



Overview on 3GPP RAN 6G Standardization

2026.09.03

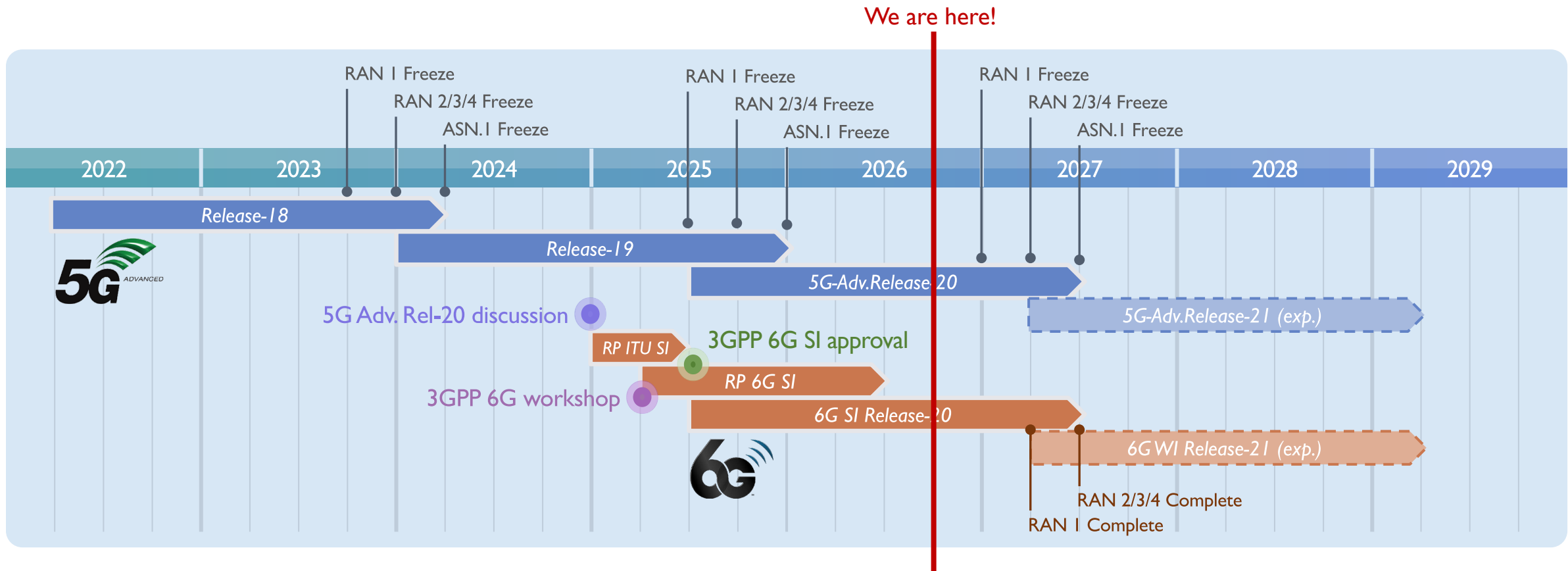
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Timeline for 6G Standardization



Study on 6G Scenarios and Requirements

- RAN-level study item for 6G: [Study on 6G Scenarios and Requirements](#)
 - Moderator: CMCC, Verizon, NTT DOCOMO, INC., Deutsche Telekom
- RAN-level study item for 6G was completed in RAN#112 (2026.06)
 - [TR 38.914](#) v1.0.0 (Study on 6G Scenarios and Requirements) was approved as [RP-261565](#)
 - Deployment scenarios
 - Requirements and key technical principles
 - Key performance indicators
 - Requirements for architecture and migration
 - Operational requirements
 - Spectrum
 - Diverse device types
 - Other
 - Requirements of New and Existing Services
 - Testing and Conformance requirements

Deployment Scenarios

- Deployment scenarios
 - High-level descriptions on deployment scenarios including
 - carrier frequency
 - aggregated system bandwidth
 - network layout
 - ISD
 - Orbit
 - BS
 - UE antenna elements
 - UE distribution
 - speed
 - service profile

6G Deployment scenarios	5G Deployment scenarios
Indoor hotspot	Indoor hotspot
Dense urban	Dense urban
Rural	Rural
Urban macro	Urban macro
Sub-Urban macro	
High speed train	High speed
Extreme long distance coverage in low density area	Extreme long distance coverage in low density area
Urban coverage for massive connection	Urban coverage for massive connection
Air-to-Ground Scenario	Commercial Air to Ground scenario Light aircraft scenario
Non-Terrestrial Network	Satellite extension to Terrestrial
Urban grid	Urban grid for connected car
Highway Scenario	Highway Scenario
Indoor Factory (InF)	
Single Cell with Large Coverage	

Deployment Scenarios

- **Sub-Urban macro**

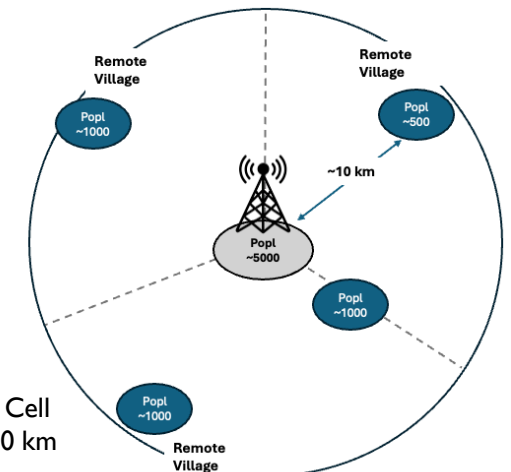
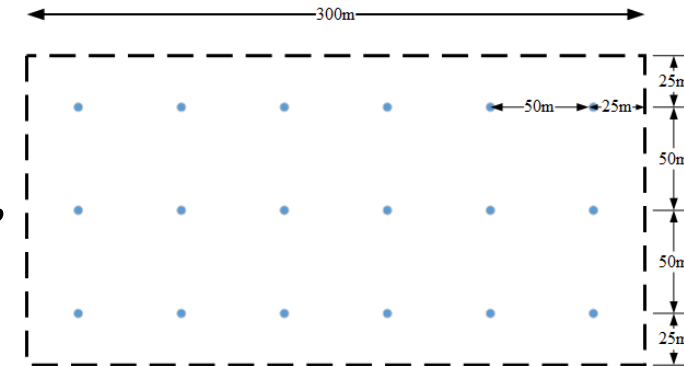
- Large cells and continuous coverage
- Continuous and ubiquitous wide area coverage supporting pedestrian and moderate speed vehicles, energy saving, positioning performance

- **Indoor Factory (InF)**

- Factory halls of varying sizes and with varying levels of density of "clutter", e.g. machinery, assembly lines, storage shelves, etc
- Small coverage per site/TRxP (transmission and reception point) and high user throughput or user density in buildings
- High capacity, high user density and consistent user experience indoor

- **Single Cell with Large Coverage**

- Single macro cell deployment in very low-density rural areas



RP-260398, Isolated Macro Cell
with a cell radius of up to 10 km

Key Performance Indicators

- Finalized KPI definitions after reaching alignment with ITU-R WP5D on key values and objectives
- 14 items (#1 - #14) are the same as 5G NR, and 6 items (#15 - #20) are newly defined for 6GR
 - Most of the values in each item have been slightly improved
 - One additional internal KPI has been added

TPR items	6GR Target values			IMT-2020 (5G) Target values		
1. Theoretical Peak Data Rate	DL: 36Gbps UL: 18Gbps			DL: 20Gbps UL: 10Gbps		
2. Peak Spectral Efficiency	DL: 60bps/Hz UL: 30bps/Hz			DL: 30bps/Hz UL: 15bps/Hz		
3. 5 th percentile user data rate	DL: 300Mbps UL: 50Mbps			DL: 100Mbps UL: 50Mbps		
4. 5 th percentile user Spectral Efficiency	Deployment Scenario		Downlink (bit/s/Hz)	Uplink (bit/s/Hz)		
	Indoor Hotspot		0.9	0.63		
	Dense Urban		0.675	0.45		
	Rural		0.36	0.135		
			0.2 (NOTE 1)	0.11 (NOTE 1)		
	NOTE1: These values are applicable for ISD of 4 km and are optional.					

Key Performance Indicators

TPR items	6GR Target values	IMT-2020 (5G) Target values																												
5. Average Spectral Efficiency	<table> <tr> <th>Deployment Scenario</th><th>Downlink (bit/s/Hz)</th><th>Uplink (bit/s/Hz)</th></tr> <tr> <td>Indoor Hotspot</td><td>27</td><td>20.25</td></tr> <tr> <td>Dense Urban</td><td>23.4</td><td>16.2</td></tr> <tr> <td>Rural</td><td>9.9</td><td>4.8</td></tr> </table>	Deployment Scenario	Downlink (bit/s/Hz)	Uplink (bit/s/Hz)	Indoor Hotspot	27	20.25	Dense Urban	23.4	16.2	Rural	9.9	4.8	<table> <tr> <th>Test environment</th><th>Downlink (bit/s/Hz)</th><th>Uplink (bit/s/Hz)</th></tr> <tr> <td>Indoor Hotspot - eMBB</td><td>9</td><td>6.75</td></tr> <tr> <td>Dense Urban - eMBB</td><td>7.8</td><td>5.4</td></tr> <tr> <td>Rural - eMBB</td><td>3.3</td><td>1.6</td></tr> </table>	Test environment	Downlink (bit/s/Hz)	Uplink (bit/s/Hz)	Indoor Hotspot - eMBB	9	6.75	Dense Urban - eMBB	7.8	5.4	Rural - eMBB	3.3	1.6				
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6. Area Traffic Capacity	40 Mbit/s/m ² in Indoor Hotspot	10 Mbit/s/m ²																												
7. User Plane Latency	IC: 4ms HRLLC: 1ms	eMBB : 4ms URLLC: 1ms																												
8. Control Plane Latency	20ms	20ms for eMBB and URLLC																												
9. Connection Density	10 ⁶ (devices/km ²) for massive communication	For mMTC, 10 ⁶ devices per km ²																												
10. Reliability	1-10 ⁻⁵ with same IMT-2020 assumptions	For URLLC, 1-10 ⁻⁵ success probability																												
11. Mobility	<table> <tr> <th>Deployment Scenario</th><th>Normalized traffic channel link data rate (Bit/s/Hz)</th><th>Mobility (km/h)</th></tr> <tr> <td>Indoor Hotspot</td><td>2.25</td><td>10</td></tr> <tr> <td>Dense Urban</td><td>1.68</td><td>30</td></tr> <tr> <td rowspan="2">Rural</td><td>1.2</td><td>120</td></tr> <tr> <td>0.675</td><td>500</td></tr> </table>	Deployment Scenario	Normalized traffic channel link data rate (Bit/s/Hz)	Mobility (km/h)	Indoor Hotspot	2.25	10	Dense Urban	1.68	30	Rural	1.2	120	0.675	500	<table> <tr> <th>Test environment</th><th>Normalized traffic channel link data rate (Bit/s/Hz)</th><th>Mobility (km/h)</th></tr> <tr> <td>Indoor Hotspot - eMBB</td><td>1.5</td><td>10</td></tr> <tr> <td>Dense Urban - eMBB</td><td>1.12</td><td>30</td></tr> <tr> <td rowspan="2">Rural - eMBB</td><td>0.8</td><td>120</td></tr> <tr> <td>0.45</td><td>500</td></tr> </table>	Test environment	Normalized traffic channel link data rate (Bit/s/Hz)	Mobility (km/h)	Indoor Hotspot - eMBB	1.5	10	Dense Urban - eMBB	1.12	30	Rural - eMBB	0.8	120	0.45	500
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Key Performance Indicators

TPR items	6GR Target values	IMT-2020 (5G) Target values																		
12. Mobility Interruption Time	For minimum requirement, 0ms	For eMBB and URLLC, 0ms																		
13. Bandwidth	400MHz	At least 100MHz, Shall support up to 1GHz for operation in higher frequency bands (e.g., above 6GHz)																		
14. Sustainability / Energy Efficiency	For IMT-2030 TPR, energy efficiency is defined as the relative energy consumption (in terms of percentage) for the selected load case(s) relative to a fully loaded reference case. 6GR shall have the capability to support energy efficient operation through low relative energy consumption in the selected load cases, considering at least the unloaded (L= 0%) and one loaded scenario (0% < L ≤ 30%), where L is load level, i.e., network resource utilization ratio. The evaluated energy efficiency values can be reported, as well as impacts on communication performance associated with the evaluated energy saving technique(s).	The sleep ratio is the fraction of unoccupied time resources (for the network) or sleeping time (for the device) in a period of time corresponding to the cycle of the control signalling (for the network) or the cycle of discontinuous reception (for the device) when no user data transfer takes place.																		
15. Positioning	<table><tr><td>Deployment Scenario</td><td>Horizontal Accuracy (m)</td></tr><tr><td>Indoor Factory</td><td>0.75</td></tr><tr><td>Urban Macro</td><td>6</td></tr></table> For 3GPP Internal KPI, the 6GR and 6G RAN shall satisfy vertical positioning accuracy of 3 meters at the 80% point of the CDF of the device positioning error.	Deployment Scenario	Horizontal Accuracy (m)	Indoor Factory	0.75	Urban Macro	6													
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16. Sensing-related capabilities	<table><tr><td></td><td>Indoor Factory</td><td>Urban Macro</td></tr><tr><td>Detection Probability</td><td>95%</td><td>95%</td></tr><tr><td>False Alarm Probability</td><td>5%</td><td>5%</td></tr><tr><td>Horizontal Localization Accuracy</td><td>2 m</td><td>5 m</td></tr><tr><td>Vertical Localization Accuracy</td><td>N/A</td><td>8 m</td></tr><tr><td>Velocity Accuracy</td><td>2 m/s</td><td>4 m/s</td></tr></table>		Indoor Factory	Urban Macro	Detection Probability	95%	95%	False Alarm Probability	5%	5%	Horizontal Localization Accuracy	2 m	5 m	Vertical Localization Accuracy	N/A	8 m	Velocity Accuracy	2 m/s	4 m/s	
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Velocity Accuracy	2 m/s	4 m/s																		

Key Performance Indicators

TPR items	Proposed requirement values	IMT-2020 (5G) Target values										
17. AI-related capabilities	AI-related capabilities refer to the ability to provide certain functionalities throughout IMT-2030 to support AI enabled applications, including. - 6GR and 6G RAN facilitating AI applications i.e., “Network for AI”. - AI to improve 6GR and 6G RAN performance, i.e., “AI for network”. 6GR and 6G RAN should support AI-related capabilities, which refer to the ability for the 6GR and 6G RAN to support mechanisms and/or signalling related to AI functionalities.											
18. Composite requirement	<table><tr><td>Deployment Scenario</td><td>Data rate (Mbit/s)</td><td>Latency (ms)</td><td>Packet success probability</td><td>Number of users (/TRxP)</td></tr><tr><td>Dense Urban</td><td>DL = 30 Mbps/UL=10 Mbps</td><td>DL=10 ms / UL=30 ms (or DL+UL total 40 ms)</td><td>99%</td><td>6</td></tr></table>	Deployment Scenario	Data rate (Mbit/s)	Latency (ms)	Packet success probability	Number of users (/TRxP)	Dense Urban	DL = 30 Mbps/UL=10 Mbps	DL=10 ms / UL=30 ms (or DL+UL total 40 ms)	99%	6	
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19. Resilience	This requirement includes the following capabilities: Resilience: It refers to capabilities of the networks and systems to continue operating correctly during and after a service disruption, such as the loss of primary source of power, etc.The 6GR and 6G RAN should support functionalities over the radio interface that enable continuous operation or rapid temporary restoration during and after disturbance to radio infrastructure. Extended Connectivity: It refers to the capability to provide connectivity in areas that are currently uncovered or scarcely covered due to challenges arising from geographical conditions, such as the lack of ground infrastructure (e.g., fibre cables and power supply), where users desire access to communication services. The 6GR and 6G RAN should have functionalities that support providing geographically extended connectivity in these areas. For resilience and extended connectivity, 6GR and 6G RAN shall support network infrastructures complementary to the terrestrial component of IMT.											

Deployment Scenarios

TPR items	Proposed requirement values	IMT-2020 (5G) Target values
20. Coverage (3GPP internal KPI)	6GR aims to re-use existing 5G mid-band (~3.5 GHz) site grid for 6G deployments in at least around 7 GHz and targeting: - Same coverage (as 5G mid-band) for initial access - Comparable to same (as 5G mid-band) coverage for data channels with same data rate 6GR aims to provide enhanced overall coverage compared to 5G in the same band, focusing on cell-edge performance and UL coverage. For a basic coverage characterized by a downlink data rate 1 Mbps and 250 kbps for 2 and 1 UE Rx antennas, respectively, and an uplink data rate 40 kbps, the target on maximum coupling loss is $\text{MaxCL} = 143 \text{ dB}$. 6GR shall also support extended coverage with a target on maximum coupling loss of $\text{MaxCL} = 153 \text{ dB}$ characterized by a downlink data rate 100 kbps and 25 kbps for 2 and 1 UE Rx antennas, respectively, and an uplink data rate 2 kbps.	

- Regarding on more ITU-R KPI, i.e., link distance, the following was agreed instead of adding the KPI
 - Link distance will be considered in the description template for IMT-2030 submission to ITU.

5.1.X Link Distance

Link distance is defined as the distance at which a specific data rate is satisfied for a cell. The proponent should indicate this distance in the description template using link budget analysis as defined in Report ITU-R M.[IMT-2030.SUBMISSION].

Objectives of RAN 6GR Study (I/4)

- l) Single technology framework based on a stand-alone architecture (Note I) to support the agreed existing and new services, and to satisfy the usage scenarios, requirements, deployment scenarios and design principles with acceptable performance/complexity trade-off, as determined by the RAN requirements in [RP-250810] and [TR38.914], including: [RAN1], [RAN2], [RAN3], [RAN4]
 - a. Ensuring appropriate set of functionalities, minimize the adoption of multiple options for the same functionality, avoid excessive configurations, excessive UE capabilities and UE capabilities reporting
 - b. Energy efficiency and energy saving: both for network and device
 - c. Enhanced spectral efficiency
 - d. Enhanced overall coverage, focus on cell-edge performance and UL coverage
 - e. Wider channel bandwidth (at least 200MHz) support for 6G deployments at least above 2 GHz, around 7 GHz
 - f. Re-use of existing 5G mid-band (~3.5GHz) site grid for 6G deployments in at least around 7 GHz and targeting comparable coverage to 5G mid-band
 - g. Target scalable and forward compatible design for diverse device types
 - h. Improved spectrum utilization and operations taking into account diverse spectrum allocations
 - i. Aim at using common 6G Radio design, which meets mobile broadband service requirements as high priority, to also meet vertical needs
 - j. Aim at a harmonized 6G Radio design for TN and NTN, including their integration
- ...

Objectives of RAN 6GR Study (2/4)

2) Physical Layer structure for 6GR

- a. Waveforms (OFDM-based) and modulations. 5G NR Waveforms and modulation should be considered for 6GR and is also the benchmark for other potential proposals. [RAN1, RAN4]
- b. Frame structure, including compatibility with 5G NR to allow for efficient 5G-6G Multi-RAT Spectrum Sharing (MRSS). [RAN1]
- c. Channel coding, using LDPC and Polar Code as baseline, considering applicable extensions to satisfy 6G requirements and characteristics with acceptable performance/complexity trade-off [RAN1]
- d. Channel Bandwidth (at least minimum and maximum), Numerology, avoiding multiple numerologies for the same band / sub-range (e.g., enabling synergies among frequency bands in the ~7GHz range) [RAN1, RAN4]
- e. Physical layer control, data scheduling and HARQ operation [RAN1, RAN2]
- f. MIMO operation [RAN1, RAN4]
- g. Duplexing [RAN1, RAN4]
- h. Initial access [RAN1, RAN2, RAN4]
 - Studies on synchronization signal and raster, broadcast signals/channel and physical random access channel [RAN1, RAN4]
 - Studies on initial access procedure, random access procedures, system information and paging [RAN2, RAN1, RAN4]
- i. 6GR spectrum utilization and aggregation. [RAN1, RAN2, RAN4]
- j. Other physical layer signals, channels and procedures [RAN1, RAN2, RAN4]
- ...

Objectives of RAN 6GR Study (3/4)

- 6) Migration from 5G NR to 6GR as well as interworking and mobility between 5G NR and 6GR:
 - a. 5G-6G Multi-RAT Spectrum Sharing for migration [RAN1, RAN2, RAN4, RAN3]
 - ...
- 8) AI/ML for 6GR and Radio Access Network, leveraging 5G AI/ML framework, as appropriate [See TR38.843] [RAN1, RAN2, RAN3, RAN4]
 - a. Identify Use Case(s) of interest (either existing or new) with compelling trade-off between e.g., performance, complexity, etc...
Coordinated discussion needs to be ensured with related design areas, where needed (e.g., MIMO, Mobility, etc...)
NOTE: lead WG depends on the use case.
 - b. AI/ML framework: Extensible AI/ML enablers based on the identified Use Case(s), including
 - LCM procedures [RAN2, RAN1, RAN3, RAN4]
 - Data collection and data management, in coordination with SA WGs [RAN2, RAN3, RAN1]

Note: NW for AI is assumed to be covered by new services

6GR and RAN design shall ensure that the 6G System can also operate without AI/ML

Objectives of RAN 6GR Study (4/4)

- 9) **Sensing** – Studies to be based on use cases and associated requirements, as defined in [TR38.914]
- a. PHY functions and procedures for sensing technology (e.g., waveform, reference signals, measurement feedback, etc...) [RAN1, RAN4]
 - b. Evaluate sensing performance and if necessary, extend channel modelling, for the selected use cases [RAN1]
 - c. Aspects of integration with communication services [RAN1]
 - d. Higher layer procedures and protocol aspects [RAN2]
- ...

Interim milestone at RAN#112 (June 2026)

- RAN1 to provide interim assessment on the following areas:
 - › **Waveform, modulation, channel coding**: scope of enhancements beyond NR baseline ((2) a, c)
 - › **Channel bandwidth (min and max), frame structure, numerology** ((2) b, d)
 - › **Basic sync signal structure and associated periodicity(ies)** ((2) h)

Interim milestone at RAN#113 (Sep 2026)

- RAN plenary to make a decision on additional migration option(s) (other than standalone, MRSS, and inter-RAT mobility between NR-6G) → Include **additional 6G-6G aggregation beyond 6G CA: 6G-6G DC**

RANI Work Plan for Rel-20 6GR Study

We are here! Interim RAN#112 & #113

	2025			2026			2026			2027
	Aug	Oct	Nov	Feb	Apr	May	Aug	Oct	Nov	Feb
TU	8	10	10	12	14	14	16	16	16	16
Overview of 6GR air interface				Distributed to respective related agendas						
Evaluation assumptions for 6GR air interface										
Waveform										
Frame structure				Merged into "General aspects and frameworks"						
Channel coding										
Modulation, joint channel coding and modulation										
Energy efficiency						Distributed to respective related agendas				
AI/ML				Distributed to respective related agendas						
General aspects and frameworks							Distributed to respective related agendas			
Multiple carrier operation										
Initial access and mobility										
MIMO operation										
CSI acquisition and report										
Downlink control channel, scheduling and HARQ										
WUS and operation										
NTN										
ISAC										
Performance evaluation										

Waveform

- 6GR waveform
 - For DL, support CP-OFDM as defined in 5G NR
 - For UL, support CP-OFDM/DFT-s-OFDM as defined in 5G NR
 - With potential enhancements/modifications on DFT-s-OFDM
 - Will not study other waveforms in waveform agenda unless tasked by RAN
- Potential enhancements on DFT-s-OFDM
 - UL coverage improvement through low PAPR enhancement for DFT-s-OFDM
 - Complete the following list of UL PAPR reduction techniques for further down-selection
 - Option 1: FDSS with no spectrum extension or truncation
 - Transparent / non-transparent
 - Modulation: Pi/2 BPSK / QPSK
 - Option 2: FDSS with spectrum extension
 - Transparent / non-transparent
 - Modulation: Pi/2 BPSK / QPSK / 16QAM
 - Option 3: FDSS with spectrum truncation
 - Transparent / non-transparent
 - Modulation: Pi/2 BPSK
 - Multi-rank UL-MIMO for DFT-s-OFDM
 - Maximum rank = 2, with non-coherent UL codebook
 - Semi-static and dynamic UL waveform switching

Channel Coding

- Data channel coding

- (Working assumption) Reusing NR LDPC design is supported for data rate within NR range
- Ongoing study on LDPC extension for data rate beyond NR range
 - Focusing on Option 1 BG structure (44 columns, $Z_{\max}=192$) for improved parallelism/complexity
 - Study application condition for BG3
 - UL BG3 support is mandatory with capability signaling, except that it is optional for UEs supporting a maximum UL bandwidth of 20 MHz or less in all bands

- Control channel coding

- (Working assumption) Reusing NR Polar code design is supported for control information within NR range (larger than 11 bits)
 - No extension/enhancement for payload size within NR range (larger than 11 bits)
- Study Polar code extension for payload size beyond NR range (larger than 1706 bits) focusing on more than 2 segments
- For small UCI with payload size of 3~11 bits, consider NR RM code as baseline
 - Study coding enhancements to address potential rank deficiency, limited minimum Hamming distance, and error-floor or performance degradation of the NR RM code, particularly at high code rates

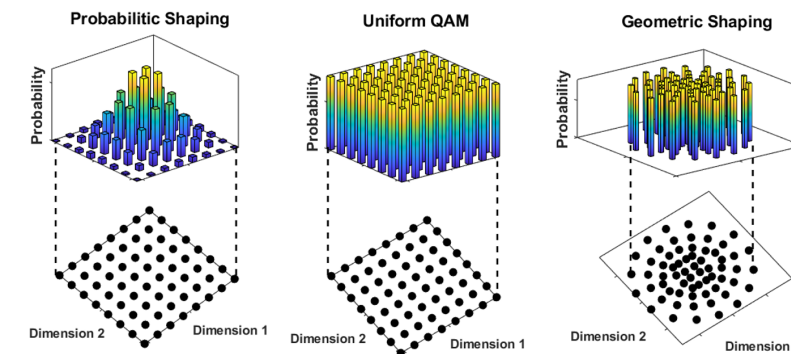
Modulation

- 6GR modulation scheme

- For DL, support 5G NR equal probability uniform QPSK, 16QAM, 64QAM, 256QAM, and 1024QAM for CP-OFDM for data channel
- For UL, support 5G NR equal probability uniform QPSK, 16QAM, 64QAM, and 256QAM for CP-OFDM and DFT-s-OFDM for data channel
 - Additionally support 5G NR $\pi/2$ BPSK for DFT-s-OFDM for data channel

- Potential enhancements

- Constellation shaping
 - Studied **GS(geometric shaping)** and **PS(probabilistic shaping)** schemes in terms of performance, complexity, and spec impact
 - **No consensus** in RAN1 to support any constellation shaping schemes
- Higher-order modulation (mainly for FWA use cases)
 - For DL 4K QAM and UL 1K QAM, discussed use cases and performed LLS and SLS evaluations
 - RAN1 recommends to adopt **1k QAM for UL**
 - **No consensus** in RAN1 to recommend adopting 4K QAM for DL
- Enhancement of MCS table design



[R1-250622] Qualcomm]

General Aspects and Frameworks (1/3)

• Numerology

- Support the following SCSs for all signals/channels except PRACH

Frequency range	SCS	Max. channel BW (network side)	Note
Sub-6GHz (FR1)	15 kHz for FDD 30 kHz for TDD	TBD	
Around 7GHz (FR1)	30 kHz	400 MHz	
Around 15GHz	TBD	TBD	Delay discussion until ITU-R spectrum confirmation
24.25 – 52.6GHz (FR2)	120 kHz	[400 or 800] MHz	FFS: 120 kHz or 240 kHz for SSB

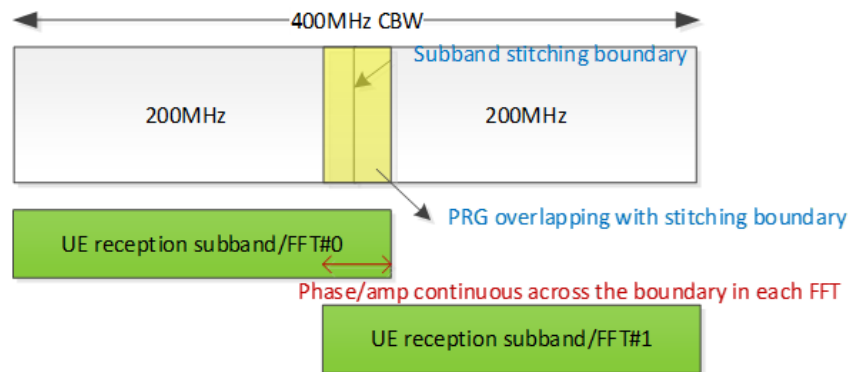
- Support only normal CP as defined in NR for 6G TN communication

• Basic frame structure

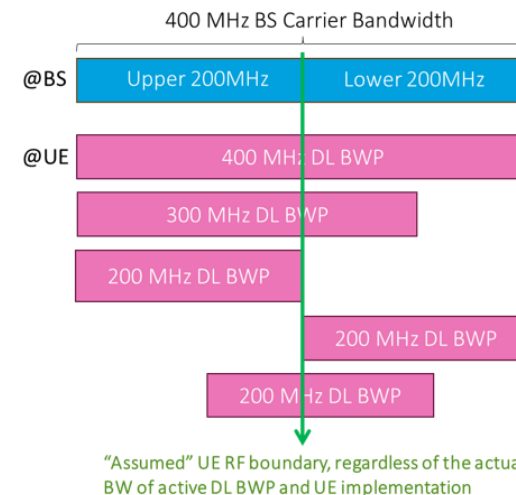
- For communication, consider NR frame structure as a starting point
 - Including RE, RB, radio frame (10 ms), subframe (1ms), slot (14 consecutive symbols), symbol duration, normal CP length, symbol boundary
- For MRSS, support resource block boundaries alignment between NR and 6G on a MRSS carrier

General Aspects and Frameworks (2/3)

- Maximum channel bandwidth for around 7 GHz
 - RAN plenary decision
 - In a BS with a CBW of 400MHz, support UEs operating with **maximum CBW of 400MHz in DL (i.e., non-CA single CC)** and **maximum CBW of 200MHz in UL**
 - Study TB/CB/CBG mapping within a PDSCH with FDRA between 200 MHz and 400 MHz considering the following two options:
 - Option A: A TB can span up to 400MHz
 - Option B: A TB can span up to 200MHz
 - Frequency location of UL with a maximum CBW of 200MHz should be configured with **certain flexibility** within the entire configured DL bandwidth



[R1-2604692. Qualcomm]



[R1-2604308. MediaTek]

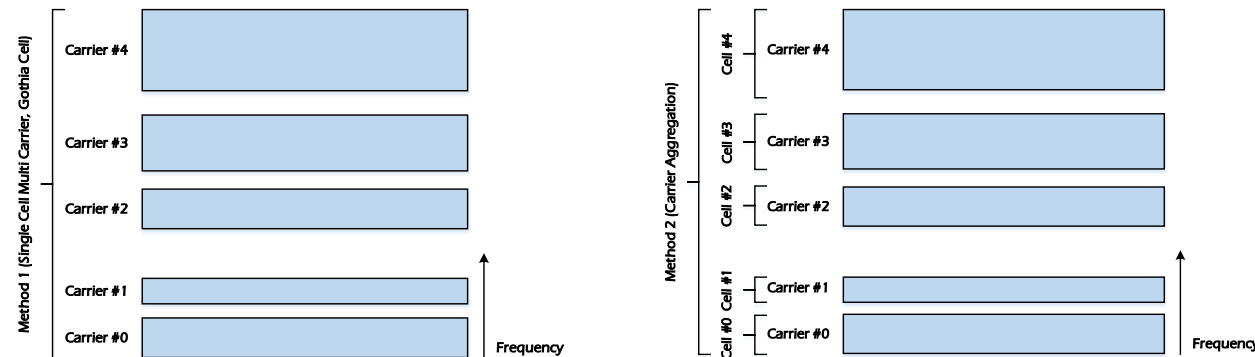
General Aspects and Frameworks (3/3)

- Smallest maximum UE bandwidth for lower-tier device(s)
 - For TDD with 30kHz SCS: 20MHz baseband and RF bandwidth for both UL and DL,
 - For full-duplex FDD (FD-FDD) with 15kHz SCS: 20MHz baseband and RF bandwidth for both UL and DL
 - For half-duplex FDD (HD-FDD) with 15kHz SCS: 20MHz baseband and RF for DL, and 5 MHz BB and 20 MHz RF for UL
- Duplex operation
 - Study at least FD-FDD, semi-static TDD, aNB semi-static SBFD, HD-FDD on UE side, and dynamic TDD
 - aNB semi-static SBFD
 - Study SBFD time-frequency resource determination, RA procedure, UE procedures
 - Dynamic TDD
 - Study link direction determination for dynamic TDD
 - Option 1: Flexible symbols in semi-static TDD pattern is only overridden by scheduling DCI, and configured Tx/Rx is valid/invalid/overwritten by scheduling DCI
 - Option 2: Flexible symbols in semi-static TDD pattern can be overridden by dynamic TDD pattern
 - Option 3: Dynamic TDD pattern is indicated (no semi-static TDD pattern)
 - Option 4: Flexible symbols in semi-static TDD pattern is only overridden by scheduling DCI, and configured Tx/Rx is valid during the time window

Multi-Carrier Operation (1/2)

- Spectrum aggregation framework

- For 6GR spectrum aggregation operation, study the following methods:
 - Method 1: Multiple physical carriers can be aggregated into [single “Gothia cell”](#)
 - Method 2: [“Carrier aggregation”](#) where multiple physical carriers can be aggregated into separate cells



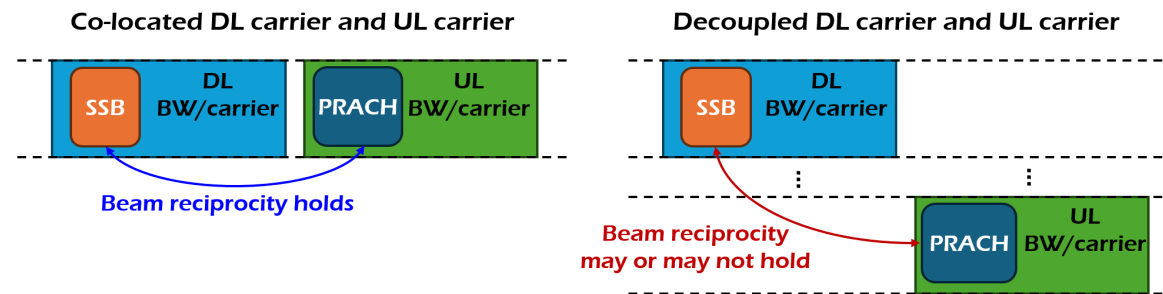
- Non-collocated spectrum aggregation

- Study 6G-6G spectrum aggregation for [non-collocated carriers \(FR1-FR2\)](#) assuming backhaul latency [~10 ms](#)
 - 6G-6G DC with two cell groups
 - 6G-6G CA with two PUCCH groups using separate TA per group, or with a single PUCCH group

Multi-Carrier Operation (2/2)

- Multi-carrier operation in idle mode

- Study multi-carrier operation where UE can transmit UL (Msg1, etc) and/or receive DL (Msg2, etc.) in one carrier **other than the carrier where SI was received**



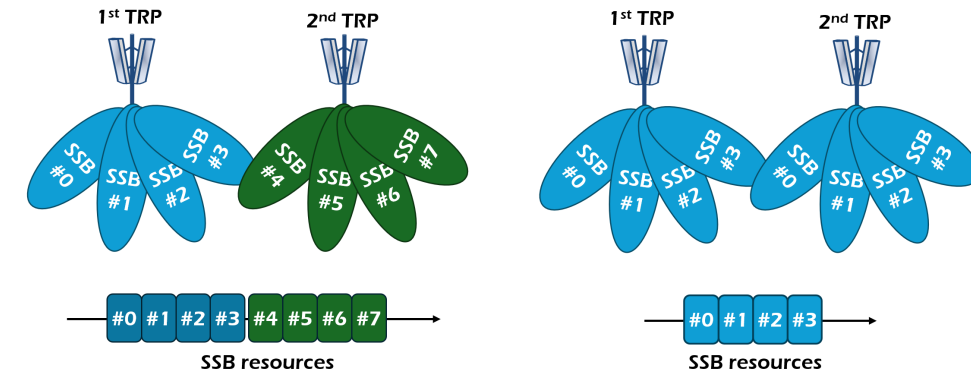
- Multi-carrier operation in connected mode

- Study UL transmission switching across carriers
- Study DL reception switching across carriers
- Study mechanisms for fast enabling/disabling access to additional carriers
- Study mechanisms for PXSCH resource allocation and scheduling
 - Self-carrier scheduling
 - Cross-carrier scheduling
 - Multi-carrier scheduling

Initial Access and Mobility (1/5)

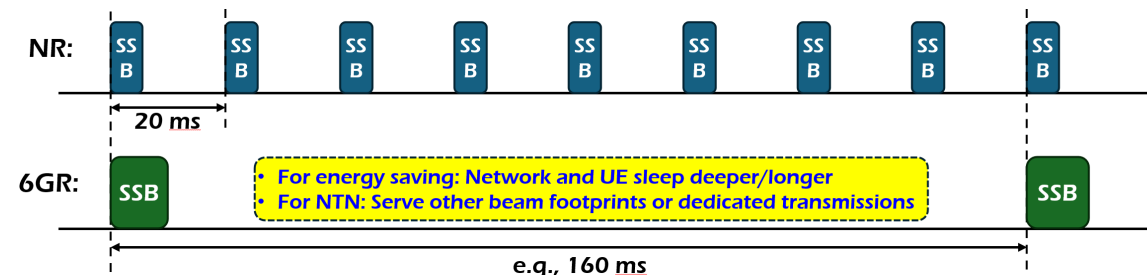
• Scenario for initial access

- For initial access and mobility, study the following scenarios:
 - Single beam and multi-beam deployment scenarios
 - Single TRP and **multi-TRP** deployments
 - Single carrier and **multi-carrier** deployments
- Multi-TRP scenarios
 - Study both transparent and **non-transparent TRP** operations
 - E.g., whether or not to provide TRP ID during initial access



• Basic sync signal structure

- 6GR SSB is defined as basic 6GR sync signal structure which consists of PSS(s), SSS(s), and PBCH(s)
- SSB default periodicity
 - Competing views: **NES gain (e.g., 160 ms, 80 ms)** vs. UE impact (e.g., retain 20 ms in NR, 40 ms)

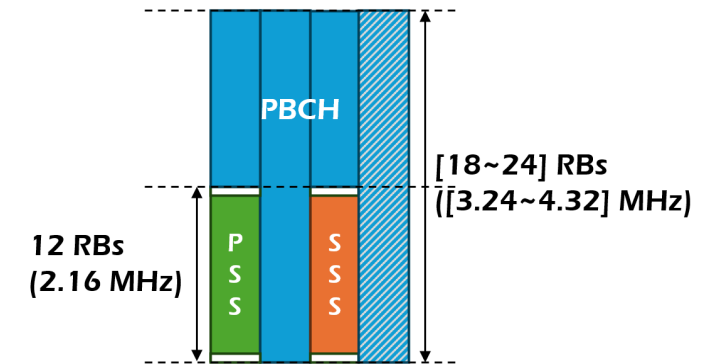


Initial Access and Mobility (2/5)

• Basic sync signal structure

• SSB bandwidth

- Related to various aspects such as minimum channel BW, smallest maximum UE BW, sync raster, NES, etc.
- One 6GR SSB spans 20 RBs and the number of RBs for PSS is 12 RBs



• SSB time domain structure

- One 6GR SSB spans X ($4 \leq X \leq 7$) OFDM symbols within a slot
- Study **SSB burst structure** for various combinations of # of beams, # of repetitions, default periodicity, and combining methods
 - Option 1: Non-adjustable number of repetitions of transmitted SSBs
 - Option 2: The actual number of repetitions of transmitted SSBs can be adjusted by the aNB



Beam 0 Beam 1 Beam 2 Beam 3

$X=16, Y=1, M=4$

Beam 0 Beam 1 Beam 2 Beam 3

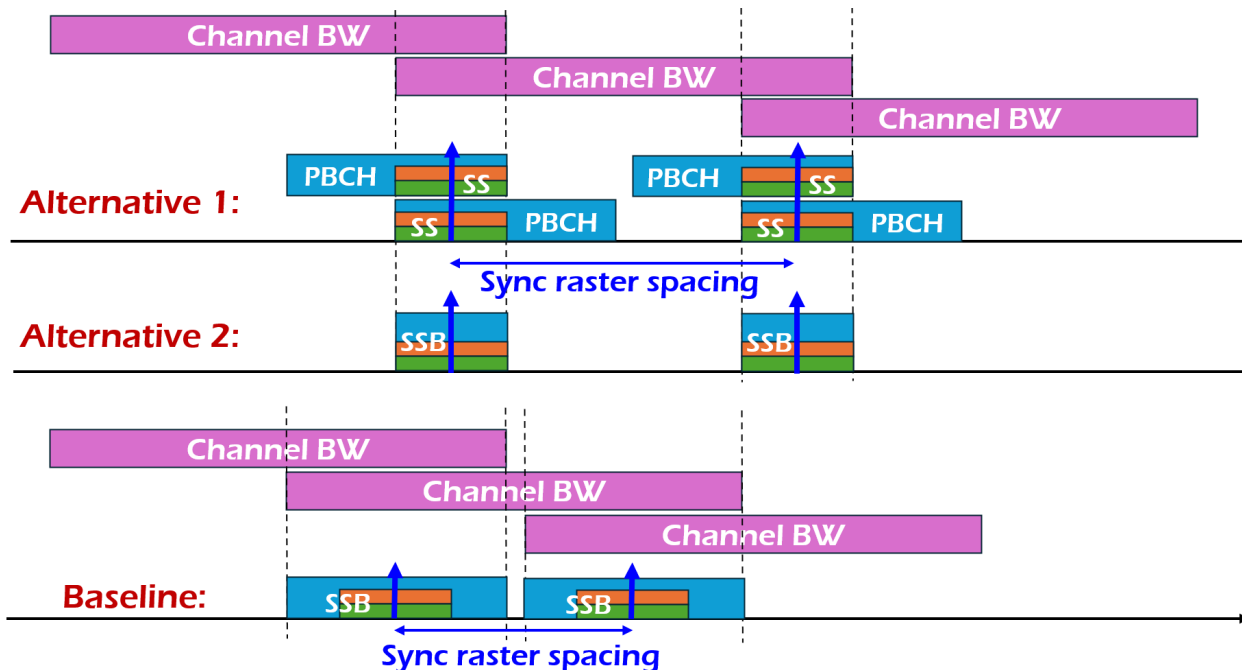
$X=4, Y=4, M=4$

Initial Access and Mobility (3/5)

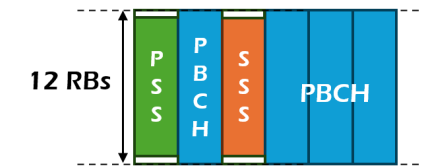
- Basic sync signal structure

- Sparser sync raster

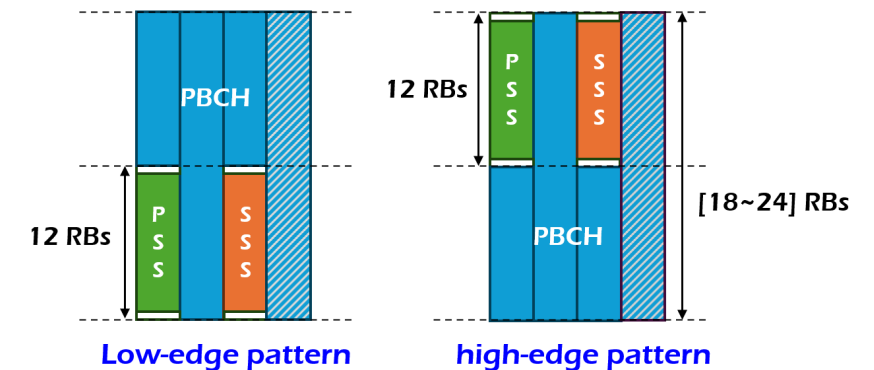
- Aim to make **sync raster sparser than NR** to reduce UE initial cell search complexity and latency, in particular with increased SSB default periodicity (no relevant agreement yet)



Alternative 1:



Alternative 2:



Initial Access and Mobility (4/5)

• Miscellaneous

- Physical cell ID
 - As baseline, # PCI = 1008 and PSS/SSS carry full PCI information
- Idle mode mobility
 - Support at least SSS-based measurement
 - Support at least RSRP for measurement metric (FFS: RSRQ, SINR)
- Connected mode mobility
 - Awaiting RAN2 progress
- Beam operation during initial access
 - Study beam acquisition, beam report/refinement
 - Study spatial/temporal beam prediction during initial access



Figure 6 SSB Spatial prediction⁴



Figure 7 Beam refinement prediction⁴

[RI-260012. Spreadtrum]

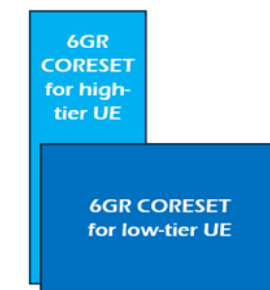
Initial Access and Mobility (5/5)

- PRACH and RACH procedure
 - Study random access framework considering energy efficiency, coverage, diverse device types, system performance, etc.
 - Study GNSS-less/free/degraded PRACH considering differential time/frequency errors
 - Develop a common PRACH design first, with NTN-specific adjustments if NTN requirements are not met
 - Study the reduction of PRACH preamble formats and whether to increase the maximum number of preambles per RO beyond 64
 - Agreed LLS EVM assumptions for PRACH evaluations
- Bandwidth operation during initial access
 - Study DL/UL bandwidth operation during initial access and idle mode considering UEs with different BW capabilities
 - Agreed to have a common bandwidth for operational simplicity on the very first two bandwidths
 - Bandwidth of CORESET for SIB1-PDCCH monitoring, and bandwidth for SIB1-PDSCH (working assumption) is determined independently of UE bandwidth capability
 - Two options for relation between CORESET bandwidth and SIB1-PDSCH bandwidth



MIMO Operation (1/2)

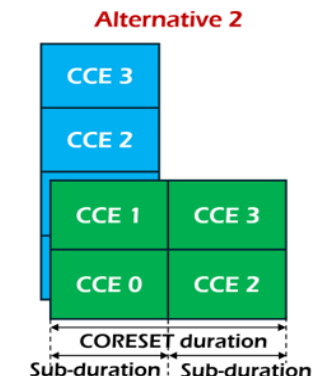
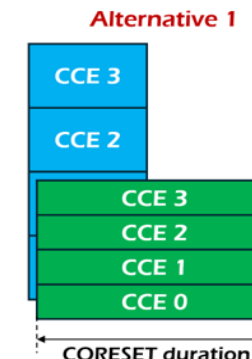
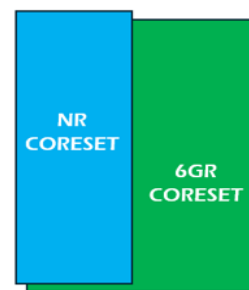
- DL transmission schemes for DL control channel
 - Study PDCCH transmission schemes including modulation, scrambling, TxD schemes, DMRS mapping, multi-port DMRS (for transparent/non-transparent MU-MIMO and SU-MIMO)
 - Agreed basic components for CORESET, search space set, PDCCH monitoring:
 - CORESET: duration in time and frequency resources used for PDCCH
 - Search space set: a set of PDCCH candidates for PDCCH monitoring
 - REG = 1 RB * 1 symbol
 - CCE = 6 REGs
 - PDCCH candidate = 1, 2, 4, 8, 16 CCE(s)
 - REG bundle: minimal granularity for PDCCH precoding, also used as interleaving unit
 - Support both non-interleaved and interleaved CCE-to-REG mapping
 - For MRSS, study dynamic sharing and/or semi-static assignment of 5G and 6G CORESETs
 - For CSI acquisition for PDCCH, study its necessity, feasibility, UE complexity, and potential benefits
 - Agreed EVM assumptions



(a) Partial overlap between 6GR CORESETs



(b) Full and partial overlap between NR CORESET and 6GR CORESET in MRSS



MIMO Operation (2/2)

- DL transmission schemes for DL data channel
 - For PDSCH transmission scheme,
 - Support **DMRS-based PDSCH transmission with one DMRS port per layer**, PRB bundling, SU/MU-MIMO, single-TRP transmission
 - Study multi-TRP transmission, (semi-)open-loop (transparent or non-transparent) transmission
 - For FDRA, support both bitmap-based and RIV-based mapping
 - For TDRA, study start symbol, length, DMRS position, single PDSCH transmission crossing slot boundary
 - For DM-RS design, consider up to 24, 32, or **48** orthogonal DM-RS ports, with Gold sequences
 - Agreed EVM assumptions including case of **low-overhead DMRS with AI/ML receiver**
 - **Study sparse orthogonal DMRS and SIP (Superimposed Pilot)**
- DL transmission schemes for UL channel
 - Support **CB-based PUSCH transmission**, study fixed/configurable/hybrid UL CB
 - Support **UCI dedicated channel** and **UCI on PUSCH** to convey the UCI over physical channel
 - Options for max number of orthogonal DMRS ports: up to 24, 32, or **48**
 - Agreed EVM assumptions including case of **AI-based receiver for PUSCH DMRS overhead reduction**
 - **Study sparse orthogonal DMRS and SIP (Superimposed Pilot)**, while DM-RS-free is deprioritized

CSI Acquisition and Report (1/3)

- DL-based CSI acquisition

JSCC: Joint Source-Channel Coding

JSCM: Joint Source-Channel Coding and Modulation

- CSI framework
 - For CSI container, support **LI-based CSI report with some principles**, i.e., separate triggering/configuration of measurement and reporting, minimizing UL collisions, streamlined CSI timeline
 - Study early CSI acquisition, UE-initiated/event-triggered CSI report, spatial/power adaptation for NES
- CSI reporting
 - Strive for **unified specified codebook** applicable for various use cases including SU/MU-MIMO, sTRP, mTRP including CJT, high/low-resolution, etc.
 - Study JSCC/JSCM based CSI compression (**AI based**)
 - Study **downloadable codebook (AI/non-AI based)**, long-term CPI report (e.g., channel correlation), **explicit CSI feedback, DMRS-based CSI report (e.g., delta CQI)**
- CSI measurement
 - Support NZP CSI-RS as CMR (FFS: DMRS) and CSI-IM as IMR (FFS: NZP CSI-RS, DMRS)
 - Study **non-AI/AI based** frequency/spatial/time domain CSI prediction
- CSI-RS design
 - Study max number of CSI-RS ports (among 128, **256**, 512), CSI-RS pattern (aggregation of localized CDM group, # slots, # RBs), low overhead design, CSI-RS sharing (e.g., MRSS)
 - Support periodic and aperiodic CSI-RS (FFS: semi-persistent CSI-RS)

CSI Acquisition and Report (2/3)

- UL-based CSI acquisition
 - SRS design and usages
 - Support $\{1, 2, 3, 4, 8\}$ ports for SRS, periodic and aperiodic SRS (FFS: semi-persistent SRS), cyclic shift and/or comb-offset for SRS design, cross-slot SRS transmission at least for consecutive S+U slots
 - Study SRS pattern, multiplexing, frequency hopping, repetition, sequence, interference randomization, rate matching for SRS, etc.
 - Study at least UL CSI acquisition, DL CSI acquisition, beam management
 - Strive for a unified SRS design that works for both AI and non-AI schemes (e.g., for low-overhead SRS)
 - Study SRS antenna switching, carrier switching, **sounding for larger DL CBW**, beyond 272 PRBs, etc.
 - Study **low-overhead SRS with AI/ML at the network side for CSI reconstruction**

CSI Acquisition and Report (3/3)

- Other aspects

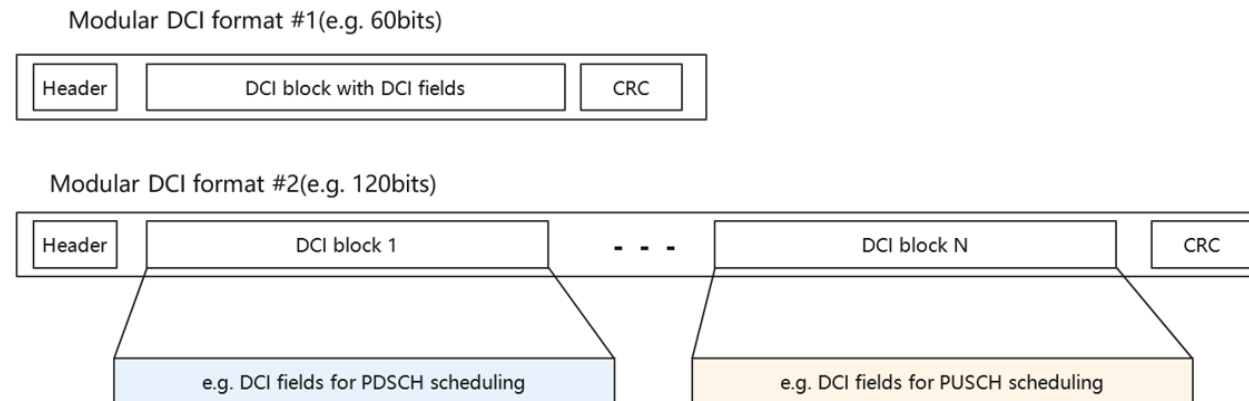
- Joint DL/UL based CSI acquisition for TDD
 - Use case 1: SRS-based CSI acquisition assisted by DL-based measurement/reporting
 - Use case 2: MCS and rank selection for DL transmission with SRS-based CSI acquisition assisted by other assistant information reporting
- T/F tracking
 - Study candidate DL signal for finer T/F tracking for connected and/or idle mode: 1) dedicated RS (e.g., TRS), 2) DMRS, 3) sync signals

- Beam management for DL and UL

- Agreed study aspects for QCL framework, DL beam measurement/report, NW-initiated beam reporting, UEIBM, etc.
 - For UE initiated beam management, Event-1 (serving beam degradation) and Event-2 (better candidate beam detected)
- Study beam measurement/prediction in spatial/temporal/frequency domain (relevant to AI/ML-based or non-AI/advanced schemes)
- Agreed EVM assumptions

DL control channel, scheduling, HARQ (1/4)

- DL control channel
 - DCI design
 - Target no hardcoded NR style “3+1” rule and **no DCI size alignment across different DCI containers**
 - Study how to determine functions of DCI container, e.g., using RNTI, **header**, DCI size, RRC configuration
 - Study mechanism to determine DCI container size
 - Study multiple PXSCH transmissions for a single carrier using a single DCI
 - PDCCH monitoring adaptation
 - Strive for simplified and/or unified framework for time-domain PDCCH monitoring adaptation techniques for RRC connected state
 - Study **adaptation of number of Rx antennas** for PDCCH monitoring for UE energy efficiency purpose

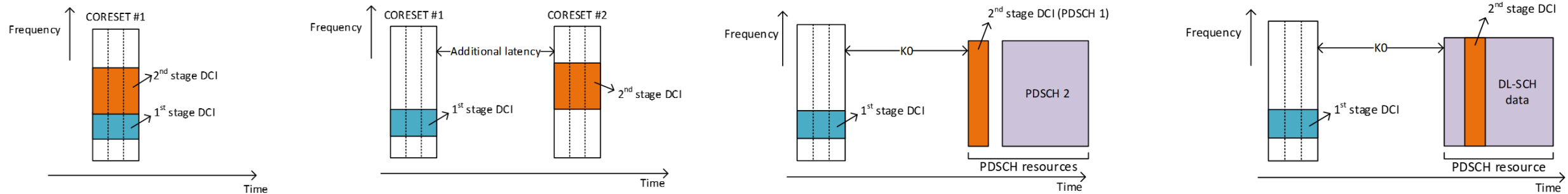


DL control channel, scheduling, HARQ (2/4)

• DL control channel (cont'd)

• Two-stage DCI

- Study options for resource type for two-stage DCI
 - Option 1: PDCCH for both 1st stage and 2nd stage(s)
 - Option 2: PDCCH for 1st stage, dedicated resource for 2nd stage(s)
 - Option 2-1: CORESET(s) for both; Option 2-2: PDSCH for 2nd stage
 - Option 3: PDCCH for 1st stage, 2nd stage/two-stage is multiplexed on PDSCH carrying DL-SCH data
 - Option 4: Sequence for 1st stage, PDCCH for 2nd stage
- Study options for information carried in two-stage DCI



[RI-2604378. ZTE]

DL control channel, scheduling, HARQ (3/4)

- HARQ aspects

- HARQ feedback container
 - Support HARQ-ACK feedback via LI signaling, while ensuring:
 - Relaxing need for tight coordination between schedulers (e.g., between carriers, between DL and UL, etc.)
 - Decoupling HARQ feedback triggering from DL assignment
- HARQ feedback mechanism
 - Study mechanisms to determine HARQ feedback timing and resource:
 - Method 1: Dynamic indication by DCI
 - Method 2: UE-initiated HARQ feedback
 - Method 3: Next available/feasible time slot
 - Method 4: Only based on RRC configuration
 - Study HARQ-ACK codebook, feedback granularity (TB-level, smaller than TB-level), feedback resource
 - Based on NR Type-1, 2, 3 codebook
- Cross-layer HARQ and ARQ integration
 - Study explicit or implicit indication for HARQ process failure to trigger faster ARQ procedure in UL
 - PUSCH scheduling DCI vs. separate DCI

DL control channel, scheduling, HARQ (4/4)

- Downlink and uplink transmission without dynamic scheduling
 - Support CG PUSCH and SPS PDSCH
 - DCI-based dynamic **retransmission** as baseline
 - Study **dynamic parameter adjustment** for CG PUSCH and SPS PDSCH
 - Support CG PUSCH activation/deactivation, and study further mechanisms for activation/deactivation
 - Support SPS PDSCH activation/deactivation by DCI
- Handling of potential multiple uplink transmissions
 - Study simplification of collision handling, resource mapping, and timeline determination
 - Prioritize **single PHY priority**; two priorities remain FFS
 - For cross-carrier PUCCH–PUSCH collision, study:
 - Simultaneous transmission
 - Multiplexing and/or prioritization

Other physical layer signals, channels and procedure

- UL resource request
 - Legacy 1-bit SR as the baseline
 - Study **CB PUSCH for BSR** and agreed on common LLS assumptions for evaluation
 - For the study of **multi-bit SR**
 - Focus on quantized buffer size
 - Study bit size, quantization, coverage, overhead and scheduling latency
 - Compare with 1-bit SR followed by BSR
- Interference management
 - Support the NR wireless-based **RIM** framework as a starting point
 - Further study backhaul-based RIM
 - Recommended to support for BS-to-BS information exchange for **CLI** handling
 - Study candidate information to be exchanged
 - Study **UE-initiated and network-controlled** UE-to-UE **CLI** reporting
 - Recommended to support for RSRP/RSSI-based UE-to-UE CLI measurement
 - Study non-transparent PUSCH resource **muting** based on Rel-19 NR mechanisms

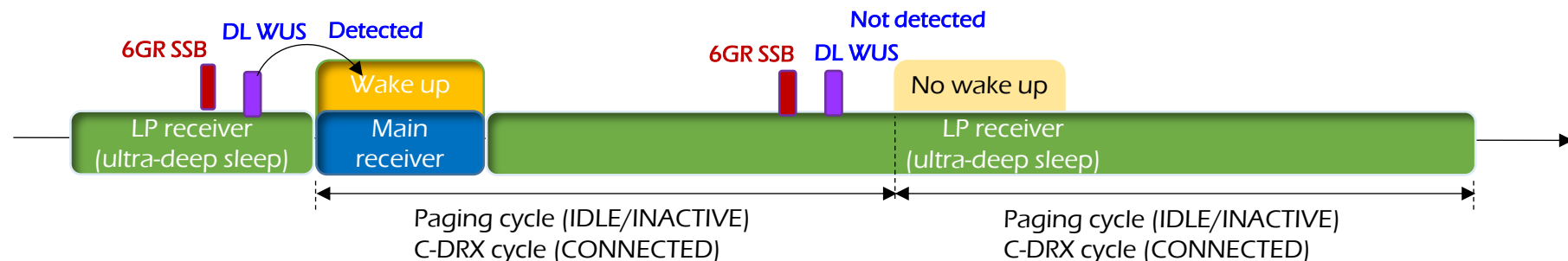
WUS and Operation (1/2)

• Design of WUS

- Study **OFDM-based WUS sequence** for better coverage
 - Competing views: Time domain sequence vs. frequency domain sequence
 - Down selection between Zadoff-Chu sequence family and Gold sequence family
 - Strive for a unified design across all RRC states
- Study how to achieve the same coverage as 6GR common PDCCH (basic and extended coverage)
- Study at least 6GR sync signal for UE synchronization for DL WUS reception

• WUS operation

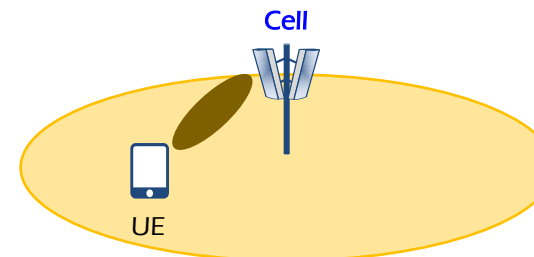
- For idle mode, study DL WUS for waking up UE for at least **paging purpose**
- For connected mode, study DL WUS **triggering PDCCH monitoring with and without C-DRX**
- For both idle and connected mode, study **serving/neighbor cell RRM measurement** based on 6GR measurement signal (e.g., at least 6GR sync signal) by EE processing



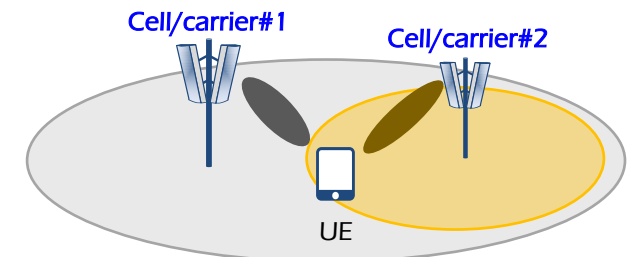
WUS and Operation (2/2)

• UL WUS and operation

- Study necessity and feasibility of UL WUS under various deployment scenarios:
 - DS#1: **Standalone cell** where UE obtains UL WUS configuration e.g., from standalone cell and/or pre-defined in the specifications
 - DS#1a: Prior to UL WUS, nothing transmitted on the standalone cell
 - DS#1b: Prior to UL WUS, always-on 6GR synchronization signals with or without PBCH on the standalone cell but no SIB1 on the standalone cell
 - DS#1c: Prior to UL WUS, always-on 6GR synchronization signals with PBCH on the standalone cell and periodic SIB1 on the standalone cell
 - DS#2: **Multi-cell/carrier** where UE obtains UL WUS configuration from cell/carrier #1
 - Always-on 6GR synchronization signals with PBCH on cell/carrier #1, and SIB1 on cell/carrier #1
 - DS#2a: Prior to UL WUS, nothing transmitted on cell/carrier #2
 - DS#2b: Prior to UL WUS, always-on 6GR synchronization signals with or without PBCH on cell/carrier #2 but no SIB1 on cell/carrier #2
 - DS#2c: Prior to UL WUS, 6GR synchronization signals with PBCH on cell/carrier #2 and periodic SIB1 on cell/carrier #2
 - Note: UL WUS can be transmitted to cell/carrier #1 or cell/carrier #2
- Study candidate use cases
 - For idle mode, UE-initiated on-demand or adaptation procedures signals/channels
 - For connected mode, UE-initiated on-demand or adaptation procedures signals/channels, UL data indication, PUSCH resource/parameter selection, etc.



Standalone scenario



Multi-cell/carrier scenario

NTN

- NTN specific requirements and design for GNSS based operation
 - For UL time-frequency synchronization,
 - UE uses its own location information (e.g., from GNSS) + satellite assistance information (at least support ephemeris, epoch time, validity duration, FFS: common TA/drift) to perform time-frequency pre-compensation
 - To combat large RTT,
 - Support large scheduling offsets, and study solutions
 - Study solutions for HARQ stalling
 - For satellite beam hopping operation (i.e., satellite having more beam footprints than simultaneously active beams),
 - Study SSB default periodicity, hierarchical beam structure
 - For multi-satellite operation,
 - Study RAN-I aspects related to mobility, inter-satellite interference management
 - Agreed EVM and link budget calculation assumptions

ISAC

UAV: Unmanned Aerial Vehicle
AGV: Automated Guided Vehicle

AF: Ambiguity Function
CAF: Cross-Ambiguity Function

- Performance evaluation for object detection and tracking
 - Consider UAV, human, vehicle, and AGV sensing scenarios
 - Agreed detection/tracking metrics and data-fusion methodology
- Integration with communication
 - Study sensing-assisted beam management and CSI acquisition/reporting
 - Study sensing RS resource structure and profile/path/object-level measurements
 - Exclude UE-side Level-A measurement reporting
- Waveform and frame structure
 - Study sensing RS sequence generation and waveform enhancements
 - Study effective CP extension using successive symbols, frequency-domain combs, and time gaps
 - Define AF/CAF and related waveform evaluation metrics

AI/ML Use Cases (RP-260747)

- For RAN2 and RAN4 AI/ML mobility/RRM related use cases, the following table provides a summary of the leading working group and other WG impacted

Use cases identified by WGs	Use case	Sub use case(s)	Leading WG	Other Impacted WG
RAN2	Measurement Prediction for mobility	L3: Cell level temporal domain prediction (case A & case B)	RAN2	RAN4
		L3: Cell level frequency domain prediction (co-located)	RAN2	RAN4
		L1: L1 RSRP Temporal domain prediction	RAN1	RAN2 RAN4
		L1: L1 RSRP frequency domain prediction	RAN1	RAN2 RAN4
		L3: Beam-level temporal and frequency domain prediction (for co-located)	RAN2	RAN4 RAN1
		L3: Beam-level spatial domain prediction	RAN4	RAN1 RAN2
		L1: Intra/inter-cell spatial domain prediction	RAN1	RAN2 RAN4
		L3: Additional inter-frequency prediction scenarios: - non-co-located sites - co-located sites with different beam patterns/sectors	RAN4	RAN1 RAN2
	Measurement event prediction for mobility	L3: Measurement event prediction (e.g., A1-A6)	RAN2	RAN4
		L1: Measurement event prediction for lower layer mobility	RAN2	RAN4, RAN1

AI/ML Use Cases (RP-260747)

RAN4	Use Case 3 AI-RRM use cases	AI-RRM Sub-Case 1: FR2-I L3 spatial domain beam-level prediction for Tx (intra-cell)	RAN4	RAN2
		AI-RRM Sub-Case 2: FR1 L3 frequency domain (within the same FR) cell-level prediction (inter-cell, non-collocated)	RAN4	RAN2 RAN1 (Note: It may require cross-WG study on channel model for AI-RRM use cases involving non-collocated prediction)
		AI-RRM Sub-Case 3: Spatial domain Rx prediction for intra-cell	RAN4	RAN1
		AI-RRM Sub-Case 4: AI/ML-based prioritization for MOs	RAN4	RAN2
		AI-RRM Sub-Case 5: Non-collocated frequency domain prediction in beam level	RAN4	RAN2 RAN1 (Note: It may require cross-WG study on channel model for AI-RRM use cases involving non-collocated prediction)

AI/ML Use Cases (RP-260592)

Use case	Motivation	Benefit/gain	WG(s) potentially involved
Network energy saving	As future 6G networks are expected to support higher traffic volumes, dense deployments, an increasing number of connected devices, and diverse services, network energy consumption is a critical concern for sustainability, operational cost, and environmental impact.	AI/ML based network energy saving to improve the following observed challenges: - Trade-off between system performance and energy efficiency. - Limitations of currently standardized energy saving mechanisms with fixed operational rules, which can be inflexible and difficult to optimize. - Risk of localized optimizations reducing overall network energy efficiency.	SA5
Mobility optimization	A UE may be frequently handed over between RAN nodes, especially in case of high mobility scenarios, and user experience should not be degraded.	AI/ML based mobility optimization to ensure service continuity, maximize performance, optimize resources, minimize service interruption time, and improve mobility robustness.	RAN2



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THANK YOU