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

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

**Agenda item:** 8.1

**Source:** Feature lead (Nokia)

**Title:** [116bis][104] Feature lead ad-hoc summary for 6G Spectrum

**Document for:** Agreement

# 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**

This summary treats the items listed above.

# Topic #1: Definition of frequency ranges and bands

Under this topic RAN4 will discuss how to define frequency ranges and bands for 6G.

## Companies’ contributions summary

See R4-2514511 for company contributions and summary of these

## 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 MHzNOTE: 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 is further discussed during the RAN4 meeting.

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

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

* Proposals
	+ Option 1: RAN4 shall define separate frequency ranges for TN and NTN for 6G
	+ Option 2: RAN4 shall define the same frequency ranges for TN and NTN for 6G

**Online Discussion:**

Samsung: too early to decide between the two proposals

CMCC: same as Samsung. We can start with TN.

ZTE: decision can be pending on WRC27.

OPPO:prefer to option 2. In 6G we should avoid specify different SCS for the same band for NTN.

Xiaomi: FR defined in 5G is still useful in 6G. too early to decide between two options.

Ericsson: too early to decide. We should discuss and decide the FR for TN in 6G first.

Huawei: need to understand how the existing 5G approach works first and decide the potential enhancement next.

Vivo: too early to decide between options. Some of the discussion depends on the progress of system paramenter discussion.

MTK:support to study option 2.

LGE: too early to decide. Especially, we need to clarify how to define 7-24GHz first for TN.

Skyworks:5G FR may not be automatically assumed in 6G. Especially between 7 and 24, different UE may have different implementation in terms of digital and analog BF.

CATT: FR is just a term and may not be so critical. Also agree with skyworks’ comment.

Sony: need to revisit the necessity to continue defining the concept of FR in 6G.

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF
	+ RAN4 will initially focus the discussion on frequency ranges based on TN deployment.
		- This does not precluded considerations for alignment with NTN deployment being used as a criterion for the frequency ranges.

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

**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

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF
	+ RAN4 acknowledge that a definition of frequency ranges depends on multiple criteria’s which may have different importance dependent on individual company views. As a starting point the following can be listed, not precluding companies to also consider others:
		- Regulatory framework
		- UE RF front-end architecture (e.g. whether antenna connector available or not)
		- Commonality of UE RF/RRM requirements
		- Numerology dependency
		- Unification of TN and NTN operation
	+ RAN4 will not discuss the individual criteria’s further but leave it to companies to take what they deem important into account for proposals on a frequency range definition(s).

**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(Huawei, CMCC)
		- Option 1a: Extended existing NR FR1 and FR2 without overlapping frequency(samsung)
			* No new frequency range designation between extended FR1 and FR2
		- Option 1b: Extended existing NR FR1 and FR2 with overlapping frequency (Xiaomi, skyworks)
			* No new frequency range designation for 7.125-24.25GHz
	+ Option 2: Define a new frequency range for the 7.125 – 24.25 GHz and keep the current FR1 and FR2-1 definitions(vivo)
	+ Option 3: Extend FR1, define a new frequency range and keep FR2-1 definitions.(vivo,CMCC,charter, MTK,samsung)
	+ 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 (ZTE,CATT,CTC)
	+ Option 7: Extend existing NR FR1 and FR2 to cover partial part of 7.124-24GHz (Xiaomi,Huawei,Ericsson,CMCC)
		- New frequency range designation for remaining part between extended FR1 and FR2

**Online Discussion:**

Xiaomi:the criteria to differentiate FR should be firstly aligned.

ZTE: extension to 7-24 is subject to ITU decision.

CATT:need to identify the boundary between OTA and conducted

Ericsson: need to clarify the criteria for FR definition.

CTC: overly extending the FR1 range may have some impact on the existing FR1 band.

Vivo: conducted or OTA should be considered as one of the key criteria to define FR.

OPPO: need to clarify the criteria for FR definition. Up to 15GHz is considered based on ITU discussion. No new FR is needed

CMCC: prefer to extend FR1
LGE: conducted/OTA, antenna type should be used as the criteria to decide FR.

Apple:the criteria for FR definition should be aligned first.

MTK: support to extend FR1 to 8.4GHz. Between FR1 and FR2, different BF and architectures may need to be supported.

CHTR: up to 8.4GHz, conducted test is most likely.

Skyworks: to address the different implementation in terms of digital/analog BF, partial overlap between FR can be considered.

Samsung:prefer to extend FR1 to 8.4GHz

Interdigital: SAR vs. MPE can be another dimension when FR is defined. SAR stops at around 10GHz. We need to understand where MPE starts.

Nokia:companies have different views on the criteria. Suggest focus on the FR itself.

CAICT:need to define the criteria first.

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF
	+ Discuss down selection of options for frequency range split.
		- Note that the frequency range definition defined during the SI phase may be modified in a WI phase.
		- Note that even a band is under FR1, FR2 or a new frequency range there can still be both conducted and OTA requirements defined as done for some bands currently.
* Note that a Power Point have been provided illustrating all the options. An Option 8 has been added based on clarification from companies on their proposals and what the FL finds may be common ground for most.

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

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

Different companies have 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.

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF
	+ RAN4 encourage companies to be precise when referring to proposed frequency ranges by only using defined NR ranges as FR1, FR2-1 or FR2-2 or write the definition with frequency point(s) when referring to a proposal.
		- Note this is not related to the discussion of a band around 7 and 15 GHz

**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”.

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF
	+ Postpone the discussion on naming for frequency ranges in 6G to after an agreement on whether and how they are defined.

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

**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

**Online Discussion:**

Qualcomm: need more time

Xiaomi: band number is still needed. How to simplify the band combination framework can be further discussed.

ZTE: foresee potential issue with option 1.

OPPO: Regarding the existing 5G spectrum, 6G band number is preferred. For new 6G spectrum, it can further discussion.

Huawei:option 1 is too liberal to be decided now.

MTK:prefix for 6G can be further decided.

Samsung: support option 2.

Nokia:option 2 is based on the existing mature approach.

* **Agreement:**
* RAN4 shall re-use the prefix concept from NR for 6G
	+ Note: this agreement has no implication or limitation on the RAN1 and potential RAN4 discussion of UL and DL decoupling.

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF
	+ Postpone the discussion on naming for the prefix of the 6G bands to next meeting to allow companies to consider their view.

**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



**Online Discussion:**

Ericsson/TMUS: confusion can be caused by the number misalignment.

Xiaomi:clarification on the proposal is needed.

TMUS: it is possible to consolidate the bands.

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF
	+ RAN4 will reuse the number range used for bands defined in NR for 6G bands. It will be further discussed whether there are reservations on band numbers for refarming from NR to 6G and if the number ranges are to follow same division as used in LTE/NR

# Topic #2: Band combination definition and simplification

Under this topic, RAN4 will discuss how to define band combinations and simplify these in 6G.

## Companies’ contributions summary

See R4-2514511 for company contributions and summary of these

## 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.

Since the topic of spectrum aggregation methods for 6G is discussed under agenda 8.4, this will not be addressed under this topic. Only, aspects to band combination simplification in the sense of the procedures etc. around this is treated under this topic

The aspects of combination simplification have also been 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))

### 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.

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 shall discuss the mechanism for different types of spectrum aggregation under the 6G general RF and UE RF agenda

### 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

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 will consider the listed options, not precluding others, and continue discussion at next meeting.

### 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

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 will consider the listed options, not precluding others, and continue discussion at next meeting.

### 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

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 will consider the listed options, not precluding others, and continue discussion at next meeting.

### 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.

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 shall discuss ∆TIB under the 6G general RF and UE RF agenda

**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.

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 shall discuss ∆RIB under the 6G general RF and UE RF agenda

### 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.

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 shall discuss REFSENS exceptions (MSD) under the 6G general RF and UE RF agenda

### 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

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 will consider the listed options, not precluding others, and continue discussion at next meeting.

**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)

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 will consider the listed options, not precluding others, and continue discussion at next meeting.

# Topic #3: Spectrum related regulatory survey

Under this topic, RAN4 will discuss spectrum related regulatory topics for 6G.

## Companies’ contributions summary

See R4-2514511 for company contributions and summary of these

## 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

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 will consider the listed options, not precluding others, and continue discussion at next meeting.

### 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

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 shall discuss SAR/PD(power density) under the 6G general RF and UE RF agenda

### 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).

**Ad-hoc Discussion:**

The FL proposed WF for discussion during the ad-hoc:

* Recommended WF:
	+ RAN4 shall discuss Micro-Cells deployment under the 6G BS RF and co-existence agenda