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뉴노멀시대 선도를 위한
ICT 표준의 역할

5G의 추구 목표를 완성하는 Release 17 무선접속 기술

LG 전자, 윤영우 수석연구위원

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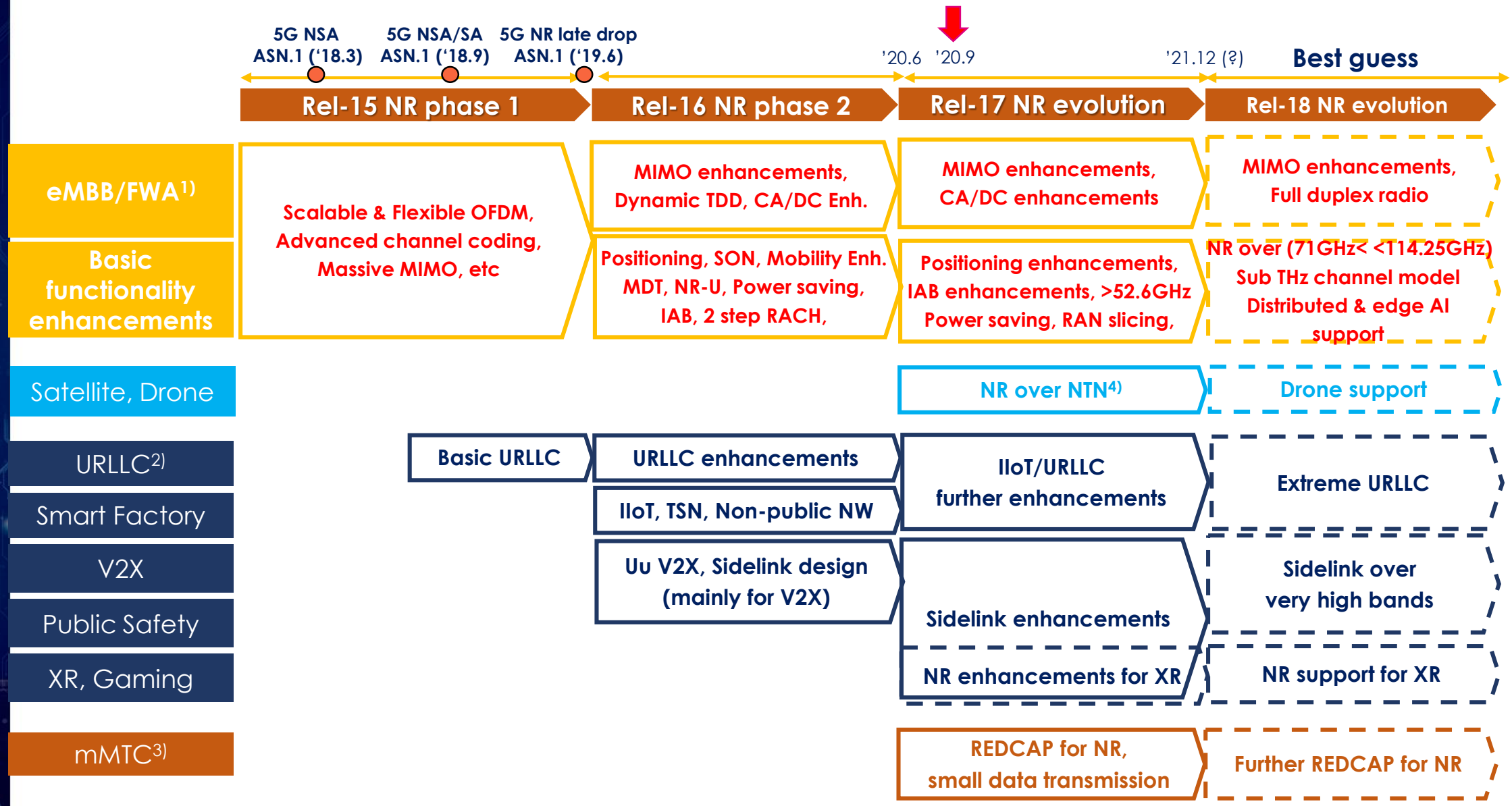
역할

5G NR overall timeline



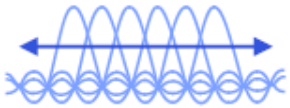
1) Enhanced Mobile Broadband / Fixed Wireless Access, 2) Ultra-Reliable Low Latency Communication, 3) Massive Machine Type Communication, 4) Non-Terrestrial Network

Rel-15 highlights

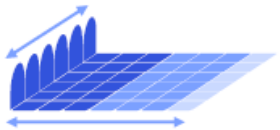
Establishing 5G NR and 5GS foundation in Rel-15

→ Phase 1 of 5G NR and 5GS designed to encompass all the use cases, but **initial focus was on the support of eMBB type services**

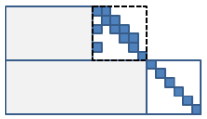
NR phase 1 main feature



Scalable OFDM based air interface

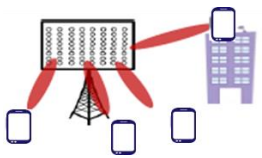


Flexible Framework



Advanced channel coding (LDPC, polar code)

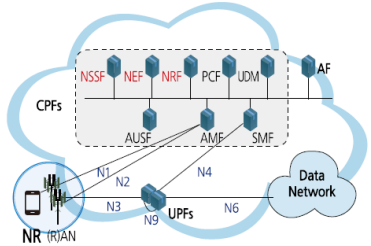
LTE-NR Dual Connectivity



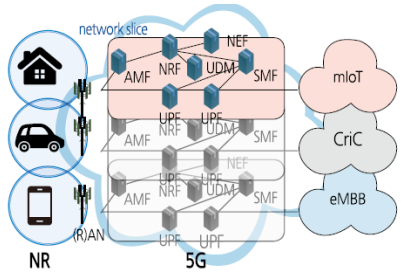
Beam based air interface for mmWave spectrum

Massive MIMO for sub-6GHz

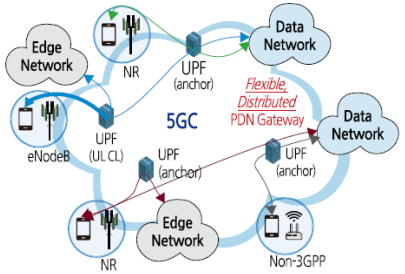
5GS phase 1 main feature



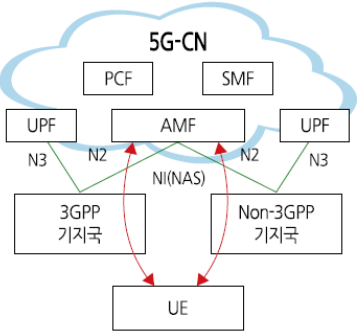
Service Based Architecture



Network slicing



Distributed UPFs & edge computing



Common core architecture

Reference: Qualcomm, "Future of 5G"

Reference: ETRI, "TTA 5G 특별 보고서"

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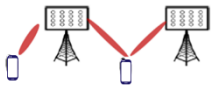
Rel-16 highlights

Extending to new use cases and industries

- Enhancing basic functionalities for more advanced eMBB use cases
- **Focusing more on support of other industries (factories, automotive, TV Broadcast, etc.)**

Rel-16 Main Features

Enhancing Basic Functionalities

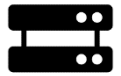


MIMO enhancements

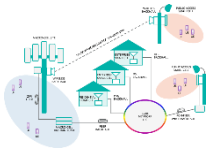
Mobility enhancements

UE power saving

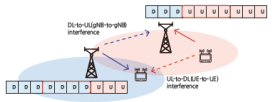
DC/CA enhancements



SBA enhancements



Integrated Access & Backhaul



CLI (Cross Link Interference) Management

NR positioning

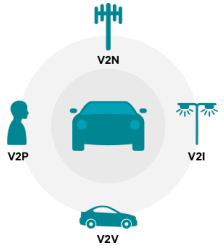
NR-U (unlicensed)

NW automation SON & MDT

Supporting other industries

URLLC enhancements

IIoT (Industrial IoT)



5G V2X

5G broadcast (w. LTE eMBMS)

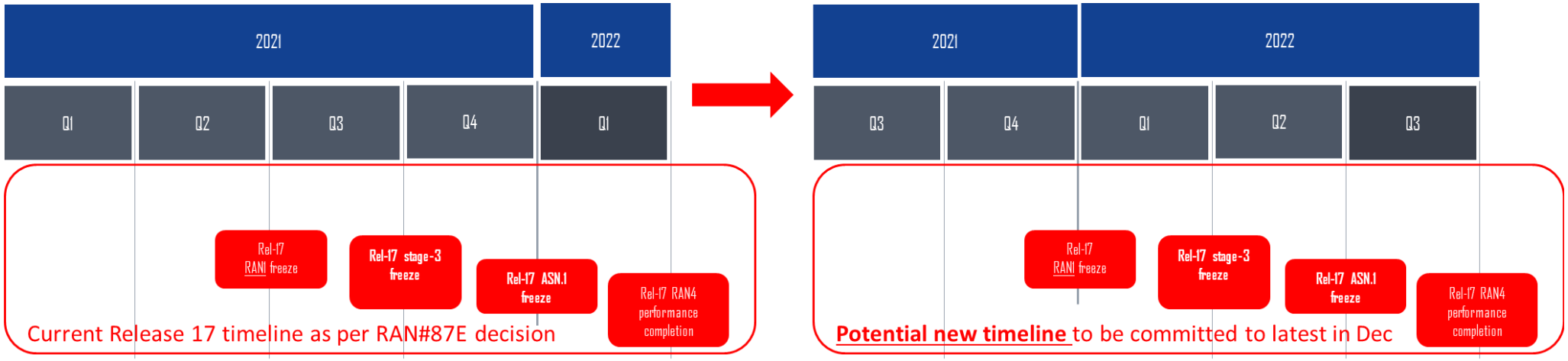
Non-Public Network

5G LAN

Rel-17 Schedule

Overall timeline for Rel-17 NR

- Current milestones below (left figure) already shows a **3-months shift compared to previous timelines approved** in '19.12
- **Potential new timeline (right figure) shows shift of further 6-months due to the effects of COVID-19**
  - Expect Electronic era to last throughout 2021 in the worst case
  - The leadership is committed to facilitate delivering Rel-17 with minimal additional delay
  - Firmly commit to a new timeline in December



Reference: RP-202047. RAN chairman, RAN WG chairmen, "Release, Meeting and TU planning"

Rel-17 Overview

Categorization of Rel-17 NR work areas

eMBB oriented features (Enhancing basic functionalities)	• NR MIMO enhancements • Positioning enhancements • UE power saving enhancements • Coverage enhancements • IAB enhancements • RAN slicing • Multi-SIM • NR broadcast/multicast • NTN (Non-Terrestrial Network) • NR support above 52.6GHz (up to 71GHz)
URLLC features (supporting more diverse vertical applications)	• Enhanced sidelink (for V2X and other commercial use cases) • Public Safety (UE-NW relaying) • Enhanced IIoT/URLLC
mMTC features (supporting diverse device types)	• REDCAP (Reduced Capability) NR → formerly known as NR-Light • Small data transmission in RRC inactive

Not an exclusive list

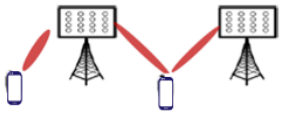
eMBB & Basic functionalities [1/6]

For eMBB & basic functionalities

- **Perfecting existing functionalities** for more advanced eMBB use cases
- **Introducing new functionalities** for new requirements from the market

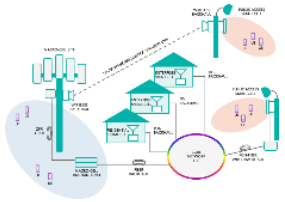
Rel-17 eMBB & basic functionalities

Perfecting existing functionalities



MIMO
Further enhancements

UE power saving enhancements



IAB enhancements

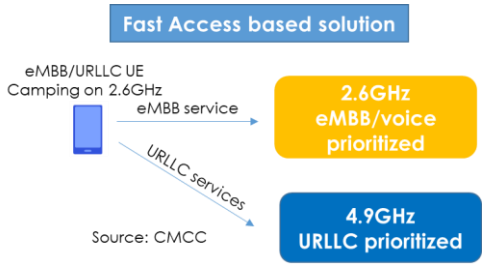
NR positioning enhancements

Introducing new functionalities

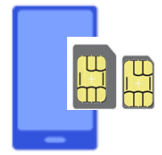
NR over NTN

Multicast/ Broadcast

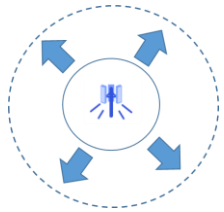
Supporting new higher bands (up to 71GHz)



RAN slicing



Supporting multi-SIM device

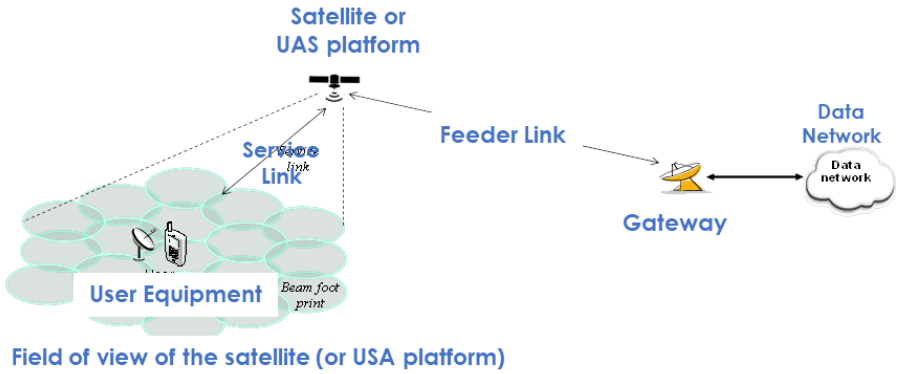


Coverage extension (FR1 & FR2)

eMBB & Basic functionalities [2/6]

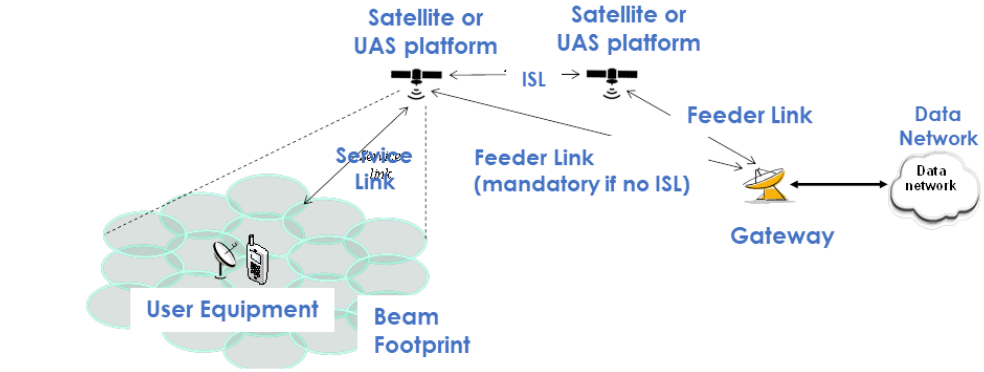
NTN (Non-Terrestrial Networks) over NR

- Main purpose
  - Providing **enhanced coverage, reliability and availability**
    - Providing **connectivity for unserved areas that cannot be covered by traditional terrestrial network**
    - Remote M2M/IoT devices, moving platforms (e.g., **aircraft, maritime vessels, high-speed trains**)
  - Ensuring service availability/reliability anywhere, especially for critical communication



- **NTN based on transparent payload**

- Radio Frequency filtering, Frequency conversion and amplification.
- Hence, **the waveform signal repeated by the payload is un-changed**



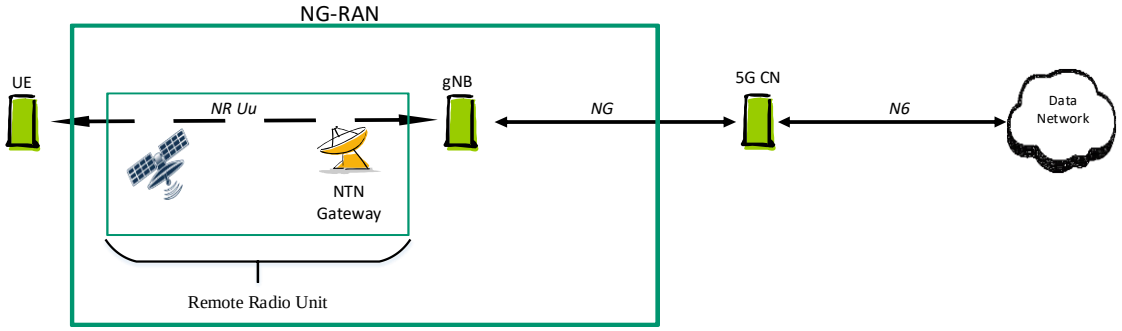
- **NTN based on non-transparent payload**

- Radio Frequency filtering, Frequency conversion and amplification as well as demodulation/decoding, switch and/or routing, coding/modulation
- This is effectively equivalent to **having all or part of base station functions (e.g. gNB) on board the satellite (or UAS platform)**

Source: 3GPP TR 38.821, Solutions for NR to support non-terrestrial networks

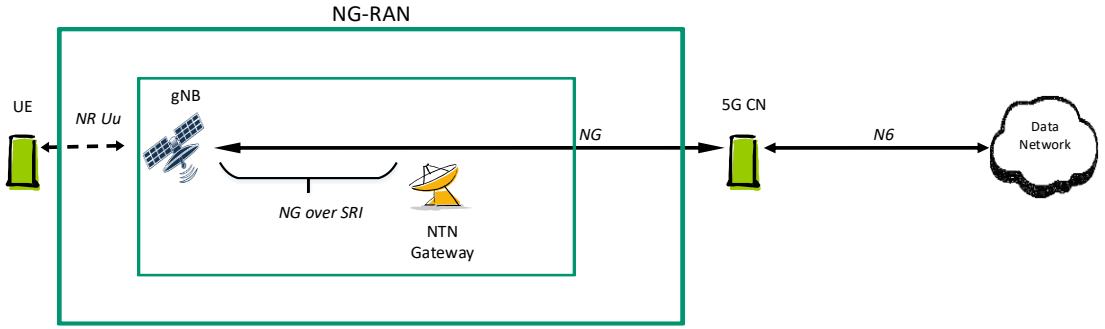
eMBB & Basic functionalities [3/6]

NTN NG-RAN architecture



Networking-RAN architecture with transparent satellite

- **Satellite repeats the NR-Uu radio interface from the feeder link** (between the NTN gateway and the satellite) **to the service link** (between the satellite and the UE) and vice versa
- **The NTN GW supports all necessary functions to forward the signal of NR-Uu interface**



Regenerative satellite without ISL, gNB processed payload

- **The satellite payload** implements **regeneration of the signals received from Earth.**
  - ✓ NR-Uu radio interface on the service link between the UE and the satellite
  - ✓ Satellite Radio Interface (SRI) on the feeder link between the NTN gateway and the satellite.
- SRI (Satellite Radio Interface) is a transport link between NTN GW and satellite

Among the above, **Rel-17 NTN normative work will be done only for transparent satellite architecture**

Source: 3GPP TR 38.821, Solutions for NR to support non-terrestrial networks

eMBB & Basic functionalities [4/6]

Types of NTN platform

- Aims to specify the enhancements identified for NR NTN (non-terrestrial networks) especially **LEO and GEO with implicit compatibility to support HAPS (high altitude platform station) and ATG (air to ground) scenarios**

Platforms	Altitude range	Orbit	Typical beam footprint size
Low-Earth Orbit (LEO) satellite	300 – 1500 km	Circular around the earth	100 – 1000 km
Medium-Earth Orbit (MEO) satellite	7000 – 25000 km		100 – 1000 km
Geostationary Earth Orbit (GEO) satellite	35 786 km	notional station keeping position fixed in terms of elevation/azimuth with respect to a given earth point	200 – 3500 km
UAS platform (including HAPS)	8 – 50 km (20 km for HAPS)		5 - 200 km
High Elliptical Orbit (HEO) satellite	400 – 50000 km	Elliptical around the earth	200 – 3500 km

Source: 3GPP TR 38.821, Solutions for NR to support non-terrestrial networks

NTN specific technical challenges

- **Very high propagation delay, Large cell size & moving cells, Very high speed mobility UEs**

eMBB & Basic functionalities [5/6]

NR Multicast & broadcast

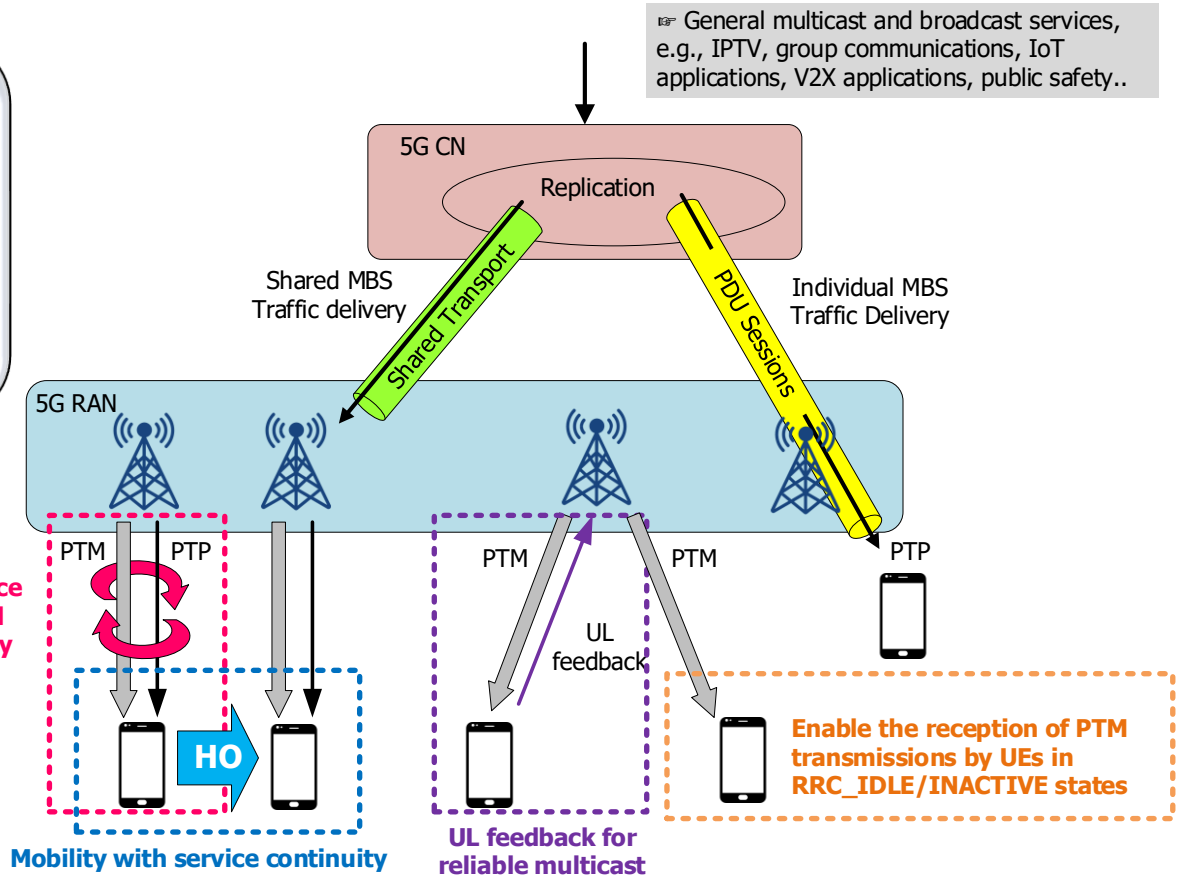
- **Main use case**
  - General multicast and broadcast services, e.g., IPTV, group communications, IoT applications, V2X applications, public safety

For UEs in RRC_CONNECTED

- **Dynamic change of Broadcast/Multicast service delivery** between multicast (PTM) and unicast (PTP) with service continuity
- **Support for basic mobility** with service continuity
- **Improve reliability of Broadcast/Multicast service**, e.g. by UL feedback

For UEs in RRC_IDLE/INACTIVE

- **Enable the reception of Point to Multipoint transmission by UEs in RRC_IDLE/RRC_INACTIVE**



eMBB & Basic functionalities [6/6]

NR support for 52.6GHz ~ 71GHz

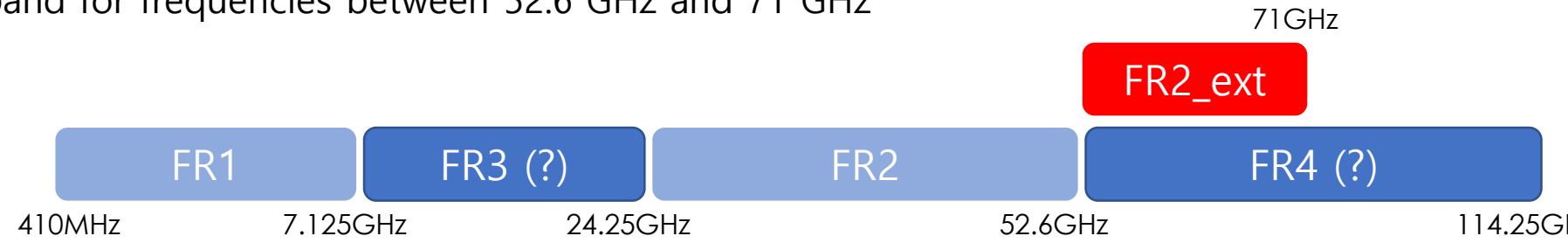
- As for frequency range > 52.6GHz, 3GPP **agreed to address the subset 52.6GHz ~ 71GHz first (so called FR2_ext) with a simple approach that extends FR2 characteristics**

Main motivation

- **60GHz bands stands-out**
  - Global, available today, regulations in place
  - No 3GPP solution which can tap on market opportunities

Main objective

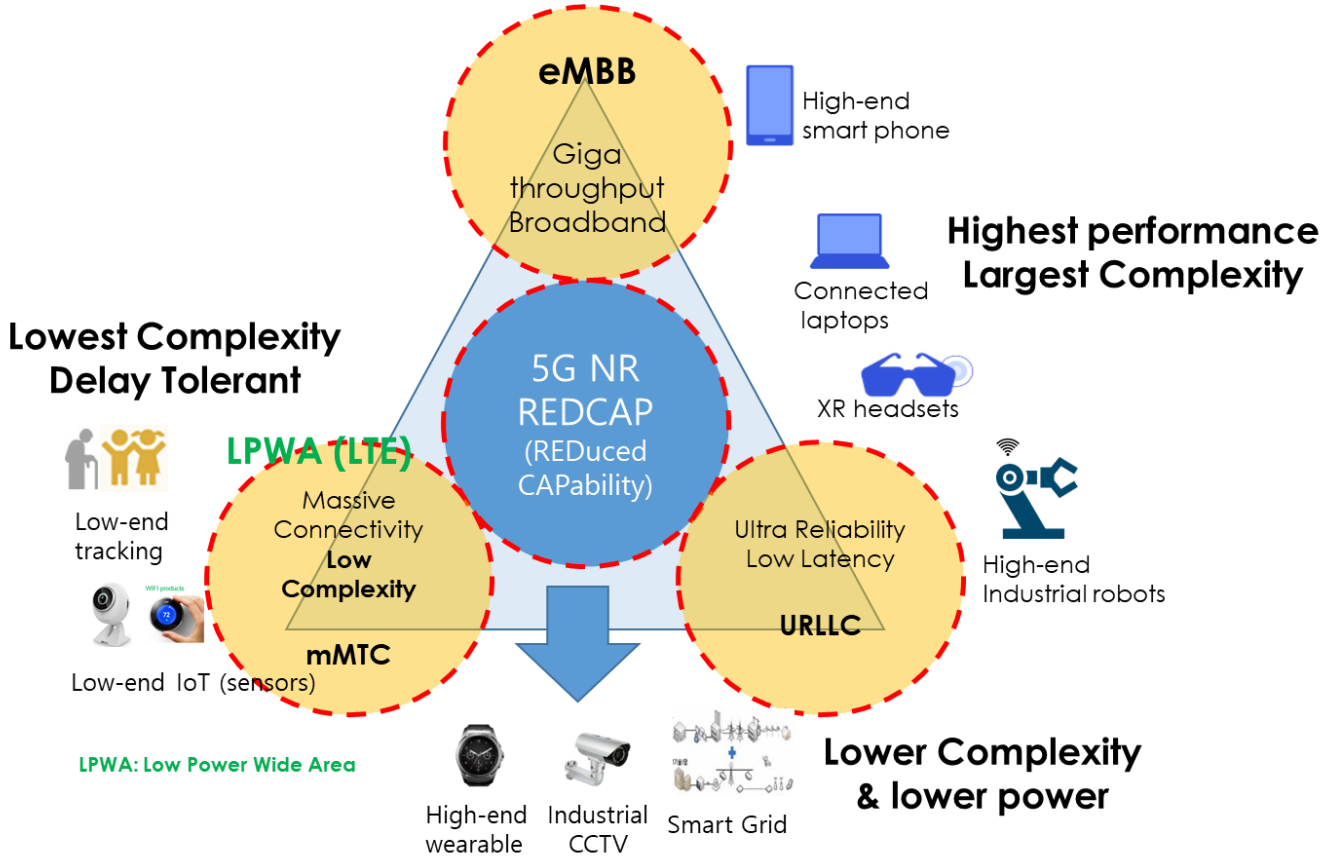
- Study of **required changes to NR using existing DL/UL NR waveform** to support operation between 52.6 GHz and 71 GHz
  - Study of **applicable numerology including SCS, channel BW (including maximum BW), and their impact to FR2 physical layer design**
- Study of **channel access mechanism, considering potential interference to/from other nodes, assuming beam based operation**, in order to comply with regulatory requirements applicable to U-band for frequencies between 52.6 GHz and 71 GHz



mMTC features [1/3]

REDCAP for NR, driving IoT expansion (A.K.A NR-Light)

- **Much lower UE complexity and power consumption** than Rel-15/16 NR, scaling down 5G NR for lower complexity IoT devices
- **Increased network efficiency and coverage optimization**



- **Target use cases**
  - ✓ 5G connectivity
  - ✓ smart city, smart grid
  - ✓ wearables

mMTC features [2/3]

REDCAP for NR, use case specific requirements

Use cases	Ref. bit rate (Mbps)	Peak bit rate (Mbps)	End-to-end latency (ms)	Reliability	Mobility	Battery lifetime
Industrial wireless sensors	< 2 (potentially UL heavy)		< 100; 5-10 for safety related sensors	Comm. service availability 99.99%	Stationary	At least a few years
Video surveillance	2-4 for economic video; 7.5-24 for high-end video (UL heavy)		<500	99-99.9%		
Wearables	5-50 in DL; 2-5 in UL	Up to 150 in DL; Up to 50 in UL				Multiple days (up to 1-2 weeks)

Main objective

- Identify and study **potential UE complexity reduction features**
  - **Reduced number of UE RX/TX antennas**, UE **Bandwidth reduction**, **Half-Duplex-FDD**, **Relaxed UE processing time, Relaxed UE processing capability**
- **UE power saving and battery lifetime enhancement for reduced capability UEs** in applicable use cases (e.g. delay tolerant)
  - Reduced PDCCH monitoring by **smaller numbers of blind decodes and CCE limits**, **Extended DRX for RRC** , Inactive and/or Idle, **RRM relaxation for stationary devices**

mMTC features [3/3]

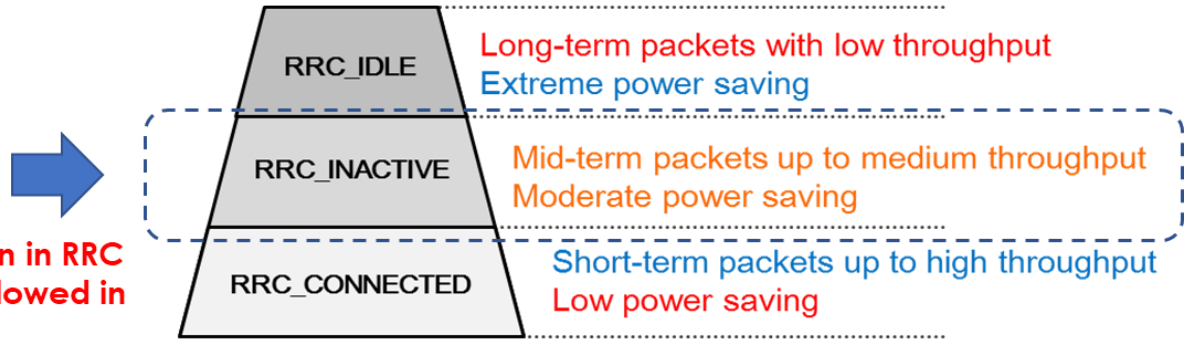
Small Data Transmission in RRC INACTIVE

- **Targeting traffic with infrequent small data transmission**
  - Traffic from meters or sensors-type NR REDCAP UEs with periodic measurement reporting
  - Traffic from wearables with periodic positioning information
  - Traffic generated from instant messaging services or heart-beat messages, etc
- Under these traffic types, **UE is often maintained by network in RRC inactive state**
- Without support of data transmission in RRC inactive state, UE has to resume the connection with RRC connected state

Main objective

- **UL small data transmissions for RACH-based schemes** (i.e. 2-step and 4-step RACH)
- **Transmission of UL data on pre-configured PUSCH resources** (i.e. reusing the configured grant type 1) – when TA is valid

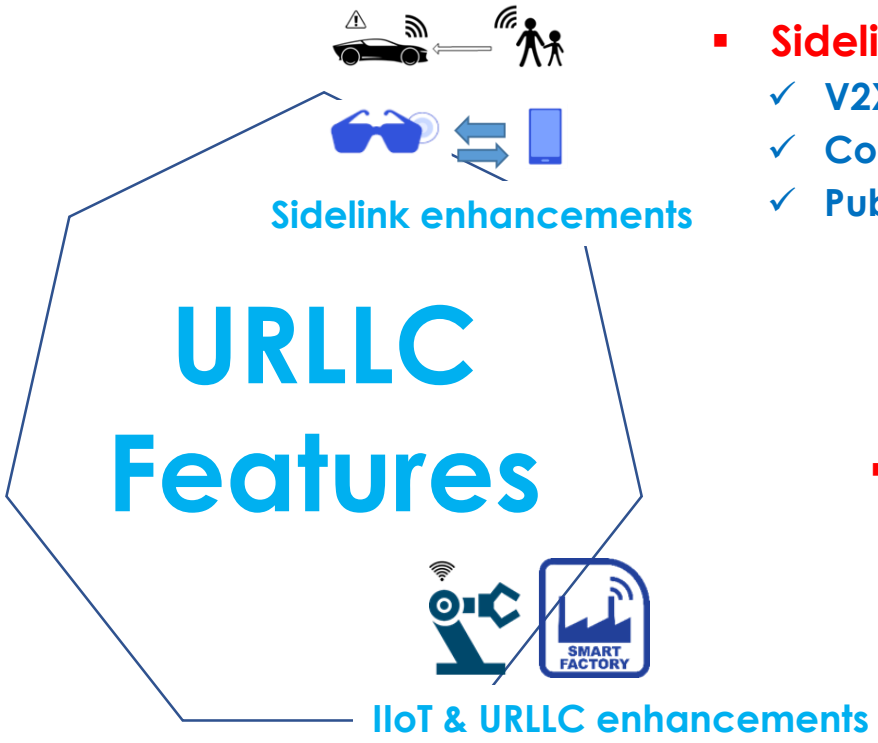
Allowing small data transmission in RRC INACTIVE state (currently not allowed in Rel-16) for signaling overhead reduction and power saving



URLLC features [1/2]

For URLLC features

- **Customizing NR further for various verticals** such as automotive, logistics, public safety, media and manufacturing use cases

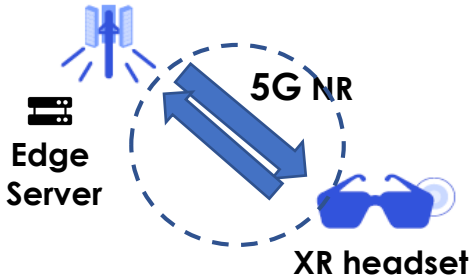


- **Sidelink enhancements,** focusing on
  - ✓ **V2X (especially for VRU protection),** VRU: Vulnerable Road User
  - ✓ **Commercial use cases** (e.g., XR headset support)
  - ✓ **Public safety (UE-NW relaying)**

- **Improved support for factory automation and URLLC**
  - ✓ **Physical layer feedback enhancements**
  - ✓ **Identification of enhancements for URLLC/IIoT operation in controlled environments on unlicensed bands**
  - ✓ **Intra-UE multiplexing and prioritization of traffic** with different priority
  - ✓ Enhancements for **support of time synchronization**

URLLC features [2/2]

- **Evaluation and gap analysis of NR performance in relation to XR support**
  - ✓ **Confirm XR and Cloud Gaming applications of interest**



XR evaluation & Gap analysis

	Cloud Gaming	VR split rendering	AR split computation
HMD/Device	5G Smartphone or Tablet 	Head-mounted with 5G modem attached 	Head-mounted with USB/Bluetooth connection to "Puck" or Smartphone with 5G modem  
5G usage	QoS/OTT	QoS	QoS
Location	Outdoor	Enterprise-Indoor, Residential-Indoor, Outdoor	Enterprise-Indoor, Outdoor
Mobility	Static, Hi-speed	Limited to head movements and restricted body movements, Hi-speed (VR in a train, back of a car)	Pedestrian, Hi-speed

Source: Qualcomm, 3GPP, RP-190836, XR & 5G

- ✓ **Identify the traffic model for each application of interest**
- ✓ **Identify evaluation methodology**
- ✓ **Evaluate needs** in terms of simultaneously providing very high data rates and low latency in a resource-efficient manner

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Conclusion

Everything under 5G

→ 5G technologies in **3GPP keep evolving so that virtually everyone and everything is connected with each other by means of 5G connectivity**, laying foundation for **digital transformation**