**3GPP TSG RAN4 Meeting #116bis R4-25 DRAFT**

**Prague, Czech Republic, 13th – 18th October, 2025**

**Agenda item:** 8.1

**Source:** Feature lead (Nokia)

**Title:** [116bis][104] Feature lead Summary for 6G Spectrum

**Document for:** Information

# Introduction

In the current Study on 6G Radio (RP-250858) the following topics are listed under (5) 6GR core and performance requirements.

|  |
| --- |
| 1. **UE RF requirement aspects including band and band combination** [RAN4]    * + UE RF requirement framework aiming at improvements and/or simplification compared to 5G NR      + Study how to improve 6G UE RF specification(s), including structure, drafting principles, and database for band combination      + Study UE RF capabilities considering different device types and implementations 2. Other aspects [RAN4]    * + Handling channel bandwidths which are not multiple of 5MHz      + **Definition of ‘frequency range(s)’** |

Furthermore, at RAN4#116 a plan for the 6G study in RAN4 was presented by the RAN4 chair as captured in [2]. One of the topics was “Spectrum” with a **scope listed as**:

* **Band/band combination definition and simplification**
* **Definition of frequency ranges**
* **Spectrum related regulatory survey**

In this contribution we discuss our considerations on the item listed above.

## Companies’ contributions summary

The list of company contributions submitted under agenda item 8.6 for RAN4#116bis fetched 06-10-2025 06:18:37 UTC. In total 19 TDocs available.

|  |  |  |  |
| --- | --- | --- | --- |
| **TDoc Number** | **Source** | **TDoc Title** | **TDoc Status** |
| [R4-2513022](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513022.zip) | Qualcomm Incorporated | Qualcomm views on 6G Spectrum | available |
| [R4-2513029](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513029.zip) | Charter Communications, Cable Labs | Adding 7 GHz Small Cells to 6G Study | available |
| [R4-2513038](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513038.zip) | MediaTek Inc. | 6G Candidate spectrums | available |
| [R4-2513046](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513046.zip) | Samsung | Discussion on spectrum for 6GR | available |
| [R4-2513059](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513059.zip) | China Telecom | Discussion on 6G spectrum | available |
| [R4-2513070](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513070.zip) | Nokia | 6G Considerations on Spectrum aspects | available |
| [R4-2513134](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513134.zip) | CMCC | Discussion on spectrum for 6GR study | available |
| [R4-2513149](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513149.zip) | Spreadtrum, UNISOC | Views on 6G spectrum | available |
| [R4-2513208](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513208.zip) | CATT | Discussion on 6G spectrum | available |
| [R4-2513252](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513252.zip) | vivo | Discussion on 6G Spectrum | available |
| [R4-2513258](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513258.zip) | LG Electronics | Initial views on 6G spectrum | available |
| [R4-2513271](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513271.zip) | ZTE Corporation, Sanechips | Views on 6G spectrum aspect | available |
| [R4-2513273](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513273.zip) | Ericsson | Considerations on 6G Spectrum and 6G Band Combinations | available |
| [R4-2513274](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513274.zip) | Xiaomi | Overview for 6GR spectrum | available |
| [R4-2513307](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513307.zip) | Huawei, HiSilicon | Consideration on spectrum for 6G | available |
| [R4-2513317](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513317.zip) | OPPO | Discussion on 6GR spectrum | available |
| [R4-2513335](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513335.zip) | KDDI Corporation | Discussion on 6G spectrum | available |
| [R4-2513350](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513350.zip) | Apple | Initial views on 6G spectrum and frequency ranges | available |
| [R4-2513353](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513353.zip) | Skyworks Solutions, Inc. | Inputs on RAN4 6G Spectrum | available |

The proposals from the listed contributions have been included under the relevant Topic(s) in the following except for proposals related to co-existence study from R4-2513307 which per request by the proponents have been moved to be treated under Agenda 8.5.

# Topic #1: Definition of frequency ranges and bands

Under this topic RAN4 will discuss how to define frequency ranges and bands for 6G. The following observations and proposals have been made.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2513350](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513350.zip) | Apple | Proposal 1a: Existing 5G mobile terrestrial and satellite bands can be re-farmed to 6G (subject for further checking and potential band optimisations).  Proposal 1b: New bands can be defined once they become available based on the outcome of the corresponding regulatory decisions.  Proposal 2a: As a starting point, existing FR1 and FR2 frequency ranges can be also considered for 6G.  Proposal 2b: FR1 frequency range can cover existing frequencies up to 7.1GHz and can be extended, if needed, to higher frequencies subject for further decisions in the regulatory domain.  Proposal 2c: FR2 frequency range can cover existing frequencies at 24.2-52.6GHz.  Proposal 2d: Introduction of a new frequency (sub-)range should be well justified by considering various factors including UE RF architecture, physical layer design and performance requirements verification. |
| [R4-2513022](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513022.zip) | Qualcomm Incorporated | Observation 2.3-1: The study on frequency ranges includes two parts; naming conventions and the actual frequencies supported by each frequency range  Proposal 2.3-1: Study the naming conventions and boundaries for the frequency ranges accounting the frequencies used first time in 6G and the outcomes of the ongoing regulatory work |
| [R4-2513046](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513046.zip) | Samsung | Observation 1: Our general views on approaches to secure 6G spectrum are outlined as above, includes new band exploration, spectrum clearing and spectrum refarming  Proposal 1: It is proposed to adopt “s” or “t” as 6G band prefix.  Observation 2: The fundamental idea for band group concept is to divide FRs into several band groups. Within one band group, only one band is allowed to operate at a time. Further, within one band group, CA via switching and/or decreased Rx chains per band can be considered.  Observation 3: The anticipated advantages include improved UE performance and reduced cost due to less insertion loss, a lighter RFFE design, more room for FR3, which are benefit from the removal of multi-plexer.  Proposal 2: We are open to discuss the band group concept, with the understanding that it should be thoroughly checked with all stakeholders, particularly the operators. In the meanwhile, traditional CA(like what we have for 5G-5G carrier aggregation) should not be precluded for 6G. |
| [R4-2513070](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513070.zip) | Nokia | Observation 1: NR currently has multiple frequency range definitions dependent on not only frequency range but also deployment type.  Proposal 1: RAN4 shall discuss whether to have separated or united frequency range definitions for TN and NTN operation in 6GR.  Proposal 2: RAN4 shall consider paring frequency ranges to specified assumptions and requirements in 6GR.  Proposal 3: There shall be no references to “FR3” before an agreed definition of this exist within RAN4.  Proposal 4: RAN4 shall discuss a split into multiple frequency ranges spanning from around 400MHz to around 52GHz in 6GR.  Observation 2: NR concept for band numbering has proven successful and very usable. This concept means that 3G, 4G, and 5G had used same band number if frequency arrangement is same. LTE uses Arabic numeral, WCDMA uses Roman numeral and NR has prefix on “n” in front of Roman numeral.  Proposal 5: For 6GR operating band naming re-use prefix concept from NR but replace “n” with “s”.  Proposal 6: Keep using numbering space 1-512 for new bands according to the division shown in Table 2.2.1-1.  A white paper with black text  AI-generated content may be incorrect. |
| [R4-2513252](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513252.zip) | vivo | Proposal 1: Discuss how to define 6G NTN and TN frequency ranges.  Proposal 2: Discuss how to introduce 6G new spectrum with the following options: • Extend FR1 to 8400MHz, and define a new frequency range as FR3. • FR3 from 8400MHz to 24250MHz  Observation 1: Band/band combination simplification for 6G is a general demand and potential consensus among device vendors.  Observation 2: Define the band groups based on division of the specific frequency range, - The workload of band categorize could be reduced and the simplification of CA combinations’ requirements would be more effective. - Some exception cases for specific band combs in requirements simplification are needed and the restriction of UE behaviour is inevitable.  Observation 3: Define the band groups based on operators/vendors’ request, - It is more in line with the implementation demand and commercial use, also leaves more flexibilities for UE design. - It is less friendly to simplification of band/band group and CA combs’ requirements. |
| [R4-2513271](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513271.zip) | ZTE Corporation,Sanechips | Proposal 1: For 6GR band definition, it is proposed to use the legacy NR FDD/TDD band definition as basis for 6GR RF requirement definition to guarantee the backward compatibility from RF front-end perspective.  Proposal 2: For 6GR band definition, it is proposed not to define the new band group definition to replace the legacy band definition to cause the discrepancy between 3GPP definition and regional regulator’s definition.  Observation 2: 5G NR band includes LTE refarming bands and New NR bands, prefix “n” is used for the band numbers to distinguish different RATs.  Observation 3: In 5G NR, band numbering 1 to 256 is reserved for FR1 bands and 257 to 512 are reserved for FR2 bands. There are lots of unused band number in each frequency range.  Proposal 3: 6GR bands, both 5G NR refarming bands (including satellite bands) and new 6GR bands should be considered. The band numbers of refarming bands in 6GR should be same with the band numbers of 5G NR, and new 6GR bands should be introduced on “first come first served” basis.  Proposal 4: All of the 6GR band numbers should be written with a new prefix.  Proposal 10: Postpone the discussion on FR extension and focus on the relevant technical discussions in 6G SI phase. |
| [R4-2513307](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513307.zip) | Huawei, HiSilicon | Proposal 1-2: RAN4 to conduct studies pertaining to the frequency range from a UE and BS implementation perspective, particularly regarding the applicability of conducted requirements.  Observation 1-5: Definitions of FR1 and FR2 frequency ranges for TN and for NTN is already mis-aligned.  Observation 1-6: NTN specification (of FR1-NTN and FR2-NTN) does already cover 7 – 24 GHz range.  Observation 1-7: Range of 10700 – 14500 MHz shall not be fragmented as it covers Ku bands. This range is already assigned to FR2-NTN.  Proposal 1-3: Refrain from introducing FR3 to cover any frequency range within 7 – 24 GHz.  Proposal 1-4: Study in 6G to develop a unified and extensible signaling mechanism that provides flexible support for regional sub-band allocations within a single band, thereby avoiding fragmented solutions. |
| [R4-2513317](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513317.zip) | OPPO | Observation 1: Millimeter waves categorized to FR2 is mainly due to adopt array antenna and lack a conductive test port.  Observation 2: RAN1 is discussing frequency range based on numerology, which is different from RAN4 where the conducted/OTA requirement definition is the focus. RAN4 need to be deeply involved in the frequency range definition.  Proposal 1: The frequency range definition shall consider the conducted/radiated requirement definition in RAN4 and also the UE implementation impacts.  Observation 3: In NR, Ku band has set an example of defining two bands within FR1 and FR2 for the same spectrum.  Observation 4: RAN4 introduced two band for same Ku spectrum, one is FR1 band, the other is FR2 band. The two bands apply same radiated requirements.  Proposal 2: Multiple numerology should be avoided in the same frequency (sub)range in 6G.  Observation 5: Multiple numerology shall be avoided for the same Band / sub-range.  Proposal 3: Frequency range can be defined based on the interface of UE RF requirements. Within each frequency range, the applicable numerology can be defined per band or per sub-frequency range basis.  Observation 6: The frequency range for TN and NTN became different from R19.  Proposal 4: In 6G, align the frequency range definition for TN and NTN.  Observation 7: For 4400-4800 MHz and 7125-8400 MHz, there is no concern that the UE can have a conducted isotropic radiation pattern antenna interface.  Observation 8: The array antenna of 15GHz is too large for physical constraints in case of handheld devices.  Proposal 5: It is feasible to apply FR1 up to 15300MHz.  Observation 9: 10700MHz-24250MHz is only used by NTN.  Proposal 6: In 6G, define frequency ranges based on the interface of RF requirements, as show in Table 3.   |  |  |  | | --- | --- | --- | | **Frequencyrange** | **Spectrum range** | **Interface of RF requirements** | | FR 1 | 410 MHz-15350 MHz | Conducted interface | | FR 2 | 10700MHz-24250 MHz  **(NTN only)** | Radiated interface | | 24250 MHz-52600 MHz |   Observation 10: 6425-7125 MHz is totally overlapping with NR band n104.  Observation 11: 10-10.5 GHz with very restrict limitation, no operator will support it in 6G clearly.  Observation 12: Candidate 6G Spectrum in WRC-27 includes 6 425-7 125 MHz, 4400-4800 MHz, 7125-8400 MHz, and 14.8-15.35 GHz which also need to be studied in RAN4.  Observation 13: New spectrum range of 4400-4800 MHz has been covered by NR band n79, furthermore, band n79 will also be considered for re-farming into 6G.  Proposal 7: RAN4 should first study whether the n79 can be re-employed for 6G to cover the new 6G spectrum 4400-4800MHz.  Observation 14: For the candidate spectrum 7125-8400 MHz, NS value could be used to solve specific requirements.  Proposal 8: RAN4 should strive to define global bands for 7125-8400 MHz and 14.8-15.35 GHz for 6G.  Observation 15: 6G will coexist with 5G NR for a long time, and operators also need time to re-farm the 5G spectrum.  Proposal 9: FR1 re-farming bands should be introduced step by step based on Operators’ request.  Proposal 10: For FR1, reuse 5G requirements for the same band with same PC, e.g., reuse same hardware for both 5G and 6G.  Observation 16: With 6G limited TU, it is important for RAN4 to identify the most important aspects to focus on.  Proposal 11: The re-farming of FR2 bands should depend on the level of interest from industry.  Proposal 12: Reuse 5G FR2 UE type/power class and Requirement directly.  Observation 17: In 5G NR, many overlapping bands have adopted same RF front-end in real UE implementation which makes defining separate bands is not meaningful.  Proposal 13: Consider to merge overlapping bands as much as possible when re-farming FR1 bands. |
| [R4-2513353](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513353.zip) | Skyworks Solutions Inc. | Observation: Depending on the types of UE, a given frequency band within FR3 could be supported both by an FR2-like antenna implementation (e.g. arrays with dual polarization), hereby supporting some level of beam forming, while for some other UEs the same band could be supported using FR1-like antennas (non-beam forming other than MIMO)  Proposal on TS handling: Consider developing a single technical specification document for 6G where RF requirements are no longer split per frequency ranges but by type of RF requirements like done for NTN in 38.101-5, i.e. Conducted transmitter/receiver characteristics for UEs not supporting beamforming via antenna arrays, e.g. FR1-like Radiated transmitter/receiver characteristics for UEs supporting beam-forming via antenna arrays, e.g. FR2-like.  Proposal on FR1-FR3 interference: Do not consider FR1-FR3 interference for UEs supporting beam-forming in an FR3 frequency band (FR2-like antenna implementation) For UEs not supporting beam-forming in an FR3 band, further discuss criteria for which self-interference may need to be considered. For example, ignore self-interference for inter-band configurations of FR1 <2.5GHz + FR3, etc..  Proposal on handling inter-band combinations Confirm if 5G+6G dual connectivity is out of scope from a network deployment perspective. If considered valid, can RAN4 no longer consider dynamic power sharing? Consider simplifying inter-band CA RF requirements by specifying band-group requirements rather than band combination specific requirements, eg. Develop LB-MB RF requirements that would apply equally to any LB aggregated to any MB ? Consider different band group split depending on type of UE/ type of RF requirement: For conducted requirements / UE type with FR1-like antenna implementation, one example of band grouping could be 0.3-0.6GHz, 0.6-1.25GHz, 1.25-2.5GHz, 2.5-5GHz, 5-10GHz For radiated requirements / UE type with FR2-like antenna array/beam forming support, one example of band grouping could be 10-20GHz, 20-40GHz, 40-52.6GHz. For inter-band UL CA aggregating two bands supported with conducted RF requirements, restrict to a maximum of 2UL bands with up to 4CCs and a maximum of 2UL clusters, eg. CA\_nXB/C-nyB/C for band “x” and “y”. |
| [R4-2513208](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513208.zip) | CATT | Proposal 1: RAN4 to consider a new frequency band definition, which is a continuous spectrum segment that can be configured to support uplink, downlink, or both, without UL operating band and DL operating band pairing.  Proposal 2: The UE can report its pairing capability and required bandwidths to the network, and network configures corresponding parameters based on the capabilities reported by the UE.  Proposal 3: A UE can support multiple UL and DL pairings. Therefore, one cell can contain multiple TRPs operating in different frequency bands, with each TRP handling the UL and DL carriers that it supports.  Proposal 4: We recommend defining only one SCS per frequency group.  Proposal 5: A band combination can be defined based on the new frequency band definition concept by utilizing frequency groups and the UE's UL and DL pairing capability.  Proposal 6: The frequency groups and SCS of FR1 are defined in Table 1.   |  |  |  |  | | --- | --- | --- | --- | | **Frequency group numbering** | **Frequency range** | **Definition** | **SCS (kHz)** | | 1 | Around 400MHz ~ 1695MHz | Low band | 15 | | 2 | 1695MHz ~ 2690MHz | Mid band | 15 | | 3 | 2690MHz ~ 3300MHz | High band | 30 | | 4 | 3300MHz ~ 5000MHz | Low ultra band | 30 | | 5 | 5000MHz ~ 5925MHz | L6G band | 30 | | 6 | 5925MHz ~ 7GHz/8GHz? | U6G band | 30 |   Proposal 7: Paired UL and DL can reside within either a single frequency group or across different frequency groups.  Proposal 8: If the paired UL and DL are in the same frequency group, they share the same SCS. If they are in different frequency groups, the SCS may differ.  Proposal 9: Band combination includes intra-cell band combination and inter-cell band combination. The former corresponds to a single cell, while the latter corresponds to multiple cells.  Proposal 10: The definition of frequency ranges is shown in table 3.   |  |  |  |  | | --- | --- | --- | --- | | **FR** | | **Frequency range** | **SCS (kHz)** | | FR1 | Low band | Around 400MHz ~ 1695MHz | 15 | | Mid band | 1695MHz ~ 2690MHz | 15 | | High band | 2690MHz ~ 3300MHz | 30 | | Low ultra band | 3300MHz ~ 5000MHz | 30 | | L6G band | 5000MHz ~ 5925MHz | 30 | | U6G band | 5925MHz ~ 7GHz/8GHz? | 30 | | [New FR] | | 7GHz/8GHz? ~ 24.25GHz | 60 | | FR2-1 | | 24.25GHz ~ 52.6GHz | 120 | |
| [R4-2513258](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513258.zip) | LG Electronics | Proposal 1: Study new terminology (e.g, CFG : carrier frequency group) to group sub-frequency range considering RF impact simplification to 5G-NR  Proposal 2: Consider to define FR3 (7.125GHz ~ 24.25GHz) to cover frequency range around 7GHz and around 15GHz |
| [R4-2513273](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513273.zip) | Ericsson | Proposal 1: In the scope of the 6G, RAN4 should study how to handle bands in the frequency range 7-24 GHz, extending existing FR1 and/or FR2 frequency ranges and/or introducing a new frequency range (i.e. FR3), considering how RF and RRM requirements are currently specified in FR1/FR2 as input. |
| [R4-2513274](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513274.zip) | Xiaomi | Proposal 3-1: RAN4 discuss the criteria for frequency range definition with candidate options  Proposal 3-2: two alternative approaches can be considered for frequency range definition: - Alt 1: Extend FR1 and FR2 to cover 7-24GHz with overlapping range - Alt 2: Introduce dedicated FR3 frequency with hybrid requirements pending on device type |
| [R4-2513335](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513335.zip) | KDDI Corporation | Proposal 3: Study the frequency ranges considering frequencies used first time in 6G and the progress/outcomes of the ongoing regulatory discussions. |
| [R4-2513038](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513038.zip) | MediaTek Inc. | Observation 1: The following spectrum will be considered as a IMT (6G) Candidate spectrum in region 1. - 3.3~3.4 GHz - 4.4 ~4.8 GHz (Russia only) - 6.425 ~7.125 GHz – [7.125 ~7.25GHz] if feasibility study between military service and IMT service are proved, then these frequency range can be used for IMT service. (except with 7.25~8.4GHz as military service)  Observation 2: The following spectrum will be considered as a IMT (6G) Candidate spectrum in region 2. - 2.7 ~ 2.9 GHz - 3.98 ~ 4.2 GHz - 4.4 ~ 4.9 GHz - 6.425 ~ 7.125 GHz (only Brazil, Mexico, Still further identification between WiFi and IMT in US) - 7.25 ~ 7.4 GHz  Observation 3: The following spectrum will be considered as a IMT (6G) Candidate spectrum in region 3. - 4.8 ~ 4.99 GHz - 6.425 ~ 7.125 GHz (China and a few South Asia countries) - [7.125 ~ 8.4GHz] (Korea/Japan still not decide the spectrum usage as same US)  Observation 4: TN/NTN harmonized bands will be further discussed based on WRC-27 decision. RAN4 need to discuss how can define the PSD threshold to protect terrestrial IMT system when ITU-R decide with option 2.  Proposal 1: For the Upper 6GHz and the lower FR3 (7.125 ~ 8.4GHz) will consider as 6G target spectrum in early stage. The FR3 mid band (10~15.35GHz) can be consider in later stage.  Proposal 2: Based on Proposal 1, RAN4 can extend FR1 definition from 410~7125MHz to 410 ~ 8400MHz in 6G. |
| [R4-2513134](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513134.zip) | CMCC | Proposal 1: it’s RAN4’s scope to discuss the frequency range for FR1 based on the options proposed in RAN1: - Option 1: extend FR1 to 8.4 GHz and define a separate mid-high band (8.4–24.25 GHz) with its own single numerology. - Option 2: extend FR1 to 8.4 GHz and merge 8.4–24.25 GHz into FR2, creating a unified FR2 family. - Option 3: define separate FR for 7.125 – 24.25 GHz. |
| [R4-2513149](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513149.zip) | Spreadtrum,UNISOC | Proposal 1: Study how to define the frequency ranges of FR3 (e.g., based on the numerology), and keep a single SCS in sub-frequency ranges/band in 6GR. |

## Open issues summary

The spectrum in focus is stated in the current Study on 6G Radio (RP-250858) description:

|  |
| --- |
| From a technology perspective, the study will address frequency ranges up to 52.6GHz, including at least the full range of FR1 (up to 7.125GHz), the range between FR1 and FR2-1 (including around ~7GHz), and FR2-1 (24.25 GHz – 52.6GHz).  NOTE: The following TRs will be taken into account:  [TR 38.921](https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3778) - Study on International Mobile Telecommunications (IMT) parameters for 6.425 - 7.025 GHz, 7.025 - 7.125 GHz and 10.0 - 10.5 GHz  [TR 38.922](https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=4300) - Study on International Mobile Telecommunications (IMT) parameters for 4400 - 4800 MHz, 7125 - 8400 MHz and 14800 - 15350 MHz  NOTE: Frequency ranges beyond 52.6 GHz are not in scope of the work. |

During the RAN#109 meeting, there were initial discussions on the potential 6G frequency ranges, which were summarised in the following document (RP-252963). However, no conclusion was reached since this is for further RAN WG4 discussions. According to the moderator’s summary report, the following options were proposed by companies:

- extend FR1 to 8.4 GHz and define a separate mid-high band (8.4–24.25 GHz) with its own single numerology.

- extend FR1 to 8.4 GHz and merge 8.4–24.25 GHz into FR2, creating a unified FR2 family.

- define separate FR for 7.125 – 24.25 GHz.

At this RAN4 meeting, even more options have been brought forward, which all are to be further discussed during the RAN4 meeting.

As a result, this topic addresses the definition and categorisation of frequency ranges for 6G, including the introduction of new frequency ranges, and the extension of existing ranges like FR1 and FR2. It discusses the harmonization of frequency definitions between terrestrial networks (TN) and non-terrestrial networks (NTN), the challenges of multiple numerologies, and the need for regulatory alignment. The importance of considering UE implementation impacts, RF requirements, and the potential for new spectrum based on WRC decisions is also highlighted.

### Sub-topic 1-1: TN and NTN Frequency Range harmonization

As pointed out in several contributions, the Terrestrial Networks (TN) and Non-Terrestrial Networks (NTN) NR Frequency Range definition is not aligned with each other. The lack of consensus on defining frequency ranges for 6G, particularly for the mid-band spectrum between 7 GHz and 24 GHz, leads to fragmentation in TN and NTN, complicating UE and network RF design, numerology selection, and spectrum management, which ultimately hinders efficient implementation and performance optimization.

**Issue 1-1-1: TN and NTN Frequency Range Harmonization**

* Proposals
  + Option 1: RAN4 shall like for NR define separate frequency ranges for NR and NTN for 6G
  + Option 2: RAN4 shall define the same frequency ranges for NR and NTN for 6G
* Recommended WF
  + Option 2 – Since the Study on 6G Radio is defined with no separation between Tn and NTN operation

### Sub-topic 1-2: Frequency Range framework

Some make the point that since we are now starting a new generation, there may not be a need to adopt the frequency ranges used by NR for 6GR. Others point out that due to co-existence would need to be alignment. An important point is that the unresolved regulatory framework for the 7-24 GHz frequency range, with critical decisions from WRC-27 scheduled post-6G study conclusion, should not hinder the progress of the design and standardization of 6G radio access technology.

**Issue 1-2-0: Principle/criteria for frequency range definition/separation**

* **Proposals: candidate criteria for further consideration** 
  + Regulatory framework
  + UE RF front-end architecture (whether antenna connector available or not)
  + Commonality of UE RF/RRM requirements
  + Numerology dependency

**Issue 1-2-1: Basis of frequency range definitions**

* Proposals
  + Option 1: Extend FR1 and FR2 to “close the gap” from 7.125 – 24.25 GHz
    - Option 1a: Extended existing NR FR1 and FR2 without overlapping frequency
      * New frequency range designation between extended FR1 and FR2
    - Option 1b: Extended existing NR FR1 and FR2 with overlapping frequency
      * No new frequency range designation for 7.125-24.25GHz
      * Sub-frequency range can be considered for extended FR1 and FR2
  + Option 2: Define a new frequency range for the 7.125 – 24.25 GHz and keep the current FR1 and FR2-1 definitions
  + Option 3: Extend FR1, define a new frequency range and keep FR2-1 definitions.
  + Option 4: Sub-divide FR1, define new frequency ranges and keep FR2-1 definitions.
  + Option 5: Clean slate and define new frequency ranges from around 400MHz to 52.6GHz
  + Option 6: Postpone the discussion on FR1 extension
* Recommended WF
  + TBA

### Sub-topic 1-3: Frequency Range naming convention

Some have already proposed to adopt “FR3” within the 6G timeframe, while others are against using that name. In relation to this, some suggest that something else than “frequency range” should be used for 6GR.

**Issue 1-3-1: Early adaptation of the name “FR3”**

* Proposals
  + Option 1: RAN4 shall adapt the name FR3 and use it for the “gap” between FR1 and FR2-1 now
  + Option 2: RAN4 shall not use any names for a frequency range before it is agreed. This does not preclude adapting the name FR3 at a later stage
  + Option 3: RAN4 shall not consider the name FR3 at any point
* Recommended WF
  + Option 2 – Different companies have even for this meeting been using FR3 for different frequency ranges, so to avoid ambiguity, it is recommended to refer to a specific range, e.g. 8.4–24.25 GHz, or only already defined NR ranges as FR1, FR2-1 or FR2-2

**Issue 1-3-2: Name it “Frequency Range” (FR) or something else for 6G**

* Proposals
  + Option 1: RAN4 shall continue to use “Frequency Range” (FR) in 6G
  + Option 2: RAN4 shall consider a different name as e.g. “Carrier Frequency Group” or “Frequency Group Numbering”.
* Recommended WF
  + TBA

### Sub-topic 1-4: Band naming convention

Multiple companies point out that there at some point will be a refarming of LTE/NR bands to 6GR bands as well of the inclusion of completely new bands. Hence, it is suggested that there is a new naming convention for 6G bands to separate these from other 3GPP bands. Some companies are proposing to reuse the number ranges now adopted for NR bands.

**Issue 1-4-1: 6G Bands Naming Convention**

* Proposals
  + Option 1: RAN4 shall not consider individual bands for 6G but utilize only frequency ranges/groups
  + Option 2: RAN4 shall re-use the prefix concept from NR for 6G bands,
    - a) “s” is to be used in front of the band number
    - b) “t” is to be used in front of the band number
* Recommended WF
  + TBA

**Issue 1-4-2: 6G Bands Number Range**

* Proposals
  + Option 1: RAN4 shall define a new number range for 6G bands.
  + Option 2: RAN4 shall re-use the NR number range for 6G bands.
    - a) All numbers from 1-512 can be reused for 6G bands.
    - b) To allow alignment to the previous refarming strategy, band numbers should be reused from existing bands when refarmed following the principle shown below

A white paper with black text

AI-generated content may be incorrect.

* Recommended WF
  + TBA

# Topic #2: Band combination definition and simplification

Under this topic, RAN4 will discuss how to define band combinations and simplify these in 6G. The following observations and proposals have been made.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2513022](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513022.zip) | Qualcomm Incorporated | Proposal 2.2.1-1: Study and conclude naming conventions for 6G bands including Single Carrier and Intra-band CA as priority  Proposal 2.2.1-2: Study the process how to migrate requirements of existing 5G bands to 6G band requirements to avoid inefficiencies during WI phase  Proposal 2.2.2-1: Pending RAN/RAN1 outcomes on the spectrum aggregation options(s) and RAN1 outcomes on detailed spectrum aggregation matters, study how to specify band combinations in a simple way, striving to avoid duplicate band combination tables in case more than one of CA, Dual Connectivity, Dual Stack are supported  Proposal 2.2.2-2: Study whether the approach of specifying all permutations for band combinations separately up to the maximum number of bands and CC’s per operator is still suitable, or if some simplification in some form could be used  Proposal 2.2.2-3: Study if ∆TIB and ∆RIB are still needed, or if they could be discontinued in 6G. If one or both ∆TIB and ∆RIB are still needed, study how to specify those using generic method  Proposal 2.2.2-4: Study how to specify REFSENS exceptions (MSD’s) for each Power Classes in more generic way, avoiding band combination specific requirements when possible  Proposal 2.2.2-5: Study which kind of MSD requirements are needed, including considerations whether to drop some of most extreme currently specified cases in 6G |
| [R4-2513046](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513046.zip) | Samsung | Observation 2: The fundamental idea for band group concept is to divide FRs into several band groups. Within one band group, only one band is allowed to operate at a time. Further, within one band group, CA via switching and/or decreased Rx chains per band can be considered.  Observation 3: The anticipated advantages include improved UE performance and reduced cost due to less insertion loss, a lighter RFFE design, more room for FR3, which are benefit from the removal of multi-plexer.  Proposal 2: We are open to discuss the band group concept, with the understanding that it should be thoroughly checked with all stakeholders, particularly the operators. In the meanwhile, traditional CA(like what we have for 5G-5G carrier aggregation) should not be precluded for 6G.  Proposal 3: For MSD simplification, continue the further exploration in 6G. Two potential directions are: Extend the MSD LUT approach to cover HPUE cases that were not addressed in Rel-19 work, and maintaining MSD requirements for each band combination Have MSD requirements as frequency ranges basis  Proposal 4: For ΔTIB and ΔRIB, it is proposed to specify general simplified rules to replace case-by-case analysis unless it is found necessary for some exceptional combos. The rules outlined in RAN4 PRD can serve as a starting point -ΔTIB and ΔRIB tables are only for exceptional cases where the general rules are not suitable General rules are expected to be captured in 6G spec  Proposal 5: It is proposed to discuss the removal of BCS concept for band combination. This means that one band within a band combination is supposed to support all CBWs that a single band supports, unless otherwise indicated If certain channel bandwidths, such as the maximum channel bandwidth, cannot be supported due to interference concerns to other bands, this can be indicated additionally |
| [R4-2513070](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513070.zip) | Nokia | Observation 3: The underscore seems not to have a clearly unified defined purpose in current band combinations.  Observation 4: The band prefix already can be used to identify DC combinations.  Observation 5: There is no need to declare the type, but use only CA, when more carriers are combined.  Proposal 7: RAN4 shall consider not to use RAT or device type indications for band combinations in 6GR.  Observation 6: Removing special band combination declarations would allow simplification of band combination notation.  Proposal 8: In 6GR the band combination syntax shall consists of a single type (“CA”), underscore separators for Type, DL and UL, one or more downlink bands separated by dash and one or more uplink bands separated by dash.  Observation 7: In NR UL and DL switching schemes means that the CA notation is no longer enough to identify a radio state configuration.  Proposal 9: RAN4 shall consider how CA attributes as DL/UL switching can be clearly identifiable for 6GR band combinations  Observation 8: In the current NR specification multiple tables are now listing band combination specific requirements meaning to understand requirements for a single band combination one will have to consult numerous long tables in the specification.  Observation 9: Currently the RAN4 UE RF specification has separate tables for each UE relaxation type, e.g. MSD due to harmonica mixing issues.  Observation 10: The to move listing of supported band combinations to a database instead of listing them in the DOCX specification is not addressing the band combination specific requirements.  Proposal 10: RAN4 shall consider for 6GR to providing a single list of supported band combinations together with their impairments requiring relaxation to provide an overview instead of spreading the information over multiple tables in the specification. |
| [R4-2513252](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513252.zip) | vivo | Proposal 4: To further minimize the standardization work and RF system design, a Band group concept can be considered as a solution to simplify band/band combination and CA combs’ requirements, the specific definition principle need guidance from operators and further study.  Observation 4: Based on low, mid, high group definition for FR1, for UL harmonic the MSD of inter-group combs could be classified according to the harmonic order and allocation. Some exception cases also exist.  Observation 5: Based on low, mid, high group definition for FR1, for harmonic mixing the MSD of inter-group combs exhibits greater dispersion compared to UL harmonic, but to some extent, it can still be classified based on harmonic order and allocation.  Observation 6: Based on low, mid, high group definition for FR1, for MSD due to crossband isolation the inter-group combs are finite and MSD values could be effectively classified, fewer exception cases are expected.  Observation 7: Based on low, mid, high group definition for FR1, the MSD of inter-group combs due to IMD exhibits the greatest dispersion but there is still some room for simplification.  Proposal 5: Further study requirements simplification based on the band group concept, e.g., MSD.  Proposal 6: For each group combination, select several typical band combinations as the starting point for requirements simplification and the related study could also be used to guide the definition of band group. |
| [R4-2513271](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513271.zip) | ZTE Corporation,Sanechips | Observation 4. In ‘band group’ conception, the bands between two different band groups can support inter-band CA band combinations by default, while for the bands in the same groups, CA is not supported and only one band is allowed to operate at a time.  Observation 5. From band combination aspect, although ‘band group’ concept can largely reduce the band combination number, there are cons e.g. it may not reflect operator’s demand in the same band group, HPUE and high order band combination and etc..  Proposal 5. To improve the PC3 band specific requirements (i.e. MSD, ΔTIB/ΔRIB). - For ΔTIB/ΔRIB, to use equation-based/LUT-like approach based on PRD guidance. - For MSD, to use LUT-like approach and use practical RF parameters to derive the MSD value.  Proposal 6: In 6GR, RAN4 should focus on the band configurations for real deployment and RAN4 should discuss the criteria on how to judge it.  Proposal 7. Discuss the necessity of BCS for inter-band NR CA in 6GR.  Proposal 8. Discuss if it is feasible to use database approach for the configuration requesting and status reports updates work.  Proposal 9. Discuss if it is feasible for the band configuration errors self-checking in the database/JSON file. |
| [R4-2513307](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513307.zip) | Huawei, HiSilicon | Observation 1-8: Regulation (e.g., additional spectrum emissions), changes could have impact on RAN4 requirements in terms of such as mandatory/optional, respective applicable release(s) for the applicable operating bands  Observation 1-9: There are mixed usages of “shall” and “may” in the definitions of the modified MPR behaviour. Different bands and even different bits for the same band follow different rationales, leading to confusion  Observation 1-10: For band n41, both bit 0 and bit 1 “shall be set to 1”. It’s unclear how to interpret bit 2 if it’s also set to 1. It’s questionable whether bit 2 can fulfil its intended purpose under the existing definitions.  Observation 1-11: modifiedMPR scheme requires CRs for earlier releases down to the release, where an associated band or feature is introduced.  Proposal 1-5: Issues written in Observations 6-8 should be addressed in 6G with a clean slate.  Observation 2-1: Supporting wide variety of band combinations and/or challenging band combinations, e.g., it requires multiplexer support is in exchange of UE Tx/Rx performance degradation due to complex transceiver design.  Observation 2-2: SI of Study on enhancement for 700/800/900MHz band combinations for NR revealed the fact that, just supporting one band combination with two or three low bands under Sub-1GHz can lead to considerable Tx/Rx performance degradation as well as the non-negligible impact on antenna efficiency.  Observation 2-3: Rel-19 WI of Low-Low band CA via switching shows an alternative feasible way to utilize low band spectrum to accommodate the RF front limitations and an insight that avoiding concurrent bands operation can minimizing the impact on MOP and REFSENS, i.e., ΔTIB,c and ΔRIB,c are zero, while it still gives more flexible spectrum usage than single carrier operation.  Observation 2-4: Total max throughput of 5.72Gbps for DL and 1.12Gbps for UL can be achieved with 4CC inter-band combinations among sub1GHz, 1.5~2.7GHz, 3.3~7GHz and 5~8GHz.  Observation 2-5: With support of band combinations compared to single band, the following issues can be observed:  - UE Antenna gain limitation for support more bands with fixed UE physical size  - Maximum output power and REFSENS degradation caused by front-end IL from multiplexer  - REFSENS degradation caused by non-linearity and IMD  - Loss of SRS antenna switching gain caused by interruption and power imbalance across ports  - The balance between the available number of transceiver paths and support CA for band with larger channel bandwidth and MIMO layers.  Proposal 2-1: Investigate mechanism on how to optimize and define the band combination in 6G Day 1 with consideration of coordination among low, medium and high frequency ranges, the support of larger channel bandwidth and higher MIMO layers by UE.  Observation 3-1: Most parameters are consistent; variations mainly depend on band group/frequency range  Observation 3-2: The feasibility of generic MSD upon types is demonstrated via Harmonic MSD & IMD MSD analysis  Proposal 3-1: Simplify band combination MSD as much as possible and focus on the typical MSD types only  Proposal 3-2: Study in 6GR whether generic MSD requirements could be specified for the baseline default power class  Proposal 3-3: Study in 6GR whether testing burden could be reduced if generic MSD requirements are defined per order/band group and the test is done via declared/selected band combinations.  Proposal 3-4: Study in 6GR whether BCS4/BCS5 could be considered as default option for requested band combinations while exceptions are allowed.  Proposal 3-5: Study in 6GR to develop a unified and simplified framework for defining delta Tib/Rib values to streamline CA implementation and reduce standardization complexity. |
| [R4-2513317](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513317.zip) | OPPO | Observation 18: It takes at least two RAN4 meetings and two RAN meetings to complete one band combination from request to introduce into the spec.  Proposal 14: Consider introduce “high speed band combination request procedure”: • Operator request one band combination and provide TR/draft CR at the same RAN4 meeting; • RAN4 endorse this TP/draft CR in that meeting; • In the following RAN plenary, operator bring this endorsed TP/CR to RAN plenary for approval directly together with the WID revision.  Proposal 15: To avoid overload RAN4: • This special procedure is limited to at most N times with M band combinations requested per operator each time; • The urgency should be well justified at the very beginning of RAN4 discussion; • The newly requested band combinations should not exceed the TU limits for basket WI.  Observation 19: BCS4 is introduced in NR in Release 17. It can be supported in 6G day one.  Proposal 16: Consider remove BCS definition for band combination.  Observation 20: In NR, there are many intra-bands congruous CA with smaller aggregated bandwidth, which will not be a typical application.  Proposal 17: In 6G, strive to avoid using multiple small contiguous CCs aggregation to derive the large CBW, and use one CC with large CBW as much as possible.  Observation 21: To resolve the deployment scenarios, Tx switching, SDL switching and intra-band NC CA sharing one RF chain were enhanced under NR CA framework, however, they were all configured all with one cell and one CC.  Observation 22: SCMC concept is discussing in RAN1 mainly for the purpose of solving CA configuration complexity and redundant control configurations.  Observation 23: From UE perspective, SCMC and CA can share one set of RF implementation, there is no significant difference between them.  Proposal 18: Study whether it is possible to define only one set of requirements for CA and SCMC when introduced in RAN1 considering CA and SCMC can share the same RF implementation.  Observation 24: The complexity of supporting SCMC + CA simultaneously is high.  Proposal 19: In 6G day one, mixed combination of SCMC + CA is not supported.  Observation 25: UL/DL decouple is discussed in RAN1 for the purpose of cell-edge performance and UL coverage.  Observation 26: UL/DL decouple have not any impact on UE RF implementation when band A and Band B adopt separate antenna in UE RF implementation.  Observation 27: New RF front-end component will increase the complexity of UE implementation and new band number cause more band combinations and bring more workload.  Proposal 20: Avoid to define a new band for UL/DL decouple pair.  Observation 28: A UE supports inter-band CA (Band A + Band B), will support the recouple pair of Band A UL and Band B DL.  Proposal 21: To enable more efficient Cell/UE management, study UL/DL decouple based on non-CA architecture.  Observation 29: New RF front-end component will increase the complexity of UE implementation although can save one set of RF chain band BB.  Observation 30: if both bands are within same band group (e.g., both are low bands), then for shared antenna UEs, this will need a new quadplexes which will increase much complexity in implementation.  Proposal 22: The decouple/recouple band combination shall not be within the same band group (e.g., both are low bands). And the UL/DL frequency separation, band A Tx to band B Rx interference also need to be considered in RAN4.  Observation 31: Dynamic scheduling between Band A UL+ Band B DL and Band A/Band B will increase the flexibility of scheduling.  Proposal 23: The decouple/recouple band combination shall be based semi-static approach if introduced due to complexities.  Proposal 24: The decouple/recouple band combination shall be UE capability based, it cannot be for any band combination.  Observation 32: Carrier switching is under discussion in RAN1 which is targeted to simplify from RF and baseband especially for the band combinations which cannot supported simultaneously like low band FDD + FDD.  Proposal 25: Study the RF impacts for carrier/band switching in terms of considering the switched carriers as one cell or two cells.  Observation 33: All these new candidates aggregated technologies have similar purpose with enhanced CA in NR, except the different of Cell/UE management.  Proposal 26: For one band combination, which aggregated technologies will be adopt need further down selection, and UE implementation complexity need to be well considered. |
| [R4-2513353](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513353.zip) | Skyworks Solutions Inc. | Observation: Depending on the types of UE, a given frequency band within FR3 could be supported both by an FR2-like antenna implementation (e.g. arrays with dual polarization), hereby supporting some level of beam forming, while for some other UEs the same band could be supported using FR1-like antennas (non-beam forming other than MIMO)  Proposal on TS handling: Consider developing a single technical specification document for 6G where RF requirements are no longer split per frequency ranges but by type of RF requirements like done for NTN in 38.101-5, i.e. Conducted transmitter/receiver characteristics for UEs not supporting beamforming via antenna arrays, e.g. FR1-like Radiated transmitter/receiver characteristics for UEs supporting beam-forming via antenna arrays, e.g. FR2-like.  Proposal on FR1-FR3 interference: Do not consider FR1-FR3 interference for UEs supporting beam-forming in an FR3 frequency band (FR2-like antenna implementation) For UEs not supporting beam-forming in an FR3 band, further discuss criteria for which self-interference may need to be considered. For example, ignore self-interference for inter-band configurations of FR1 <2.5GHz + FR3, etc..  Proposal on handling inter-band combinations Confirm if 5G+6G dual connectivity is out of scope from a network deployment perspective. If considered valid, can RAN4 no longer consider dynamic power sharing? Consider simplifying inter-band CA RF requirements by specifying band-group requirements rather than band combination specific requirements, eg. Develop LB-MB RF requirements that would apply equally to any LB aggregated to any MB ? Consider different band group split depending on type of UE/ type of RF requirement: For conducted requirements / UE type with FR1-like antenna implementation, one example of band grouping could be 0.3-0.6GHz, 0.6-1.25GHz, 1.25-2.5GHz, 2.5-5GHz, 5-10GHz For radiated requirements / UE type with FR2-like antenna array/beam forming support, one example of band grouping could be 10-20GHz, 20-40GHz, 40-52.6GHz. For inter-band UL CA aggregating two bands supported with conducted RF requirements, restrict to a maximum of 2UL bands with up to 4CCs and a maximum of 2UL clusters, eg. CA\_nXB/C-nyB/C for band “x” and “y”.  Proposal on simplifying intra-band CA requirements: Do not introduce intra-band contiguous CA RF requirements when the CA aggregated bandwidth can be supported by single carrier operation. For example, in bands where 6G single carrier operation can be supported up to 200MHz CBW, do not introduce RF requirements for say intra-band CA aggregated CBW<= 200MHz. To optimize uplink coverage, restrict intra-band contiguous CA operation only to contiguous RB allocations, To minimize RAN4 workload and TS complexity, do not specify RF requirements for CC1/CC2 CBW that cannot be practically deployed in a given region, for example to account for spectrum ownership considerations. |
| [R4-2513208](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513208.zip) | CATT | Proposal 1: RAN4 to consider a new frequency band definition, which is a continuous spectrum segment that can be configured to support uplink, downlink, or both, without UL operating band and DL operating band pairing.  Proposal 2: The UE can report its pairing capability and required bandwidths to the network, and network configures corresponding parameters based on the capabilities reported by the UE.  Proposal 3: A UE can support multiple UL and DL pairings. Therefore, one cell can contain multiple TRPs operating in different frequency bands, with each TRP handling the UL and DL carriers that it supports.  Proposal 5: A band combination can be defined based on the new frequency band definition concept by utilizing frequency groups and the UE's UL and DL pairing capability.  Proposal 7: Paired UL and DL can reside within either a single frequency group or across different frequency groups.  Proposal 8: If the paired UL and DL are in the same frequency group, they share the same SCS. If they are in different frequency groups, the SCS may differ.  Proposal 9: Band combination includes intra-cell band combination and inter-cell band combination. The former corresponds to a single cell, while the latter corresponds to multiple cells. |
| [R4-2513273](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513273.zip) | Ericsson | Proposal 3: Study how to improve and simplify selection of MSD values based on the proposed band group concept  Proposal 4: Don’t specify BCS’s and specific channel BW’s per band for 6G Inter-band combinations. but keep specific channel BW’s and BCS’s for intra-band combinations.  Proposal 5: Study how existing NR CA band combinations can be transferred directly into a 6G specification baseline  Proposal 6: JSON database is to be used instead of configuration tables for all 6G band combinations.  Observation 2: Discuss further how to align HPUE and PC3 work items and the meeting procedurals for them. |
| [R4-2513274](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513274.zip) | Xiaomi | Proposal 2-1: RAN4 needs to further study how to handle 4G/5G migration spectrum/bands to 6G with potential research area  Proposal 2-2: RAN4 needs to study how to simplify band combination including below direction: - Data base tool - New CA framework for requirement definition e.g., Band Group basis CA requirements for cross -BG CA |
| [R4-2513038](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513038.zip) | MediaTek Inc. | Proposal 3: RAN4 to wait for RAN1 on the conclusions of multi-carrier cell concept and check its potential impact to RAN4 RF requirement.  Proposal 4: When discussing band combo simplification, RAN4 needs to also consider concept like flexible Tx/Rx switching and DL-UL decoupling together.  Observation 5: For better UL coverage and DL throughput performance, UL/DL decoupling can be considered.  Observation 6: For the incumbent spectrum blocks migration from 5G to 6G, maintain the FR1 legacy FDD/TDD band definition and duplex can be considered as starting point.  Proposal 5: Incumbent frequency band/band index shall be re-used in 6G as starting point. FFS on whether band index can be simplified, considering RAN2’s potential enhancement on UE capability reporting.  Proposal 6: To enable agile spectrum utilization, the decoupling of uplink and downlink (UL/DL) can be considered, considering other impact on cross-carrier scheduling, RF/PHY implementation, Antenna performance for wide aggregated CBW, …, etc. |
| [R4-2513134](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513134.zip) | CMCC | Proposal 3: RAN4 can further study the options to reduce band combination workload and reduce RF front end complexity based on following options: • Option 1: use band group concept. For the bands belong to the same band group, switching instead CA is suggested. For the bands cross band group, the CA is suggested. ◦ RAN4 can further study the applicable frequency range, e.g. further check whether can extend the upper frequency to 2GHz. • Option 2:reuse current 5G RF requirements for 6G for the legacy band/band combinations and further study the method to reduce conformance testing workload. • Option 3: define new bands for the lower frequency range. • Option 4: decouple DL and DL and support feasible combinations |
| [R4-2513149](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513149.zip) | Spreadtrum,UNISOC | Proposal 2: To simplify band combinations definition, band group can be studied in 6G. |
| [R4-2513059](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513059.zip) | China Telecom | Proposal 2: Define the band combinations as several groups based on different type of MSD requirements, each group includes band lists and share the same requirements. |

## Open issues summary

This topic addresses the simplification of band definitions and combinations in 6G, focusing on the challenges posed by numerous frequency bands and carrier aggregation (CA) combinations. It includes discussions on the band group concept, the optimization of band combinations, and the need for unified requirements for carrier aggregation. The proposal emphasises the importance of reducing complexity in RF front-end design and ensuring backward compatibility with legacy systems.

The aspects here have also been partly addressed during the NR timeframe:

During Rel-18 timeframe RAN4 has conducted a SI on Study on simplification of band combination specification as captured in [TR 38.846](https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=4057) which party resulted in the first RAN 4 Permanent Reference Document ([PRD01](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/PRD/PRD01%20version%200.3.0%2C%20Rules%20guidelines%20and%20ways%20of%20working%20for%20introduction%20of%20band%20combinations.docx))

RAN4 needs to continue to explore options to reduce the workload related to band combinations and RF front-end complexity in 6G. The challenges faced in 5G regarding the specification of numerous bands and ongoing work on how to improve this should also be taken into account.

Since the topic of spectrum aggregation methods is discussed under agenda 8.4, some of the proposals related to this may not be fully incorporated in the following sub-topics, and companies are encouraged to bring their discussion under the relevant agenda for the next meeting.

### Sub-topic 2-1: Band combination types

Since other WGs and RAN4 discussions are to study and conclude on the possible deployment scenarios for 6G, the focus should be kept on carrier aggregation as a general term. The discussion on the specific types of spectrum aggregation resulting in different band combinations should be deferred to relevant WGs and/or agendas

**Issue 2-1-1: Band combination types**

* Proposals
  + Option 1: RAN4 shall not discuss the mechanism for different types of spectrum aggregation under this agenda item.
  + Option 2: RAN4 shall discuss the mechanism for different types of spectrum aggregation in parallel under this agenda item.
* Recommended WF
  + Option 1

### Sub-topic 2-2: Band combination introduction

Some companies propose to speed up the adaptation of 6G and reduce the workload to transfer current NR band combinations to 6G. It is, however, not clear which requirement shall apply. Other companies want to define band combinations based only on explicit operator demand.

**Issue 2-2-1: Band combination introduction**

* Proposals
  + Option 1: RAN4 shall consider transferring existing NR band combinations to be applicable also for 6G.
    - a) Applicable requirements are FFS
    - b) Applicable requirements are also transferred from NR
  + Option 2: RAN4 shall define 6G band combinations only based on request, meaning no band combinations will be automatically supported.
  + Option 3: RAN4 investigate on how to optimize and define the band combination in 6G Day 1 with consideration of coordination among low, medium and high frequency ranges, the support of larger channel bandwidth and higher MIMO layers by UE
* Recommended WF
  + TBA

### Sub-topic 2-3: Band Group Concept for band combination simplification

Multiple companies proposed to explore the Band Group Concept for band combination simplification in the sense that it may simplify the way band combination-specific requirements are defined.

**Issue 2-3-1: Band Group Concept for band combination simplification**

* Proposals
  + Option 1: RAN4 shall further study the Band Group Concept for band combination simplification
  + Option 2: RAN4 shall not consider the Band Group Concept
* Recommended WF
  + Option 1 – At this stage, it would be beneficial to allow further study to clarify the potential benefits of this concept

### Sub-topic 2-4: Bandwidth Combinations Sets (BCS) in 6G

To allow the addition of supported channel bandwidths to already defined bands, the concept of BCSs was introduced to the specification. However, lately in NR, only the so-called BCS 4&5 method, meaning all supported channel bandwidths are utilized. Therefore, some are proposing to abandon the BCs concept in 6G.

**Issue 2-4-1: Bandwidth Combinations Sets (BCS) in 6G**

* Proposals
  + Option 1: RAN4 shall not use Bandwidth Combinations Sets (BCS) in 6G
  + Option 2: RAN4 shall further investigate the need for Bandwidth Combinations Sets (BCS) in 6G
  + Option 3: RAN4 shall introduce Bandwidth Combinations Sets (BCS) in 6G
* Recommended WF
  + TBA

### Sub-topic 2-5: ∆TIB and ∆RIB in 6G

The ∆TIB and ∆RIB defined per specific band combination roots in the first introduction of CA in LTE times. Therefore, some companies are now questioning whether there is really still a need for these in 6G. Additionally, there have been multiple attempts to align and clarify the rules for defining the ∆TIB and ∆RIB values, but there is still no unified way specified. This is wanted to be addressed by other companies.

**Issue 2-5-1: ∆TIB in 6G**

* Proposals
  + Option 1: RAN4 shall not consider ∆TIB for 6G
  + Option 2: RAN4 shall study if ∆TIB is needed, defined for 6G
  + Option 3: RAN4 shall continue to define ∆TIB for 6G but unify and specify how a value is determined.
* Recommended WF
  + TBA

**Issue 2-5-2: ∆RIB in 6G**

* Proposals
  + Option 1: RAN4 shall not consider ∆RIB for 6G
  + Option 2: RAN4 shall study if ∆RIB is needed, defined for 6G
  + Option 3: RAN4 shall continue to define ∆RIB for 6G but unify and specify how a value is determined.
* Recommended WF
  + TBA

### Sub-topic 2-6: REFSENS exceptions (MSD) in 6G

A great amount of effort has been spent by RAN4 to address REFSENS exceptions (MSD) concerns within the NR timeframe. Some progress has been made to simplify procedures and requirements, but still, multiple companies are proposing to further develop this work within the 6G timeframe. The current consensus seems to be that something has to be improved here, and the difference in opinion seems to be whether to proceed along the same path as taken in NR or to completely change the MSD concept. This is from some companies' perspective related to the Band Group Concept.

**Issue 2-6-1: REFSENS exceptions (MSD) basis**

* Proposals
  + Option 1: RAN4 shall study which REFSENS exception (MSD) types are needed and consider if all currently defined for NR are needed in 6G
  + Option 2: RAN4 shall use REFSENS exception (MSD) types defined for NR, but study how to simplify specifying the exact values
  + Option 3: RAN4 shall discuss REFSENS exception (MSD) as part of the Band Group Concept.
* Recommended WF
  + TBA

### Sub-topic 2-7: Working procedures and Database for band combinations

One company is proposing changing the working procedure for band combination work. Multiple companies want to utelize the ongoing NR work related to the band combination database with JSON files also for 6G.

**Issue 2-7-1: Database adaptation**

* Proposals
  + Option 1: RAN4 shall study further development of the use of the Band Combination Database (JSON files) for 6G
  + Option 2: RAN4 shall wait for the outcome of the NR work on the Band Combination Database before starting the study on further developments
* Recommended WF
  + TBA

**Issue 2-7-2: Working procedures**

* Proposals
  + Option 1: RAN4 shall discuss the working procedures for band combinations under this agenda
  + Option 2: RAN4 shall discuss the working procedures for band combinations under the 6G operation efficiency agenda (8.13)
* Recommended WF
  + TBA

# Topic #3: Spectrum related regulatory survey

Under this topic, RAN4 will discuss spectrum related regulatory topics for 6G. The following observations and proposals have been made.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2513350](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513350.zip) | Apple | Proposal 1b: New bands can be defined once they become available based on the outcome of the corresponding regulatory decisions. |
| [R4-2513022](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513022.zip) | Qualcomm Incorporated | Observation 2.1-1: There are several target candidate bands for 6G, including the upper 6 GHz and the WRC-27 bands currently investigated at ITU-R (i.e. 4 400-4 800 MHz, 7 125-8 400 MHz, and 14.8-15.35 GHz). The regulatory discussions for some of these bands are still ongoing.  Proposal 2.2.1-3: Account regulatory timelines and outcomes in studying the characteristics of 6G bands for new frequencies/regions |
| [R4-2513046](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513046.zip) | Samsung | Proposal 6: For new spectrum for 6GR including 15GHz, among the three options, our recommendation for FR1 is to extend it to 8.4 GHz at least, considering the channel propagation characteristics and previous studies of IMT SI.  Observation 4: The selection of potential 6G example bands should take the ITU status into account. |
| [R4-2513070](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513070.zip) | Nokia | Observation 11: Spectrum for 6GR is based on the availability provided by international designations for IMT and regional regulations.  Observation 12: Potential new 6GR TN spectrum around is focused around 7GHz, 12GHz and 15GHz  Observation 13: ITU-R is engaging in defining the studies to evaluate the potential of the bands 4.4-4.8, 7.1-8.4 GHz and 14.8-15.35 GHz  Observation 14: FCC is assessing the potential of the bands 3.1-3.45 GHz 12.7-13.25 GHz.  Observation 15: The currently most attractive band, in our view, for 6GR studies within RAN4 is the around 7GHz band.  Proposal 11: RAN4 shall initially focus on a new 6GR band around 7GHz. |
| [R4-2513029](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513029.zip) | Charter Communications, Inc | Proposal 1: The 7125 – 8400 MHz band is currently licensed to national security related links. It is not feasible to clear this band for public mobile networks (e.g., IMT-2030 or 6G), instead, this 7125 – 8400 MHz band will need to be shared. A set of low-power assumptions could make sharing more feasible and a larger portion of the band more available, such as using power class 5 (PC5) for UE. High-power UMa BS could risk sharing and reduce available bandwidth.  Proposal 2: Non-AAS and AAS with small array sizes (e.g., 2×2, 2×4, or 4×4) parameters are of interest for the 7125 – 8400 band for medium-range and local-area microcells. The BS antenna gain for non-AAS is 6 dBi with an omnidirectional pattern in the azimuth plane.  Proposal 3: Macro-cell deployment in the 7125 – 8400 band may not be feasible due to large losses in these high frequencies. RAN4 will need to study the feasibility: what is the maximum urban macro (UMa) inter-site distance (ISD) to achieve 95% coverage (> -10 dB SINR) in both DL and UL by considering the aggregated co-channel interference from all the neighbouring Macro cells (CCI)? If the UMa ISD limit is too small, RAN4 shall suggest ITU-R WP 5D that these high-frequency bands are not applicable for the macro scenario.  Proposal 4: We propose to add Micro-Cells to Rel-20 to the current Macro-cell in the 7125 – 8400 band. |
| [R4-2513271](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513271.zip) | ZTE Corporation,Sanechips | Observation 1: There are some proposals for the spectrum in WRC-23 conference, i.e. 4.4-4.8GHz, 7.125-8.4 GHz and 14.8-15.35 GHz. However the final decisions for the IMT-2030/6G spectrum will be made in the WRC-27 conference. |
| [R4-2513307](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513307.zip) | Huawei, HiSilicon | Observation 1-1: 4.4 – 4.8 GHz, 7.125 – 8.4 GHz and 14.8 – 15.35 GHz were studied in Ｒ19 SI of FS\_NR\_IMT\_4400\_7125\_14800MHz, where a spectrum like 4.4-4.8GHz didn’t do co-existence study and the co-existence study for all the spectra didn’t consider practical aspects such as higher power classes.  Observation 1-2: Some parameters impacting on co-existence results such as Channel bandwidth, the number of Tx/Rx antennas etc., are under discussion in R20 RAN led SI (FS\_6G\_RAN\_Scen\_Req) and in R20 RAN1 led SI (FS\_6G\_Radio).  Observation 1-3: From observation 1 and 2, it would worth revisiting and re-evaluating the SI with new parameters which under discussion in TSG RAN/RAN1.  Observation 1-4: Frequency range of 6425 MHz – 7125 MHz has not been yet fully unleashed and it may be possible to obtain even more suitable requirements like ACLR with consideration of new parameters like channel bandwidth, the number of Tx/Rx antenna etc., under R20 RAN level study item and RAN1 for WG level SI.  Proposal 1-1: Consider at least 4.4 – 4.8 GHz, 7.125 – 8.4 GHz, 14.8 – 15.35 GHz and 6.425 – 7.125 MHz for further study with co-existence evaluation. |
| [R4-2513317](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513317.zip) | OPPO | Observation 7: For 4400-4800 MHz and 7125-8400 MHz, there is no concern that the UE can have a conducted isotropic radiation pattern antenna interface.  Observation 8: The array antenna of 15GHz is too large for physical constraints in case of handheld devices.  Proposal 5: It is feasible to apply FR1 up to 15300MHz.  Observation 9: 10700MHz-24250MHz is only used by NTN.  Observation 10: 6425-7125 MHz is totally overlapping with NR band n104.  Observation 11: 10-10.5 GHz with very restrict limitation, no operator will support it in 6G clearly.  Observation 12: Candidate 6G Spectrum in WRC-27 includes 6 425-7 125 MHz, 4400-4800 MHz, 7125-8400 MHz, and 14.8-15.35 GHz which also need to be studied in RAN4.  Observation 13: New spectrum range of 4400-4800 MHz has been covered by NR band n79, furthermore, band n79 will also be considered for re-farming into 6G.  Proposal 7: RAN4 should first study whether the n79 can be re-employed for 6G to cover the new 6G spectrum 4400-4800MHz.  Observation 14: For the candidate spectrum 7125-8400 MHz, NS value could be used to solve specific requirements.  Proposal 8: RAN4 should strive to define global bands for 7125-8400 MHz and 14.8-15.35 GHz for 6G. |
| [R4-2513208](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513208.zip) | CATT | Proposal 11: The conclusions of 6G spectrum related regulatory survey are shown in table 4 (See Tdoc). |
| [R4-2513258](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513258.zip) | LG Electronics | Proposal 3 : Study impact by the higher SAR/PD(power density) on RF in frequency > 7 GHz |
| [R4-2513273](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513273.zip) | Ericsson | Observation 1: It would be premature to investigate further regulations in the 7-24 GHz frequency range in the scope of the 6G study.  Proposal 2: Postpone further regulatory survey in the 7-24 GHz frequency range until Regulators published a new decision. |
| [R4-2513274](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513274.zip) | Xiaomi | Observation 1: The ITU-R is working on searching and identification new spectrum for IMT 6G, the potential frequency bands are 4 400–4 800 MHz, 7 125–8 400 MHz and 14.8–15.35 GHz.  Observation 2: The sharing and compatibility studies of WRC-27 agenda item 1.7 in under study, the identification methods, requirements, and regulations for the new bands for IMT are also under discussion in ITU-R.  Observation 3: 6425-7125 MHz is regarded by multiple nations as the primary frequency band for 6G.  Observation 4: The ITU-R is working on the in-band sharing and compatibility study for searching and identification new spectrum for DC-MSS-IMT service, the potential frequency bands including the IMT bands: 694-960 MHz, 1 710-1 880 MHz, 1 885-2 025 MHz, 2 110-2 200 MHz, 2 300-2 400 MHz, 2 496-2 690 MHz.  Observation 5: The sharing and compatibility studies for DC-MSS-IMT, including the in-band scenario study with the terrestrial IMT to identify new spectrum to the DC-MSS-IMT system in the scenario of cross-border.  Observation 6: For the DC-MSS-IMT system, the criterial and mechanism for protecting IMT systems operating is still on discussion. |
| [R4-2513335](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513335.zip) | KDDI Corporation | Observation 1: Some regions/countries are proactively discussing to allocate Upper 6 GHz to IMT.  Proposal 1: Study several candidates as 6G bands for 6.425-7.125GHz identified in WRC-23 and 4.4-4.8, 7.125-8.4 and 14.8-15.35 GHz being discussed toward WRC-27 considering the regulatory discussions are still ongoing.  Proposal 2: Study whether some existing 5G bands can be optimized and re-defined in 6G. |
| [R4-2513038](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513038.zip) | MediaTek Inc. | Observation 1: The following spectrum will be considered as a IMT (6G) Candidate spectrum in region 1. - 3.3~3.4 GHz - 4.4 ~4.8 GHz (Russia only) - 6.425 ~7.125 GHz – [7.125 ~7.25GHz] if feasibility study between military service and IMT service are proved, then these frequency range can be used for IMT service. (except with 7.25~8.4GHz as military service)  Observation 2: The following spectrum will be considered as a IMT (6G) Candidate spectrum in region 2. - 2.7 ~ 2.9 GHz - 3.98 ~ 4.2 GHz - 4.4 ~ 4.9 GHz - 6.425 ~ 7.125 GHz (only Brazil, Mexico, Still further identification between WiFi and IMT in US) - 7.25 ~ 7.4 GHz  Observation 3: The following spectrum will be considered as a IMT (6G) Candidate spectrum in region 3. - 4.8 ~ 4.99 GHz - 6.425 ~ 7.125 GHz (China and a few South Asia countries) - [7.125 ~ 8.4GHz] (Korea/Japan still not decide the spectrum usage as same US)  Observation 4: TN/NTN harmonized bands will be further discussed based on WRC-27 decision. RAN4 need to discuss how can define the PSD threshold to protect terrestrial IMT system when ITU-R decide with option 2.  Proposal 1: For the Upper 6GHz and the lower FR3 (7.125 ~ 8.4GHz) will consider as 6G target spectrum in early stage. The FR3 mid band (10~15.35GHz) can be consider in later stage. |
| [R4-2513134](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513134.zip) | CMCC | Observation 1: above list the regulatory status survey of 6425-7125MHz, 4400-4800MHz, 7125-8400MHz and 14.8-15.35GHz.  Proposal 2: it’s work item scope of detailed band definition among 7125-8400MHz based on the conclusion of WRC-27. at study phase, RAN4 study system parameter/RF requirements using around 7GHz as 6G new spectrum. |
| [R4-2513059](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116bis/Docs/R4-2513059.zip) | China Telecom | Proposal 1: Introduce frequency range of (6425 MHz - 7125 MHz) as 6G spectrum. |

## Open issues summary

This topic addresses the impact of evolving regulatory requirements on the definition and management of frequency bands for 6G. The discussions include the implications of WRC outcomes and the need for ongoing studies to ensure compliance with regional regulations. The unresolved regulatory framework for the 7-24 GHz frequency range, with critical decisions from WRC-27 scheduled post-6G study conclusion, means there are some assumptions that need to be made to progress the standardization work.

### Sub-topic 3-1: New spectrum/bands for consideration during the 6G SI

As pointed out by multiple companies, the regulatory framework will not be completely clear before the end of WRC-27. However, there are still suggestions for new spectrum/bands to consider during the 6G SI.

**Issue 3-1-1: New spectrum/bands for consideration during the 6G SI**

* Proposals
  + Option 1: RAN4 shall not consider any new spectrum under the 6G SI before the regulatory framework is completed for it.
  + Option 2: RAN4 shall consider candidate spectrum bands: 4400-4800 MHz, 6 425-7 125 MHz, 7125-8400 MHz, and 14.8-15.35 GHz
  + Option 3: RAN4 shall consider candidate spectrum bands: 4400-4800 MHz, 7125-8400 MHz, and 14.8-15.35 GHz
  + Option 4: RAN4 shall consider candidate spectrum bands: 7125-8400 MHz, and 14.8-15.35 GHz
  + Option 5: RAN4 shall consider “around 7GHz” (i.e. 6 425-8400 MHz) as a candidate spectrum band
* Recommended WF
  + TBA

### Sub-topic 3-2: SAR/PD(power density) on RF in frequency > 7 GHz

One company points out that there is a need to also study SAR/MPR/PD for new spectrum above 7 GHz.

**Issue 3-2-1: SAR/MPR for spectrum above 7 GHz**

* Proposals
  + Option 1: RAN4 shall study SAR/MPR for the spectrum above 7 GHz
  + Option 2: RAN4 shall not study SAR/MPR for spectrum above 7 GHz before the regulatory framework is resolved, i.e. at least after WRC-27
  + Option 3: There is no need for RAN4 to study SAR/MPR for the spectrum above 7 GHz
* Recommended WF
  + TBA

### Sub-topic 3-3: Micro-Cells deployment in a 7125 – 8400MHz band

One company proposed to study Micro-Cells deployment in a 7125 – 8400MHz band. The intention seems to be related to the sharing mechanism. Since this seems related to co-existence studies, it may be beneficial to have this discussion there.

**Issue 3-3-1: Micro-Cells deployment in a 7125 – 8400MHz band**

* Proposals
  + Option 1: RAN4 shall discuss Micro-Cells deployment in a 7125 – 8400MHz band under this agenda.
  + Option 2: RAN4 shall discuss Micro-Cells deployment in a 7125 – 8400MHz band under the co-existence agenda (8.5).
* Recommended WF
  + TBA