5G Standards Developments in 3GPP Release 16 and Beyond

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Agenda

Opening/Overview

Services

Systems Architecture and Core Networks

Radio Access Network

Long Term Outlook

Q&A: *Please submit questions via chat during the webinar*
ATIS and 3GPP

• ATIS is a founder of, and the North American Organizational Partner (OP) for, the 3rd Generation Partnership Project (3GPP)
  – Recognizing the value of globally aligned mobile standards that meet regional needs
• Broad ecosystem of members addressing the information and communications (ICT) industry’s top challenges
• History of advancing cooperative solutions between industry and government
• Supports members in incorporating regional requirements and technology proposals in 3GPP specifications
Managing 3GPP’s Work During Covid-19

• Since May 2020, 3GPP replaced all face-to-face meetings with online working
  – Expected to continue in to 2021

• Productivity is better than many people expected, but not as good as face-to-face meetings
  – Corridors and bars are very effective locations for technical discussions!

• We are still improving the tools and working methods.
  – Some degree of online work will likely outlast the current crisis
Delivering on the 5G vision

$13.2 Trillion in global economic value by 2035*

*The 5G Economy, an independent study from IHS Markit, Penn Schoen Berland, and Berkeley Research Group, commissioned by Qualcomm
5G momentum accelerating globally

- 60+ Operators with 5G commercial deployed
- 380+ Operators investing in 5G globally
- 200M 5G smartphones to ship in 2020
- 750M+ 5G smartphones to ship in 2021
- 1B+ 5G connections by 2023 - 2 years faster than 4G
- 2.8B 5G connections by 2025

Sources: 5G commercial networks and operators investing in 5G: GSA and operator announcements, Apr. '19; 5G device shipment projections: Qualcomm estimates (2020 projection is at mid-point of guidance range), Nov. '19; 5G connection projections: 2023 - GSMA Intelligence (Dec. '19); ABI (Nov. '19); 2026 - ABI (Oct. '19), CCS Insight (Oct. '19), Ericsson (Nov. '19)
Driving 5G Technology Evolution

Rel-15 eMBB focus
• 5G NR foundation
• Smartphones, FWA, PC
• Expanding to venues, enterprises

Rel-16 industry expansion
• eURLLC and TSN for IIoT
• NR in unlicensed (NR-U)
• Positioning

Rel-17+ long-term expansion
• Lower complexity NR-Light
• Boundless extended reality (XR)
• Higher precision positioning and more...

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 SA 1
SMARTER (5G Services)
- Initial effort
Release 14 & 15
SMARTER Study – Release 14

- Started in 2015
- Based on 5G whitepapers and company contributions
- Consolidated into 74 use cases with potential requirements
• Conclusions and recommendations
  – Organized into 4 areas
  – Massive IOT
  – Critical Communications
  – Enhanced Mobile Broadband
  – Network Operations
Initial 5G Services - Summary

• Massive IOT
  – Supporting larger numbers of IOT devices ranging from simple to complex communication
  – Non-time critical communication such as smart wearables

• Critical Communications (commercial and public safety)
  – Factory and process automation/VR/AR/Mission Critical
  – Range from higher reliability, availability and lower latency to ultra high reliability, availability and ultra low latency

• Enhanced Mobile Broadband
  – Larger range of data rates
  – Larger density ranges (very sparse to very dense)
  – Increased coverage in challenging environments such as indoors
  – Higher user mobility speeds

• Network Operations
  – Increased flexibility such as slicing for serving market segments and verticals
  – Increased scalability
  – Support for an increased variety of mobility scenarios
  – Self back hauling
  – Increased access options such as by satellite
5G phase 1 – normative specification of 5G service requirements

Incorporated into TS 22.261

Following releases enhance and extend 5G services as additional services and verticals are identified
3GPP SA 1 5G Services - Enhancement
Release 16 - Today
3GPP SA 1 Service Development Approach

• Identify a feature, capability or vertical segment for 5G support
• Collect illustrative use cases along with proposed service requirements and KPIs
• Consolidate proposed service requirements and KPIs and categorize by support/not supported by current 5G specifications
• Based on the study, add the normative service requirements and KPIs not supported by current 5G specifications to new or existing normative stage 1 specifications
5G Services – Release 16

• Additional verticals
  – Vertical industries using cyber-physical control (real-time) – such as industrial processes and factories
  – Railways
  – Maritime communication
  – Extending business role models supported by slicing and non-public networks
  – Satellite access
  – Non-public networks - dedicated networks such as used by factories, enterprise campus, building automation

• Additional service capabilities
  – Enhanced messaging to support 5G IOT
  – V2X enhancements in 5G
  – Precise location services for factory and industrial processes
  – Support user centric identifiers and authentication
  – VR (KPIs)
5G Services – Release 17

• Release 17 features were prioritized, stage 1 work is complete, stage 2 & 3 is under development. Further feature reduction is possible but not currently planned

• Additional verticals
  – AV production such as sports events
  – Asset tracking such as warehouse or container port
  – Critical medical applications

• Additional service capabilities
  – Network controlled interactive services
5G Services – Release 18

• Stage 1 on Release 18 just started, if more projects are agreed, SA 1 will undertake prioritization and this list may change

• Additional verticals
  – Access to localized services such as in arena sport event broadcasts
  – Timing and synchronization as a service
  – Smart power grid

• Additional service capabilities
  – Vehicle mounted relays
  – AI/ML model transfer and distribution
  – Personal IOT networks (home IOT/wearables)
Further Reading

• High level summary of the major changes and additions in a 3GPP release
  – 3GPP TR 21.915 Release 15 Description; Summary of Rel-15 Work Items
  – 3GPP TR 21.916 Release 16 Description; Summary of Rel-16 Work Items
  – Newer release summaries will be made available around the time of release completion
The Rel-16 work can be informally grouped into several “focus areas”:

- **5G System (5GS) enablers for new verticals** e.g.
  - Cellular Internet of Things (CIoT)
  - Industrial IoT, including 5G LAN Type service, Time Sensitive Networking (TSN), Non-Public Networks (NPNs), and Ultra Reliable and Low Latency Communication (URLLC)
  - Vehicle-to-Anything (V2X) communication

- **Wireless Wireline Convergence** (5WWC), including support for Access Traffic Steering, Switching and Splitting (ATSSS)

- **Other 5GS enhancements** e.g. enhancements for Network Analytics (eNA), optimized UE radio capability signaling (RACS), enhanced Network Slicing (eNS), enhanced Service Based Architecture (eSBA), Single Radio Voice Call Continuity (5G-SRVCC), enhanced Location Services (eLCS)

- **Stabilizing the Rel-15 5G System specifications**
Cellular IoT Support and Evolution for the 5G System

- Control Plane CIoT 5GS Optimisation
- User Plane CIoT 5GS Optimisation
- Early Data Transmission (EDT)
- Preferred and Supported Network Behaviour
- The Non-IP Data Delivery (NIDD)
- Reliable Data Service (RDS)
- Extended Discontinuous Reception (DRX) for CM-IDLE and CM-CONNECTED with RRC-INACTIVE
- Enhancements for the Mobile Initiated Connection Only (MICO) mode
- High Latency Communication
- Support for Monitoring Events
- Enhanced Coverage
- Serving PLMN rate control
- Small Data Rate Control
- Congestion control
- Service Gap Control
- Inter-UE QoS for NB-IoT
5G LAN-Type Service

- **5G LAN-type service** provides services with similar functionalities to Local Area Networks (LANs) and VPN’s but improved with 5G capabilities (e.g., high performance, long distance access, mobility and security).

- The 5G LAN type service enables **management of 5G Virtual Network (VN) Group** identification, membership and group data.

- 5GS supports optimized routing by enabling support for local switching at the UPF without having to traverse the data network for UE-UE communication when the two UE(s) are served by the same User Plane Function.
Support for Time-Sensitive Communication

• Support of the fully centralized IEEE TSN configuration model (IEEE 802.1Qcc)
  ▪ The 5GS architecture for TSN support is largely over-the-top because the TSN-related functionality is primarily confined to TSN Translator (TT) functions at the 5GS ingress points (AF, UPF, UE).

• IEEE 802.1AS-based time synchronization
  ▪ Rel-16 supports only “downlink synchronization” i.e. scenarios with TSN GM clock residing on the network side.

• QoS support for TSN traffic
  ▪ 5GS supports Time-aware scheduling (IEEE 802.1Qbv) and PFSP (Per Stream Filtering and Policing) capabilities (IEEE 802.1Qci).
Support for Non-Public Networks

• A **Non-Public Network (NPN)** enables deployment of 5G System for private use. An NPN may be deployed as:
  – a **Stand-alone Non-Public Network (SNPN)**: operated by an NPN operator and not relying on network functions provided by a PLMN, or
  – a **Public Network Integrated NPN (PNI-NPN)**: a non-public network deployed with the support of a PLMN.

• An SNPN is identified by a combination of PLMN ID and NID (Network identifier).

• SNPN RAN broadcasts PLMN ID and NID in the System Broadcast enabling network (re-)selection, overload control, access control and barring.

• **PNI-NPNs** are NPNs made available via PLMNs e.g. by means of dedicated DNNs, or by one (or more) Network Slice instances allocated for the NPN. Closed Access Groups (CAG) may optionally be used to apply access control.
Enhancement of Ultra-Reliable Low-Latency Communication

- **Enhancements of session continuity**
  - PSA relocation for Ethernet PDU Session.
  - Enhancements for ULCL relocation
  - Enhancements to AF-influenced traffic routing mechanism

- **QoS Monitoring**
- **High reliability by redundant transmission in user plane**
  - Dual-connectivity-based end-to-end redundant user plane paths
  - Support of redundant transmission on N3/N9 interfaces
  - Support of redundant transmission at transport layer
Enablers for Network Automation for 5G

- **Network Data Analytics Function (NWDAF)** was defined to provide analytics to 5GC Network Functions (NFs), and OAM.
- The **NWDAF** supports the following services in Rel-16:
  - Slice load level related network data analytics
  - Observed Service experience related network data analytics
  - NF load analytics
  - Network Performance analytics
  - UE related analytics
  - User Data Congestion analytics
  - QoS Sustainability analytics
Wireless and Wireline Convergence for 5G System

- Support for **Trusted Non-3GPP Access Network** (TNAN).
- Residential Gateway (5G capable and legacy RG) capable of connecting via wireline access networks defined by BBF to the 5GC.
- Residential Gateway capable of connecting via NG RAN to the 5GC.
- Residential Gateway capable of connecting simultaneously via both 5G RAN and wireline access to 5GC.
- 5GC capable UE and UE not supporting NAS behind Residential Gateway capable of connecting via wireline access network or NG RAN to the 5GC.
- IPTV service defined by BBF for Residential Gateway connected to Wireline Access Network and to NG RAN.
• Support for Multi-access PDU Session

• Support for Two ATSSS steering functionalities:
  – MPTCP functionality, for TCP traffic, with MPTCP proxy in UPF, by using the MPTCP protocol over the 3GPP and/or the non-3GPP user plane; and
  – ATSSS-LL functionality for all types of traffic, including TCP traffic, UDP traffic, Ethernet traffic, etc. ATSSS-LL functionality is mandatory for MA PDU Session of type Ethernet.

• Support of Performance Measurement Function (PMF)
Enabling 5G Vertical Application and Network APIs

- Middleware between the vertical applications and the underlying infrastructure
- Common API Framework (CAPIF) – unified 3GPP northbound API Framework
- Service Enabler Architecture Layer (SEAL) – offers common application enabling layer for verticals e.g. V2X
- EDGEAPP – Architecture for enabling Edge applications
5G System Evolution in Rel-17

**Release 15**

**Basic features for eMBB**
- Service Based Architecture
- End to End Network slicing
- Enhanced QoS
- Network Capability Exposure to 3rd party application service providers
- Session and Service Continuity (SSC) modes
- Location Services support
- Emergency and IMS Services support
- Support for untrusted non-3GPP access (aka untrusted WiFi integration)

**Release 16**

**Support for URLLC, mIoT/IoT**
- Support for Cellular IoT
- Support for 5G LAN, Non-Public Networks (NPN) and IEEE Time Sensitive Networks (TSN)
- URLLC Enhancements
- Network Automation/Data Analytics
- Wireless and Wireline convergence (including support for trusted non-3GPP access network)
- Access Traffic Steering, Switching, and Splitting
- Advanced V2X services
- UE capability signaling optimizations
- Enhanced Location Services
- Single radio voice call continuity from 5GS to 3G

**Release 17**

**More Vertical use cases**
- Support for Multi-USIM devices
- Support for Unmanned Aerial System (UAS)
- 5G D2D/Proximity services
- 5G Multicast-Broadcast services
- Support for Satellite systems
- Interactive cloud services support
- Support for Edge Computing
- Enhancements for Non-Public Networks (NPN)
- Time Sensitive Communication (TSC) enhancements
- Access Traffic Steering, Switching, and Splitting Phase-2
- Further enhancement for Network Automation, 5G Location services.
Radio Access Network

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September 24, 2020
Building on the Technology Foundation for the 5G Expansion

- **High-precision positioning**: Accurate indoor and outdoor positioning
- **Mission-critical design**: Ultra-high reliability of up to 99.9999%
- **Unlicensed spectrum**: Improved capacity and new use cases
- **Advanced power saving and mobility**: Better device performance and coverage
- **New deployment models**: New deployments e.g., IIoT and enterprise
- **Sidelink**: Advanced safety use cases

**Expanded 5G foundation in Release 16**

**5G NR Release 15 technology foundation**

- Flexible slot-based framework
- Scalable numerology
- Advanced channel coding
- Massive MIMO
- Mobile mmWave
Driving foundational enhancements

3GPP Release 16
Enhancing 5G NR massive MIMO performance

Enhanced multi-user MIMO
Reducing overhead and supporting Rank 4 MIMO, finer quantization and PMI\(^2\) granularity by improving Type II CSI\(^3\)

Multi-transmission/reception points
Improving reliability by allowing device to transmit and receive\(^4\) data to/from multiple base stations

Better multi-beam management
Supporting secondary cell beam failure recovery, interference-aware beam selection, overhead reduction

Improved power efficiency
Reducing PAPR (peak-to-average ratio) with improved uplink and downlink reference signal\(^5\)

Extended uplink coverage
Achieving full-power uplink for all MIMO capable devices\(^6\)

Release 16 MIMO Enhancements\(^1\)
Improve performance, efficiency, reliability

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1. Also includes LTE MIMO enhancements, such as improved SRS capacity and coverage; 2. Precoding Matrix Indicator; 3. Channel State Information, similar overhead yields 15% improvement in CSI performance compared to R15 Type II CSI design; 4. Supporting SDM, FDM, and TDM transmissions with single or multi DCI (DL control information); 5. OFDM for PDSCH & PUSCH and DFT-S for PUSCH & PUCCH; 6. For single layer MIMO, for low-complexity MIMO non-/partially coherent devices
Further enhancing device power efficiency

**Wakeup signal (WUS)**
A low-power control channel to indicate activity or lack thereof in the corresponding DRX¹ period

**Enhanced cross-slot scheduling**
Such as introducing explicit minimum scheduling offset parameter and better support for BWP² switching

**Adaptive MIMO layer reduction**
Supporting turning off transmit/receive chains (e.g., from 4 to 2) to save power

**Rel-16 new power saving techniques**
Also standardized power model and evaluation methodology

**Low power mode groups**
Carriers can be configured with different DRX duration (e.g., shorter active time for mmWave vs. sub-7 GHz)

**Device-assisted power saving**
Devices can request preferred power saving parameters (e.g., DRX, # of carriers, max bandwidth)

**Relaxed radio resource management**
In idle or inactive mode, device can relax measurements if it has low mobility or is not at the cell edge

**Low-power carrier aggregation control**
Efficient activation and deactivation of secondary cell is controlled by the primary cell

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¹ Discontinued reception; ² Bandwidth part; ³ Carrier aggregation
Rel-16 brings 5G NR mobility enhancements
Also further enhancing LTE mobility management

Sub-7 GHz and mmWave
Both inter- and intra-frequency handovers
Beneficial to high-mobility use cases (e.g., train, aerial)

Reduced interruption time
0ms handover enabled by dual active protocol stack with concurrent source/target cell transmissions/reception

Improved mobility robustness
Device-driven conditional handover for single and dual connectivity, and fast handover failure recovery
Further improving 5G NR spectrum aggregation
Carrier aggregation (CA) and dual connectivity (DC)

Enhancing Rel-15 CA/DC capability and performance

Supporting cross-carrier scheduling & CSI trigger w/ different numerologies, enhanced single Tx switching, async DC with NR power sharing, and unaligned CA

Early measurements and faster CA/DC activation

Defining configuration, signaling, reporting procedure for early measurement, and blind resume, faster activation for secondary cell(s)

Faster link recovery in dual connectivity

Improving robustness in case of master cell(s) failure when link to secondary cell(s) is still available
Enhancing ultra-reliable, low-latency communication

Rel-16 eURLLC builds on Rel-15 URLLC foundation

**Improved HARQ**
Multiple HARQ-ACK feedbacks per slot for latency reduction

**Coordinated multi-point (CoMP)**
Multi-TRP\(^1\) for redundant communication paths with spatial diversity

**Increased redundancy**
Number of PDCP\(^2\) packet duplicates increasing to 4 from 2

**Inter-device service multiplexing**
Uplink cancellation indicator and power boosting

**Intra-device channel prioritization**
Concurrently supporting differentiated levels of service (e.g., eMBB & mission-critical)

**More flexible scheduling**
Multiple active SPS\(^3\) configurations & reduced periodicity, more efficient DL control monitoring, UL repetition with cross-slot boundaries

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1. Multiple transmission and reception points; 2 Packet Data Convergence Protocol; 3 Semi-persistent scheduling
Two-step random access (RACH) procedure enhances efficiency
Over existing 5G NR Rel-15 four-step RACH procedure

- Reduces signaling overhead and latency
- Improves capacity and power efficiency
- Supports small grant-free uplink

### 4-step RACH Procedure

1. **msg1**: Random access preamble
2. **msg2**: Random access response
3. **msg3**: Scheduled transmission
4. **msg4**: Contention resolution

### 2-step RACH Procedure

1. **msgA**: Random access preamble and PUSCH payload
2. **msgB**: Contention resolution
Addressing interferences to improve system reliability

Remote Interference Mitigation (RIM)

Base stations can communicate and coordinate¹ mitigation of base station TDD DL-to-UL ducting interferences²

Cross-Link Interference (CLI)

Devices can measure and report inter-/intra-cell interferences³ caused by neighboring devices with different TDD configurations

1 Via reference signals (RIM-RS) over-the-air or in combination with backhaul signaling; 2 To indicate the presence of interference and whether enough mitigation is in place; 3 Inter-cell: when devices have semi-static TDD scheduling, Intra-cell: when devices support dynamic TDD

Cross-Link Interference (CLI)

Cross-link interference

Ground wave: normal range

Tropospheric ducting

Interference: 100’s of km away

Receiver

Transmitter

Downlink

Uplink
5G NR mmWave IAB\(^1\) for cost-efficient dense deployments

Improves coverage and capacity, while limiting backhaul cost

- mmWave access inherently requires small cell deployment
- Running fiber to each cell site may not be feasible and can be cost prohibitive
- mmWave backhaul can have longer range compared to access
- mmWave access and backhaul can flexibly share common resources

Traditional fiber backhaul can be expensive for mmWave cell sites
Improving uplink performance in higher bands

Single and dual uplink switching

Device with 2 Tx chain

Carrier 1: lower FDD band (e.g., n1 – 2.1 GHz)

Carrier 2: higher TDD band (e.g., n78 – 3.5 GHz)

Device can switch between 2 modes of uplink transmission

- Mode 1\(^1\): 1 Tx on carrier 1 and 1 Tx on carrier 2
- Mode 2: 0 Tx on carrier 1 and 2 Tx on carrier 2

Supporting inter-band aggregation

- Uplink carrier aggregation
- Supplemental uplink (SUL) without LTE/NR DC
- LTE/NR DC without SUL

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1 Applicable to UL CA and LTE/NR DC; for SUL, 1 Tx in carrier 1 and 0 Tx in carrier 2
Improving efficiency of radio access capability signaling
To address rapid increase in device capability size due to more band combinations and features

Uplink RRC message segmentation
Overcoming the maximum PDCP SDU¹ size (i.e., 9kB defined in 5G NR) by dividing device capability information into multiple smaller segments

Device radio capability ID
Identifying device's radio capability, stored in the network, which can be assigned by device manufacturer or serving network

¹ Packet Data Convergence Protocol Service Data Unit
Maintaining call continuity with circuit-switched fallback

Defining fallback procedures from 5G NR to circuit-switched 3G FDD network

Applying to also emergency (E911) calls

Excludes 3G TDD network support, packet switched and video service continuity

For VoNR deployments with limited or no VoLTE coverage
Data collection for network performance enhancements
Part of 3GPP Release 16

**Enhanced Network Automation (eNA)**
New enhanced core network function for data collection and exposure

**Minimization of Drive Testing (MDT)**
Logged and immediate MDT, mobility history information, accessibility & L2 measurements

**Self Organizing Network (SON)**
Mobility robust optimization (MRO), mobility load balancing (MLB), and RACH optimization

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1 NWDAF – Network Data Analytics Function; 2 Network Function, Application Function, Operations Administration and Maintenance; 3 For standalone and dual connected 5G NR systems
Expanding the reach of 5G

3GPP Release 16
Rel-16 introduces NR in unlicensed spectrum

**Anchored NR-U**
Unlicensed spectrum is combined with other licensed or shared spectrum as anchor

-Licensed or shared anchor spectrum
-Unlicensed NR-U spectrum*  
  -≤ 100 MHz UL BW
  -≤ 400 MHz DL BW

**Standalone NR-U**
Only unlicensed spectrum is used

-Unlicensed NR-U spectrum*  
  -≤ 100 MHz UL BW
  -≤ 400 MHz DL BW

*Still under discussion in Rel-16

Unlock more spectrum globally
New markets and verticals
New deployment scenarios
5G private networks brings benefits to industrial IoT

**Dedicated**
Local network, dedicated resources, independently managed

**Secure**
Cellular grade security, sensitive data stays on-premise

**Optimized**
Tailored performance for local applications, e.g., low latency, QoS\(^2\), APIs for managed 3rd party access

**Coverage, capacity, and, mobility**
Outdoor/indoor, high data speeds, seamless handovers, public network fallback

**Reliability and precise timing**
Industrial grade reliability, latency and synchronization (eURLLC\(^3\) and TSN\(^4\))

**Interoperability**
Global standard, vast ecosystem, future proof with rich 5G roadmap

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1. Also referred to as non-public network (NPN); 2. Quality of service; 3. Enhanced ultra-reliable low-latency communication; 4 Time sensitive network
5G V2X sidelink

Release 16 brings new benefits for automotive use cases

Enhanced autonomous driving
Real-time situation awareness and sharing of new kinds of sensor data enhances autonomous driving

Faster travel/energy efficiency
More coordinated driving for faster travel and lower energy usage

Accelerated network effect
Sensor sharing and infrastructure deployment bring benefits, even during initial deployment rollouts

Sidelink communications

Vehicle to vehicle (V2V)  
Vehicle to infrastructure (V2I)  
Other communication modes coming in future releases

Sidelink also essential for other use cases such as public safety, data offload
Rel-16 established the baseline for 5G-based positioning

New PRS$^1$ for devices to detect/measure more neighboring TRPs$^2$

Meeting initial 5G positioning accuracy requirements$^3$

- 3m (indoor) to 10m (outdoors) for 80% of time

1 Positioning Reference Signal; 2 Transmission Points; 3 5G positioning requirements defined in TS 22.261
enTV is evolving in Rel-16 to become 5G broadcast
Fulfilling all 5G requirements\(^1\) defined for broadcast

**Rel-16 enTV – 5G Broadcast – focuses on supporting more diverse deployments**

- Add support for MPMT\(^2\) and HPHT\(^3\) deployments with rooftop reception (CP\(^4\) of 300μs)
- Enhance support for high speed (~250km/h) in car-mounted LPLT\(^5\) deployment (CP of 100μs)
- Other potential enhancements are captured in TR 36.776 (SI) and RP-190732 (WI).

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1 Defined in 3GPP TS 38.913; 2 Medium Power Medium Tower (50km ISD, 60 dBm, 100m height); 3 High Power High Tower (125km ISD, 70 dBm, 300m height); 4 Cyclic Prefix; 5 Low Power Low Tower (15km ISD, 46 dBm, 35m height)
Evolving eMTC & NB-IoT for 5G massive IoT

Part of 3GPP Release 16

In-band eMTC / NB-IoT in 5G carrier

5G NR 2^n scaling of 15 kHz subcarrier spacing is natively compatible with eMTC and NB-IoT numerologies

5G core network support

For deploying eMTC and NB-IoT in networks operating in 5G NR standalone mode (SA) with a common core network

Further enhanced efficiency

Group wakeup signal, preconfigured uplink, multi-block scheduling, early data transmission, mobility enhancements

Flexible framework designed to support future evolution addressing even broader IoT use cases

1. Cat-M1 uses 6 Resource Blocks (RBs) with 12 tones per RB at 15 kHz SCS; 2. Cat-NB1 uses 1 Resource Block (RB) with 12 tones with 12 tones per RB at 15 kHz SCS, single-tone option also available
Intelligently connecting our world in the 5G era

Continued evolution

Rel-15 eMBB focus

Rel-16 and 17 Expanding to new industries

Rel-18, 19, 20 and beyond Continued 5G proliferation

Strong 5G momentum sets the stage for the global expansion

A unified connectivity fabric this decade

Next technology leap for new capabilities and efficiencies

Historically 10 years between generations
Thank you!

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Long-Term Outlook

Iain Sharp
Principal Technologist

September 24, 2020
5G Evolution in Response to Market Demands

• Full capabilities of 5G are evolving over several 3GPP releases
• ATIS work program and members are shaping 3GPP requirements and solutions based on North American experience and market needs
• U.S. spectrum
  – e.g. CBRS, new channel bandwidths
• 5G vertical market support
  – e.g. Vehicle Communication, Mission Critical Communications, Smart Cities, UAVs
• Enhanced system capabilities
  – e.g. Satellite as 3GPP accesses, IoT optimizations
• Regulatory features
  – e.g. Wireless Emergency Alert, E911 positioning
While 5G is already delivering powerful solutions to the North American market, the 6G “game” has already begun:

- Regions are undertaking coordinated 6G research programs with industry and academia
- Global standards groups are already developing next generation requirements and roadmaps (e.g., ITU-R IMT Technology Trends, and planned Vision Beyond IMT-2020)
- In May 2020, ATIS issued a “Call to Action to Promote U.S. 6G Leadership”
- As we define the vision for “next G”, we want leadership from a broad set of regional stakeholders including industry, academia and government
ATIS Proposed Architectural Principles for Next-Gen Networks

• Highly-distributed and customizable:
  – Required to support different applications and usage models

• Software-driven, dynamic and elastic:
  – Required to support distribution and customization cost effectively

• Data powered, AI-driven network automation:
  – Required to support management and monitoring at scale with dynamics
  – To become a fully autonomous network with closed loop control and policy governance for dynamic behavior
Concluding Remarks

• Like all organizations, 3GPP has had to adapt its working methods due to Covid-19
  – The drive for innovation is undiminished
  – Learnings from this experience will persist after the crisis

• 3GPP is delivering a rich roadmap of 5G specifications to enhance their range of use-cases and operational capabilities

• Thanks to our speakers for making time in their schedules to share their expertise
Thank you for attending the 5G Standards Developments in 3GPP Release 16 and Beyond Webinar

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