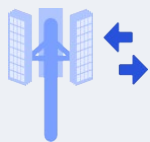


Release 18

3GPP Release 18 sets off the 5G Advanced Evolution

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

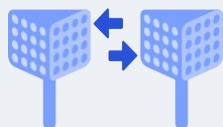
Strengthen the end-to-end 5G system foundation



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

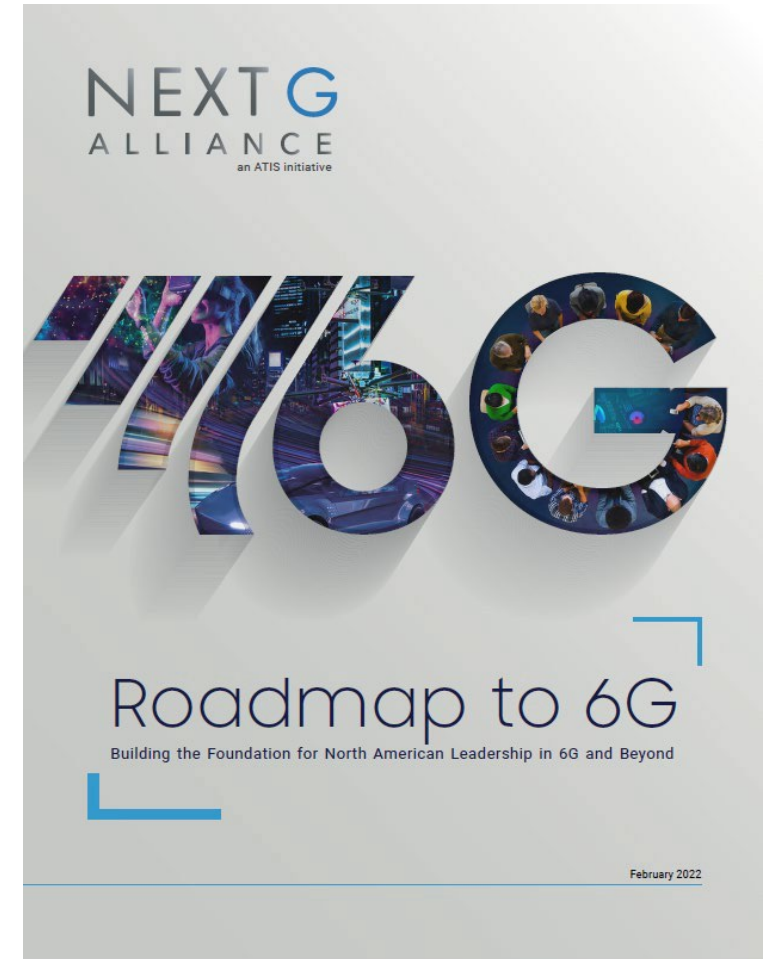
Iain Sharp

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

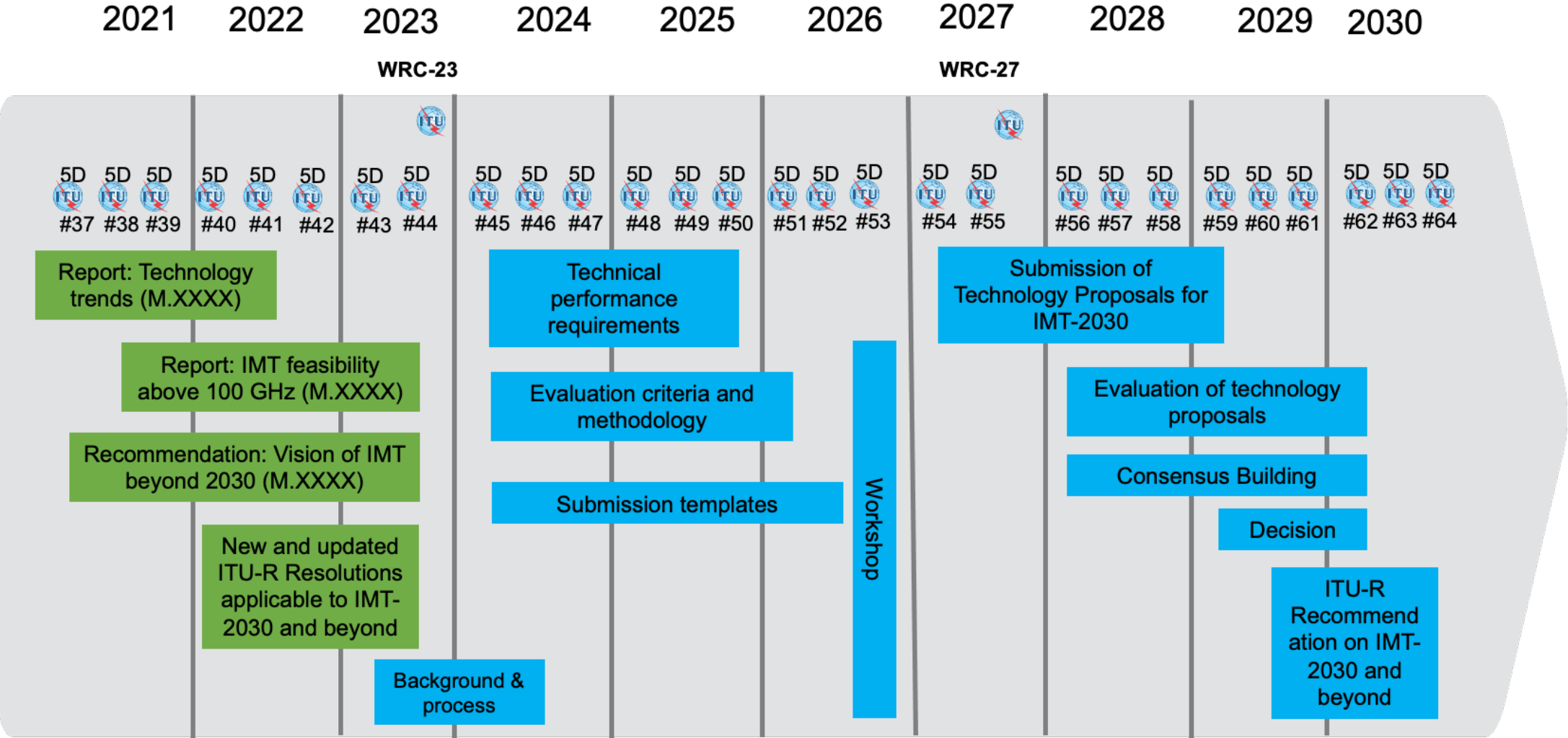


North American 6G Roadmap defines the path for connecting every stage of the lifecycle and progressing to an end-of-decade 6G Vision



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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