3GPP TSG RAN#108 **RP-250871**

Prague, Czeck Republic, 9th -13th June 2025

Agenda Item: 16.2

Source: VIAVI

Title: VIAVI Views on Release 20 RAN WG SIs for 6G

Document for: Discussion

1 Introduction

This document provides VIAVI's view on RAN topics to be included for 6G study in Release 20 building upon document 6GWS-250132 presented at the Incheon 6G Workshop [1]. The topics covered are artificial intelligence (AI) for the air interface, multiple access schemes, integrated sensing and communications (ISAC), non-terrestrial networks (NTN), and quantum safety. A proposal is included for each topic containing elements to be considered for inclusion within the scope of the appropriate study item.

2 Topics for Release 20 RAN WG 6G Study

2.1 AI for Air Interface

Release 18 studies revealed that AI could help enhance performance of the air interface for several use cases, namely channel state information (CSI) feedback enhancements, beam management, and positioning accuracy enhancements. In addition to the work in 3GPP, there have been various research initiatives running in parallel that explore the potential role of AI for other aspects of the air interface, including constellation design, transmit precoder/beamformer design and receiver design [2]. It would be valuable for 3GPP to now evaluate such techniques as part of a RAN WG-level 6G study item. In addition to considering the performance gain, appropriate testing methods should be thoroughly evaluated to ensure deployment is feasible and robust.

Proposal 1 **3GPP to evaluate the use of AI counterparts (e.g. deep neural networks) for replacing or enhancing different transmit and receive functions within the air interface as part of a Release 20 RAN WG 6G study item, considering the potential for enhanced throughput, reduced reference signal overhead and reduced energy consumption. Some examples to consider within scope for the relevant study item include constellation design, transmit precoder/beamformer design and receiver design.**

Proposal 2 **For the multiple-input multiple-output (MIMO) case, consider evaluating the following:**

a. **Transmitter 1 (T1): AI-based constellation design**
b. **Transmitter 2 (T2): AI-based transmit precoding/beamforming design**
c. **Full AI transmitter with joint design of T1 and T2**
d. **Receiver 1 (R1): AI-based unified receiver design replacing channel estimation, equalization and symbol de-mapping operations**
e. **Receiver 2 (R2): AI-based decoding**
f. **Full AI receiver with joint design of R1 and R2**
g. **Two-sided end-to-end AI transceiver considering T1, T2, R1 and R2**
h. **Use 5G NR as a benchmark with different pilot schemes (including pilotless) studied to reduce the pilot overhead**

2.2 Multiple Access

5G NR combines orthogonal frequency-division multiple access (OFDMA) and space-division multiple access (SDMA) to serve multiple users in the network. The performance of SDMA, also known as multi-user MIMO (MU-MIMO), can degrade significantly when CSI quality is low. New or improved multiple access techniques have the potential to increase robustness for these low-quality CSI conditions and provide higher levels of spectral efficiency, which would be particularly beneficial for use cases with crowded areas. Recognising the interest from industry, ETSI recently established an Industry Specification Group (ISG) for multiple access techniques (MAT), which would serve as valuable and complementary input to a 3GPP RAN WG 6G study item [3].

Proposal 3 3GPP to evaluate new multiple access schemes as part of a Release 20 RAN WG 6G study item that consider a large number of user terminals under a range of spatially correlated and mobile conditions. The following techniques should be considered with each evaluated against 5G NR MU-MIMO performance in both the downlink and uplink:

- **a. Rate splitting multiple access (RSMA)**
- **b. Power domain non-orthogonal multiple access (NOMA)**
- **c. Code domain multiple access schemes such as sparse coded multiple access (SCMA)**

2.3 Integrated Sensing and Communications (ISAC)

The RAN1-led ISAC study in Release 19 has been defining channel modelling aspects to support object detection and/or tracking (as per the SA1 meaning in TS 22.137). In Release 20, a logical progression would be a RAN WG 6G study item that considers architecture and physical layer procedures.

Proposal 4 3GPP to evaluate transmitter/receiver architectures and physical layer procedures for ISAC as part of a Release 20 RAN WG 6G study item. Specifically, the following aspects should be included within the scope of a study for all six sensing scenarios defined by 3GPP (mono/bi-static, with gNB and/or UE as Tx or Rx):

- **a. Waveform and pilot design (including existing waveforms and pilots used for communications)**
- **b. Transmit precoding/beamforming design (codebook or non-codebook-based options)**
- **c. Receiver combining/beamforming design (codebook or non-codebook-based options)**
- **d. Sensing related feedback design at the receiver (base station or user equipment)**
- **e. Synchronization issues for bi-static scenarios**
- **f. Self-interference issues for mono-static scenarios**

2.4 Non-Terrestrial Networks

The NTN Ku Band in 5G is the first band to fall within “frequency range 3” (FR3) ahead of any terrestrial network (TN) definitions. To avoid confusion or fragmentation of future 6G specifications, 3GPP should consider how to define FR3 such that it accommodates the existing NTN Ku Band work whilst ensuring clarity with the test requirements.

Proposal 5 3GPP to consider how to define FR3 within the Release 20 RAN WG 6G study phase such that it accommodates the existing NTN Ku Band work whilst ensuring clarity with the test requirements.

2.5 Quantum Safety for 6G

It is expected that a 6G network will be based on both an AI and cloud-native architecture and, as such, a zero-trust network (ZTN) is assumed as essential. In addition, the 6G network must be Quantum Safe leveraging appropriate technologies such as QKD (Quantum key distribution) and PQC (Post-quantum cryptography).

Proposal 6 **3GPP to consider how to adopt Quantum Safe technologies in 6G RAN as part of a Release 20 RAN WG 6G study item.**

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3 Proposals

Proposal 1 **3GPP to evaluate the use of AI counterparts (e.g. deep neural networks) for replacing or enhancing different transmit and receive functions within the air interface as part of a Release 20 RAN WG 6G study item, considering the potential for enhanced throughput, reduced reference signal overhead and reduced energy consumption. Some examples to consider within scope for the relevant study item include constellation design, transmit precoder/beamformer design and receiver design.**

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4 References

[1] 6GWS-250132, VIAVI's vision & priorities for 6G radio technologies, 3GPP 6G Workshop, March 10th-11th, 2025

[2] "Samsung Electronics Demonstrates AI-RAN Technologies, Paving the Way for Convergence of Telecommunications and AI", Samsung Newsroom, https://news.samsung.com/global/samsung-electronics-demonstrates-ai-ran-technologies-paving-the-way-for-convergence-of-telecommunications-and-ai, December 31st 2024

[3] "ETSI Launches New Group on Multiple Access Techniques for 6G Networks", ETSI, https://www.etsi.org/newsroom/press-releases/2484-etsi-launches-new-group-on-multiple-access-techniques-for-6g-networks?jjj=1747931470458, January 28th 2025

3GPP TSG RAN Meeting #108 **RP- 251248**
Prague, Czech Republic, June 9-13, 2025

Agenda item: **16.2**

Source: **Telstra, Reliance Jio, Telefonica, Cohere, Bell, Spark NZ, BBC, Telus**

Title: **Views on new RAN WG SI on 6G**

Document for: **Discussion and Decision**

1 Introduction

The 3GPP 6G workplan and timelines [1] was noted at the 3GPP 6G workshop held in Incheon in March 2025. The timeline calls for the approval of RAN 1 working group Study Item at RAN#108, June 2025. This submission offers insights and proposals for consideration.

2 Justification

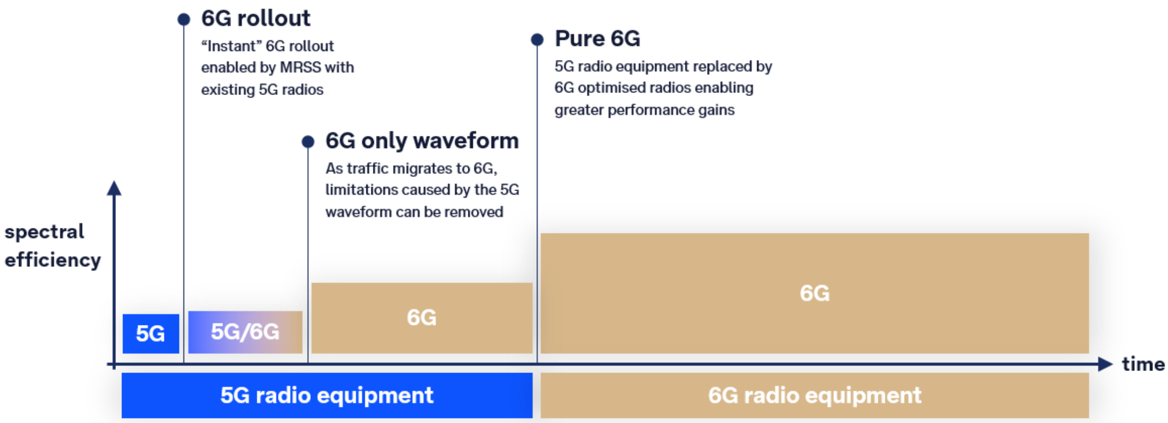
Every ten years, our industry offers the world a step change in mobile network capability, which has – without exception – unlocked extraordinary new use cases and societal benefit. Mobile network operators (MNOs) are facing unprecedented challenges with declining revenues in the face of growing community expectations for greater data allowances at faster and more reliable speeds. This means that the efficiency of existing spectrum and mobile network infrastructure is more important than ever before.

So that we can meet the expectations of the community, 3GPP should ensure that 6G significantly improves the efficiency of spectrum and infrastructure. It is reasonable to assume that, after twenty years of service, OFDM has matured and is unlikely to yield significant further gains. The task for RAN1 is to resolve two requirements in tension:

- Research and evaluate new waveforms that can significantly improve spectral efficiency by addressing any of OFDM's shortcomings; and
- Ensure that the chosen waveform can be supported by 5G radios while also carrying 5G and 6G traffic simultaneously

Whilst finding a new waveform with impactful change may seem to conflict with the need to support 6G on 5G infrastructure, we believe the answer lies in understanding the full lifecycle of radio equipment. Supporting 5G infrastructure will enable MNOs to roll out 6G as software on existing 5G infrastructure, which will be further enhanced with MRSS to enable efficient dynamic sharing of spectrum between 5G and 6G.

However, as 6G matures, 5G traffic will decline, meaning that the need to dynamically share spectrum between 5G and 6G will be relatively short lived. In addition, 5G radio infrastructure will be replaced for lifecycle reasons over time. This gives the industry an opportunity to take the benefits of a new 6G waveform in a targeted way, with increasing benefit as the technology lifecycle proceeds [2]. Importantly, this provides MNOs the opportunity to invest in technology improvement driven by need: some sites will continue with 5G radio equipment for many years, while others will benefit from early 6G radio investment to address local capacity needs.



OFDM has several well recognised limitations that stem from characterising the radio channel in the time / frequency domain. Time frequency domain measurements have a short coherence time (particularly in instances of high Doppler spreads), meaning that measurements transmitted over the air are limited in resolution to avoid overloading signalling channels. In addition, time frequency measurements have a narrow coherence bandwidth (particularly under large delay spread channels) and are valid only for the measured frequency.

It is therefore important that 3GPP embarks on an open and transparent study of the RAN physical layer, including the evaluation of new waveforms.

2 Objectives

The following text is proposed for addition to the Objectives of the Study Item.

Proposal 1: Guiding principles for the new RAT

A set of standardisation principles for 6G, supported by a mix of global operators and equipment vendors was presented at RAN#107 [3]. The proponents of this proposal feel that these principles should be included in the approved 6G working group study items as a high-level guidance of what should drive the development of 6G technologies. A subset of relevant principles for the new RAT

(1) The new RAT SI shall capture the following principles:

- Drive extreme efficiency of 6G radio and network on both existing and new spectrum, allowing much-improved TCO and cost per GB. Enable easy macro 6G deployments on both existing and new spectrum with efficient aggregation of carriers.

- Full performance of 6G is understood to be realized with RAN infrastructure refresh in existing or new bands as driven by operator business needs. Deployment of software-based 6G features should be possible on capable 5G RAN infrastructure in legacy bands including leveraging efficient 5G-6G MRSS, whilst ensuring a single branch of 6G standards development.

- Design for high 6G radio performance through a revolutionary leap in performance by exploiting UE-non-backwards compatible 6G radio design, prioritising improved median & cell edge performance.

- Strive for architectural simplicity, optimized spectrum sharing (MRSS) with 5G, macro deployments using the existing macro sites, native support for legacy services (e.g. eMBB, Voice, FWA, etc…), and aggregation to achieve competitive 6G user experience, as determined by the results of the study items.

- Scalable 6G RAT that supports diverse device types ranging from the lowest capability device (e.g., 3GPP LPWA) to higher capability devices in the first release. Ensure a globally aligned meaningful minimum set of capabilities and normatively specified testing and certification procedure for 6G RAT.

- Introduction of 6G native IoT technology, including LPWA technology, in the first release that facilitates long term commercial obligations that may outlive the 6G RAN.

- All digital (and non-digital) industries strive for much improved levels of sustainability and energy efficiency. Standards shall enable the mobile industry to reach its committed sustainability goals and dramatically reduce its energy usage and carbon footprint.

Proposal 2: Study of fundamental physical layer signal structure for new RAT

(2) The new RAT SI shall capture and focus on the following areas:
  - Waveform based on OFDM
  - Evaluate other candidate waveforms and multiple access techniques, including but not limited to:
    - Orthogonal Time Frequency Space (Zak-OTFS) [4]
    - Rate-Splitting Multiple Access (RSMA) [5]
  - Waveform evaluations shall be conducted in line with TR 38.914 [6], across new and legacy spectrum. Evaluations shall consider at least:
    - Spectral efficiency
    - Energy consumption, both RAN & UE, including device/receiver complexity & PAPR minimization
    - Capacity impact of pilot (eg lean carrier, reduced physical layer overheads)
    - Ability to simultaneously use the same spectral resources for both sensing & communication for ISAC
    - Minimisation of performance degradation when operating 5G & 6G simultaneously (MRSS) and/or operating on 5G RAN infrastructure
    - Capacity & performance for NTN, including spectrum reuse with TN
    - Ability to support all device types and capabilities, eg FWA, MBB, NTN, ISAC, IoT, etc
    - Capacity and performance gains offered by FDD reciprocity beamforming and MU-MIMO pairing
  - Basic frame structure(s)
  - Channel coding scheme(s)

References

[1] 6GWS-250240: 3GPP 6G workplan and timelines

[2] 6GWS-250091: Telstra’s Vision and Priorities for 6G RAN

[3] RP-250771: 6G Standardization – Principles, “T-Mobile USA, AT&T, BT, Ericsson, KPN, KT, MediaTek, Nokia, NTT DOCOMO, Qualcomm, Rakuten, Samsung, Softbank, Telstra”

[4] 6GWS-250233: Cohere's view - Enabling Waveform Innovation in 6G[5] 6GWS-250104: A BBC View on MAT for 6G

[6] TR 38.914: Study on scenarios and requirements for next generation access technologies

3GPP TSG RAN Meeting #108
Prague, Czech Republic, June 9-13, 2025

RP-251270

On Downlink Multiple Access Techniques for RAN WG Study Item on 6G

Source: BBC, VIAVI Solutions, Imperial College London, EURECOM, Centre tecnologic de Telecomunicacions de Catalunya (CTTC), EchoStar, Institute for Communication Systems - University of Surrey (ICS), Vestel, Turk Telekomunikasyon, Telstra, Department for Science Innovation and Technology (DSIT), Federated Telecoms Hub / TITAN (FTH), German Aerospace Center (DLR)

For: Discussion

Agenda item: 16.2 - New RAN WG SI on 6G

Motivation

- Multiple Access Techniques (MAT) are considered as a key technology to enhance the spectrum efficiency of the radio interface for IMT-2030 [1], [2].

- **Increased spectrum efficiency** is a key target for 6G as emphasized by multiple operators and vendors to the 3GPP 6G Workshop [3]

[1] *Framework and overall objectives of the future development of IMT for 2030 and beyond*, Recommendation ITU-R M.2160-0, Nov. 2023
[2] *Future technology trends of terrestrial International Mobile Telecommunications systems towards 2030 and beyond*, Report ITU-R M.2516-0, Nov. 2022
[3] 6GWS-250243, *Chair's summary of the 3GPP workshop on 6G*, 3GPP RAN 6G Workshop, Incheon –South Korea, March 10-11, 2025

Motivation

- Relevant **research and pre-standardization activities** → ETSI ISG MAT [3], [4]
  - ETSI Industry Specification Group on Multiple Access Techniques – ETSI ISG MAT
  - Focus on downlink MAT for the physical layer of the 3GPP radio interface that enhance the transmission efficiency (e.g., spectrum efficiency, power consumption, latency, user fairness, etc.) of specified approaches
  - ETSI ISG MAT exploring candidate techniques such as OMA (Orthogonal Multiple Access), SDMA (Spatial Division Multiple Access), NOMA (Non-Orthogonal Multiple Access) and RSMA (Rate-Splitting Multiple Access)

[3] RP-250031 LS on establishment of ETSI Industry Specification Group on Multiple Access Techniques (ETSI ISG MAT)
[4] ETSI press release, *ETSI Launches New Group on Multiple Access Techniques for 6G Networks* [link]

Baseline MAT for the 6G Study – downlink (1/2)

- MAT specified in 3GPP to be used as baseline for performance comparisons against any candidate MAT
  - SU-MIMO, and
  - MU-MIMO including advanced receivers to mitigate inter-user interference: TS 38.101-4 [5], TR 38.878 [6]

[5] 3GPP TS 38.101-4: "NR; User Equipment (UE) radio transmission and reception; Part 4: Performance requirements“
[6] 3GPP TR 38.878: "NR demodulation performance evolution".

Baseline MAT for the 6G Study – downlink (2/2)

- Multi-User Superposition Transmission (MUST)
  - multiplexes messages from multiple UEs in a given time-frequency resource using superposition coding in the power-domain
  - MUST can increase the spectral efficiency and improve user fairness, particularly benefiting users at the cell edge who typically suffer from poor signal conditions.
- MUST was **studied and specified for LTE** [7]
  - superposition of two broadcast signals was only studied in Rel-16 [8]
- Limited/no commercial uptake of MUST

[7] 3GPP TR 36.859: “Study on Downlink Multiuser Superposition Transmission (MUST) for LTE”.
[8] Study on LTE-based 5G terrestrial broadcast, 3rd Generation Partnership Project (3GPP), Technical Report TR 36.776 V16.0.0, Mar. 2019

Candidate MAT for the 6G Study – downlink (1/2)

- Rate-Splitting Multiple Access (RSMA)
  - RSMA is a flexible MAT with interference management capabilities that can improve the system performance in key scenarios such as high demand density areas and joint multicast-unicast transmissions
    - **increased spectral efficiency**, and
    - **increased fairness** of rates between scheduled UEs
  - RSMA can support multiple delivery modes with the same transmitter and receiver architecture: unicast-only, multicast-only, as well as joint multicast- unicast
- Performance improvements against MU-MIMO including advanced receivers reported in [9], [10]
- **RSMA has not yet been studied in 3GPP**

[9] RP-231938 Rate Splitting Multiple Access (RSMA) for Multi-User MIMO - Enhancement of Unicast and Joint Unicast/Multicast Delivery
[10] 6GWS-250104 A BBC View on Multiple Access Techniques for 6G

Candidate MAT for the 6G Study – downlink (2/2)

- Cache-aided MU-MIMO
  - Significantly **enhances spectral efficiency** for delivery of popular multimedia content (e.g. VoD) where most of the content can be cached in advance
  - Relies on **paradigm of coded caching** where **memory at the receiver** is used to intelligently store interfering data prior to transmission
  - **Multiple low-dimensional MU-MIMO** transmissions are **super-imposed** and interference is cancelled using the cached data in the device memory

- Performance improvements against conventional MU-MIMO reported in [11]

- **Cache-aided MU-MIMO has not yet been studied in 3GPP**

[11] 6GWS-250203 EURECOM View on 6G RAN

Proposal

- Include downlink Multiple Access Techniques (MAT) as part of the scope of the RAN WG Study Item on 6G
  - MAT specified in 3GPP to be used as baseline for performance comparisons against any candidate MAT
    - SU-MIMO, and MU-MIMO including advanced receivers to mitigate inter-user interference: TS 38.101-4, TR 38.878.
    - MUST
  - Candidate MAT for the RAN WG Study Item on 6G include Rate-Splitting Multiple Access (RSMA) and Cache-aided MU-MIMO

Continental
The Future in Motion

Views on 6G RAN WG SI

RP-251317

Source: Continental Automotive Technologies GmbH, Germany

Meeting: Prague, Czech Republic
Agenda item: 16.2 - New RAN WG SI on 6G
Date: June 9-13, 2025

This document provides general aspects to be considered for the definition of the scope of RAN 6G studies. In addition, we provide a set of topics (concrete elements and keywords) that in our view muss be part of the studies.

The intention is to indicate these are our priorities and to express our support to the topics listed herein.

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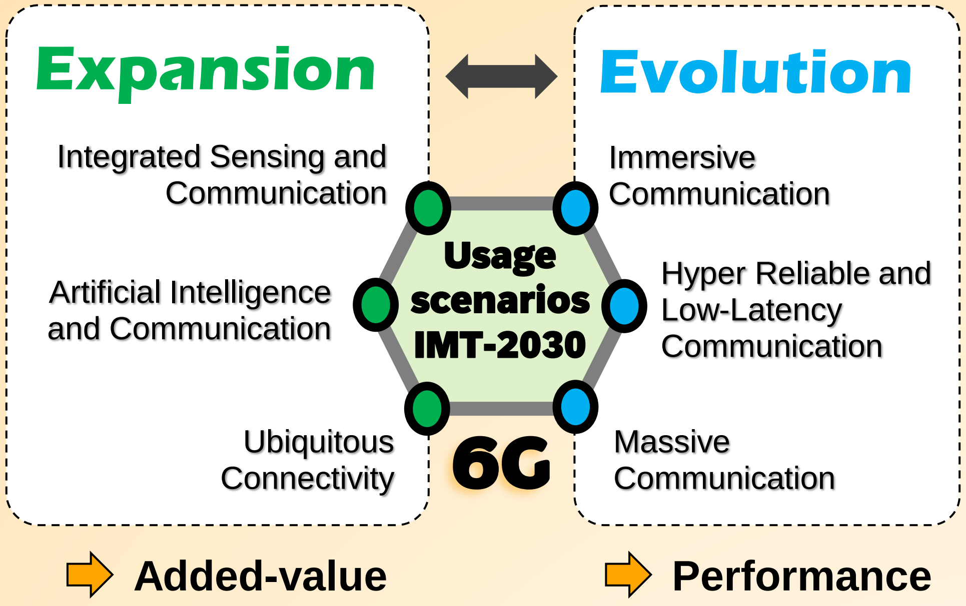
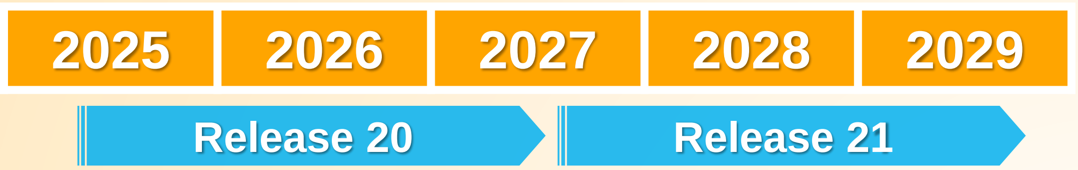
1. **General Aspects**
2. **Vision, Priorities, and Added-value aspects for 6G RAN**
3. **Final Remarks and Proposals**

IMT-2030 and 6G Timeline in 3GPP

- IMT-2030 has defined a set of 6 usage Scenarios for 6G. They can be regarded as follows:
  - *Evolutions* of the originally-defined 5G use cases: eMBB, URLLC, and mMTTC.
  - *Expansions* of later additions made during 5G timeframe: ISAC, AI/ML, and NTN.

- Currently, RAN faces the important task of completing the scope definition for the 6G studies, which will eventually shape how 6G would look like (and for what it could in-reality be used).
  - For automotive, a smooth transition to 6G is foreseeable (at some point after first specification is released) as the deployment/adoption of 5G is ongoing now; with the expectation that 6G will provide **clear and substantial enhancements and benefits** (business opportunities).
  - Thus, 6G should not be perceived as an alternative to 5G now, but as a **necessary/potential complement** later on.





June 2025. RAN#108, **RP-251317**: Views on 6G RAN WG SI
Continental Automotive Technologies GmbH

What do we expect from 6G?

In general terms, successful adoption of 6G will depend on providing clear and substantial improvements in the aspects indicated here. Those enclose most of the key drivers for 6G development.

Performance
- Verticals and costumer KPIs and requirements.
- For all usage scenarios.

Business Opportunities
- Unprecedented user experience and value for customers (use cases).

Cost/Complexity
- Reduction by introducing higher level of <u>Modularity</u> and more specialization for verticals, e.g., different UE-types.
  - Simple: *Less is more*.
  - Allow people to pay for what they need only.

Sustainability
- Industry responsibility: environment and society.
- Lifecycles: production, operation, disposal.

Security and Trustworthiness
- Functional safety type-of concepts should/could be considered/discussed.

Interoperability
- At least some forms of interoperability or coexistence with 5G, e.g., for V2X, are needed.
- While we support not-having so many deployment options, few basic configurations would provide an appropriate *flexibility* in Day-1.

What’s on beyond-2030 horizon?

An Automotive Perspective

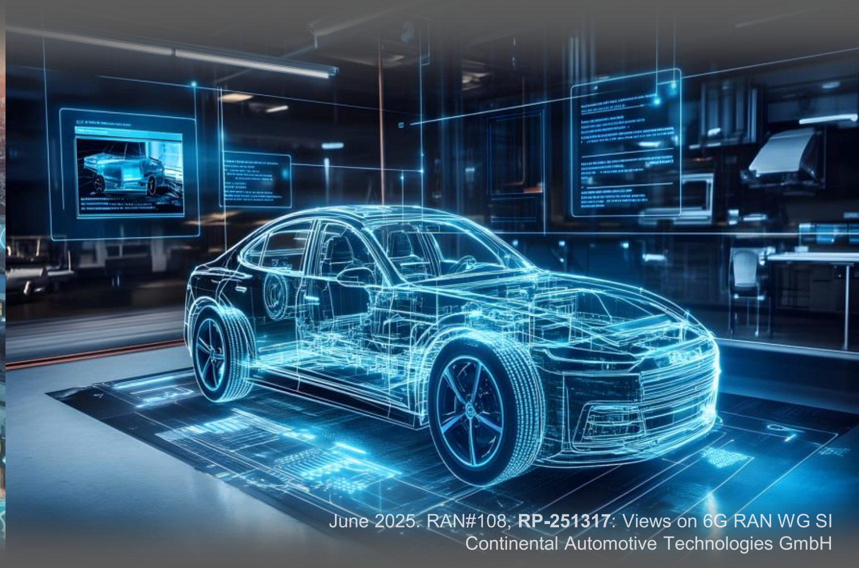
Five Important Goals

Scope selection in RAN’s 6G studies must consider guaranteeing support of these objectives.

It’s all about data

Collection | Storage
Sharing | Processing

- **Inmersiveness**
- **Secure, trustworthy, and reliable V2X communication, including high mobility scenarios**
- **Digital Twins and Cooperative Environment perception**
- **Coverage for off-road scenarios and industries**
- **Autonomous and tele-operated driving**



1 General Aspects

2 **Vision, Priorities, and Added-value aspects for 6G RAN**

3 Final Remarks and Proposals

Spectrum

400 MHz	7 GHz	24 GHz	52.6 GHz	71 GHz
FR1	FR3	FR2-1	FR2-2	Above 71 GHz and sub-THz

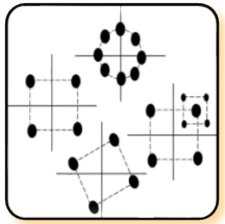
- **6G should consider <u>all</u> frequency ranges.** They are all important (and have some pros and cons) from different points of view. In addition, there are important region-specific aspects.
  - FR1:
    - ☑ Essential long-range layer and important for IoT.
    - ☒ Spectrum availability leading to capacity limitations.
  - FR2: Peak data rates in (outdoor and indoor) hotspots.
    - ☑ Peak data rates in (outdoors and indoor) hotspots.
    - ☑ Good resolution for sensing applications.
    - ☑ Additional unlicensed and ITS spectrum.
    - ☒ Outdoor-to-indoor. Consider lessons learnt from 5G.
  - FR3:
    - ☑ Capacity expansion. Spatial diversity and MIMO layers.
    - ☒ Regional availability, e.g., Japan. Coexistence with incumbents must be considered.
  - Sub-THz:
    - ☐ At least the frequency range 100-275 GHz can be considered for 6G studies [1-3].
- Spectrum aggregation schemes (CA and/or DC) should consider cost and implementation complexity aspects, which could be vertical-specific.

[1] ITU Radio Regulations. Vol 1, Articles. Geneva 2020.
[2] ETSI GR THz 001: TeraHertz modeling (THz); Identification of use cases for THz communication systems, 2024.
[3] ETSI GR THz 002: TeraHertz technology (THz); Identification of frequency bands of interest for THz communication systems, 2024.

Physical Layer

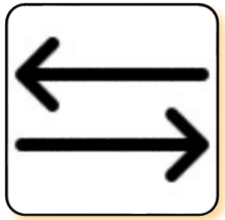
Waveforms

- In our view, it is clear that 5G NR waveforms (CP-OFDM + DFT-s-OFDM) should be supported in 6G, as baseline. Merits and limitations are well-known from experience. Backward compatibility would be facilitated.
- However, we are also supportive to study **other waveforms** in the 6G studies. There is strong evidence of their merit and feasibility. Criteria for selection should include performance (e.g., spectral efficiency, PAPR, etc.), complexity, *fitting* to other services and **multi-functionality** (e.g., sensing/ISAC), high mobility conditions, multiple-access schemes, etc.



Modulations

- 5G modulation schemes can be used as baseline.
- We support including **new modulation schemes** as part of 6G studies. Potential techniques and enhancements, with significant well-demonstrated benefits, for certain scenarios/applications including AI-based modulation, index modulation, non-uniform constellations, adaptive modulations, joint channel coding and modulation, etc.



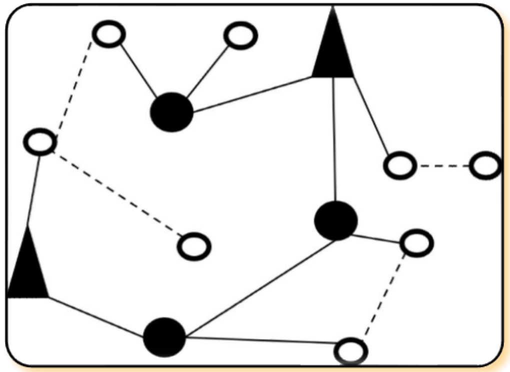
Duplexing schemes

- 6G should flexibly provide several duplex schemes, including conventional TDD; FDD, and newer modes, such as sub-band full-duplex (SBFD), in-band full duplex (IBFD), dynamic duplexing, and full-duplex.
- The relevance and compatibility of these techniques with several features, such as ISAC and Reconfigurable Electromagnetic Structures (REMS), e.g., Reflexive Intelligent Surfaces (RIS), is also known.

Artificial Intelligence and Machine Learning (AI/ML)

- AI/ML framework was introduced few releases after baseline specifications of 5G were made. We consider that despite of the several difficulties found, it was a right decision to align among companies and gain common understanding and experience. The motivation was to leverage AI/ML to improve certain features, such as beam management, positioning, and CSI.
- **AI/ML must be a day-1 design consideration for 6G**, i.e., AI/ML should be a native feature. Both paradigms, AI for Network (AI4NET) and Network for AI (NET4AI) shall be supported in 6G, and hence, included and discussed in 6G studies.
  - Suggested focus: latency and processing requirements and schemes for integration of (distributed) computing resources.

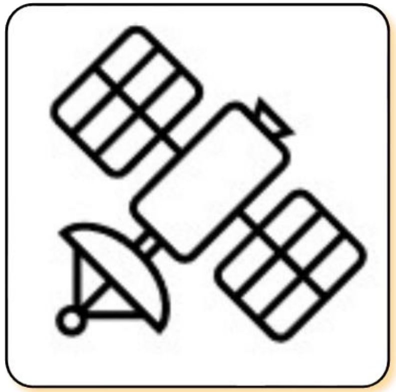
Network Elements, Topology, and Interfaces



- **Sidelink**: direct communications (e.g., ad-hoc communications) is an essential paradigm in wireless communications, and particularly important for V2X.
  - While there is no critical commercial need to have sidelink in Day-1 of 6G, our preference is to **include it as part of the 6G studies** to identify potential challenges, technology components, features and confirm evaluation scenarios/assumptions.
  - For 6G, basic functionalities that can be provided over sidelink could include communication, relaying, positioning, and (UE-based) sensing.
  - Finally, due to its nature and practical relevance for V2X, enhancements to facilitate the adoption and deployment of smart/connected infrastructure, e.g., Road-side Units (RSU) should also be identified and discussed.

- Other aspects whose inclusion in 6G (perhaps not in Day-1) could be discussed in the studies include relaying/repeaters (including sidelink-based), integrated access and backhauling, aerials/HAPS, cell-free, UE-centric-cells, moving-cells, etc.

Non-Terrestrial Networks



- Support of Non-Terrestrial Networks (NTN) has been developed for 5G NR. The relevance and momentum of NTN is currently, and in the 6G era, out-of-question. This is true for the automotive industry as well.
- In our view, NTN is an essential part of the discussions in the 6G studies, and hence, appropriate design considerations to guarantee the best possible integration and interworking between terrestrial and non-terrestrial components, including spectrum, **should be addressed in Day-1**.

Other Relevant Aspects (1/2)

Last and listed below, but, **definitely not least** …

… a set of topics we fully support to be included as part of the scope of 6G studies:

- Advanced/cooperative **positioning**, including **rigid body localization** (RBL). Solutions should comprise network-based, UE-based, and hybrid schemes.
- Strategy principles for **6G device types**. For automotive, this is particularly important when considering TN and NTN components. Number and characteristics of antennas is also relevant.
- **Trustworthiness** in 6G system. Taking into consideration the set of critical applications that will be supported by 6G, including inmersiveness, autonomous vehicles and safety, digital twins, etc., it is of utmost important that 6G guarantees an operation that ensures **privacy, reliability, safety, and resiliency**.
- **ISAC**. As 5G will primarily focus on network-based sensing, we support that Day-1 ISAC scope focuses on **UE-based sensing** (services). It should be discussed whether ISAC functions should enable sensing-assisted communication, communication-assisted sensing, and distributed/AI-assisted sensing. For sensing operations, FR2 is our preference. Finally, full interworking with non-3GPP sensing-data sources should be discussed/considered as well.
- Integration of **computation**, **communication**, and **sensing**. We consider that addition of integrated computing paradigms from Day-1 would enable 6G to become an **end-to-end intelligent system** able to collect, transmit, and process information in the most efficient and effective manner.

Other Relevant Aspects (2/2)

- **REMS/RIS**. Initial focus should be coverage enhancements. Focus: FR2 and FR3, outdoor-to-indoor and outdoors.
- **Multiple Access**. A discussion on the feasibility of enable **orthogonal** (OMA), **non-orthogonal** (NOMA), and other recent multiple access schemes (e.g., Rate splitting multiple access, RSMA) is of utmost importance to be part of 6G studies. Distributed resource allocation, ad-hoc networking, and sub-networking are also of interest.
- Continue development and evolution of **IoT** and **A-IoT** technology within the 6G timeline.
- Introduction of a **Data-Plane**, in addition to user and control plane. Important and beneficial for sensing services and possibly for the overall AI/ML framework.

1 General Aspects

2 Vision, Priorities, and Added-value aspects for 6G RAN

3 Final Remarks and Proposals

- **Do not forget**: every new “**G**” is a *particularly good* and somehow unique opportunity to introduce new technology components.
  - Decisions made today will have impact on the adoption and commercialization of 6G systems, and 3GPP technology.

- The automotive sector is, and expects to continue being, **one of the most important users of 3GPP technology**, with significant impact on several aspects of people: mobility, transportation, environmental impact, safety, etc.
  - It is essential to consider circumstances (time scales and product life-cycles), requirements, expectations, and objectives provided by verticals.

- Proposals and recommendations indicated in this document are mainly **automotive-driven**, but are *well-aligned* with several 3GPP requirements for 6G Radio targeting overall **performance**, **user experience**, and **TCO reduction** as indicated in [4].

[4] TSG RAN Meeting 108. RP-250810: Revised SID: Study on 6G Scenarios and requirements. March 2025.

Proposal: Include in the scope of RAN 6G Studies, the topics listed below.

- ☑ Spectrum: FR1, FR2, FR3, and sub-THz
- ☑ Waveforms
- ☑ Modulations
- ☑ Duplexing Schemes
- ☑ Native AI/ML Framework
- ☑ IoT / A-IoT
- ☑ Network Elements/Topology/Interfaces
- ☑ Advanced Positioning
- ☑ Harmonized 6G Design for TN and NTN
- ☑ 6G Device Types
- ☑ Trustworthiness
- ☑ ISAC
- ☑ Integrated Computation (in-network, over-the-air, etc.)
- ☑ REMS/RIS
- ☑ Multiple Access
- ☑ Data-Plane