**3GPP TSG RAN WG1#105-e R1-21nnnnn**

**e-Meeting, May 10th – 27th, 2021**

**Agenda Item: 8.2.7**

**Source: Moderator (Lenovo)**

**Title:** **Draft discussion [105-e-NR-52-71GHz-05] on analysis or recommendation to RAN#92e (June) on how to introduce the 52.6-71GHz frequency range**

**Document for: Discussion, Decision**

# Introduction

During the WID revision discussion in RAN#91e, one aspect has been the definition of the frequency range 52.6-71GHz in the specifications. Companies have different views on whether to e.g. define a new frequency range (FR3) or extend FR2. The conclusion was that “RAN1, RAN2 and RAN4 are asked to provide its analysis or recommendation to RAN#92E (June) on how to introduce the 52.6-71GHz frequency range.”

Therefore, an additional thread for AI 8.2.7 has been assigned as follows.

[105-e-NR-52-71GHz-05] Email discussion/approval focusing on analysis or recommendation to RAN#92e (June) on how to introduce the 52.6-71GHz frequency range with checkpoints for agreements on May 25, May 27 – Alex (Lenovo)

# Discussion

FL NOTE: Excerpts from submitted documents are listed in Section 3.

FL Observation: From the submitted documents, several companies propose to extend the FR2 definition to include 52.6-71 GHz. At the same time, several companies point out that such an extension of FR2 should not be adopted. Overall, there seems to be benefits and drawbacks for any of the suggested notations.

Potential options:

* Extend FR2 to cover the whole frequency range 24.25 - 71 GHz (no new notations)
* Introduce a new notation for the new frequency range 52.6 - 71 GHz, and keep FR2 to denote 24.25 – 52.6 GHz.
* Introduce a new notation for the new frequency range 52.6 - 71 GHz, and extend FR2 to denote 24.25 – 71 GHz.
* Introduce new notations for each of 24.25 - 52.6 GHz and 52.6 - 71 GHz, and extend FR2 to denote 24.25 – 71 GHz.

FL Suggestion: Discuss a possible set of conclusions observations that reflect the views established in RAN1, and inform RAN plenary and other RAN working groups accordingly.

## Specification Impact in RAN1

Do you agree on the following:

Proposed Conclusion 1: Regarding the impact on RAN1 specifications, there are only relatively small differences between potential options.

### First round discussion

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| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional Comment** |
| Intel | Agree | It should be good to also mention that specification changes in RAN1 are manageable. |
| Qualcomm | Agree |  |
| vivo | Agree |  |
| Samsung | Agree |  |
| Futurewei | Agree |  |
| AT&T | Agree |  |
| Ericsson | Agree | The reason why the impact is limited is that the RAN1 specification have relatively few references to FR2. |
| Apple | Agree |  |
| Nokia | Agree |  |
| InterDigital | Agree |  |
| Charter | Agree |  |
| LG Electronics | Agree |  |
| CATT | Agree |  |
| ZTE | Agree |  |
| DOCOMO | Agree  |  |
| MediaTek | Agree |  |
| Huawei, HiSilicon | Agree |  |
| OPPO | Agree |  |
| Lenovo, Motorola Mobility | Agree |  |

**FL Summary:**

**The GTW session on 21 May 2021 arrived at the following:**

Conclusion:

Regarding the impact on specifications maintained by RAN1, there are only relatively small differences between potential options.

## Leave decision to other WGs/Plenary

Do you agree on the following:

Proposed Conclusion 2: RAN1 can adapt to other groups' decisions on the notation for 52.6-71 GHz.

### First round discussion

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional Comment** |
| Intel | Agree |  |
| Qualcomm | Agree | We expect the impact to RAN4 is more substantial |
| vivo | Agree |  |
| Samsung | Agree |  |
| Futurewei | Agree |  |
| AT&T | Agree |  |
| Ericsson | Agree | Agree with Qualcomm that RAN4 is more critical for this decision |
| Apple | Agree | We also agree that the decision has a greater impact on RAN4. |
| Nokia | Agree |  |
| InterDigital | Agree | We also agree that this decision is more critical to RAN4, but we don’t agree to leave the decision to RAN as RAN already agreed to leave the decision to the working groups.  |
| Charter | Agree |  |
| LG Electronics | Agree |  |
| CATT | Agree |  |
| ZTE | Agree |  |
| DOCOMO | Agree |  |
| MediaTek | Agree |  |
| Huawei, HiSilicon | Agree |  |
| OPPO | Agree |  |
| Lenovo, Motorola Mobility | Agree |  |

**FL Summary:**

**The GTW session on 21 May 2021 arrived at the following:**

Conclusion:

RAN1 can adapt to other groups' preferences on the notation for 52.6-71 GHz.

## Recommendations on notation from RAN1's perspective

Do you agree on the following:

Proposed Conclusion 3: From RAN1's perspective, the FR notation should allow an easy distinction between features, capabilities and other characteristics in the specifications that apply specifically to:

* 24.25-52.6 GHz (NOTE: this is the current definition of FR2)
* 52.6-71 GHz
* 24.25-71 GHz

### First round discussion

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional Comment** |
| Intel | Agree | If such distinction is possible, this would be preferrable. However, if RAN2/4 decisions do not have specific qualifying notation, we believe RAN1 could still work with this.One example of such case is TS38.213 Section 4, where RAN1 specification directly discussed frequencies. So directly having frequency ranges applied to features is not new.So while we are supportive and it is good to have, we don’t think this is absolutely necessarily from RAN1 perspective. |
| Qualcomm | Agree | There are many locations FR2 is mentioned in RAN1 spec. We expect some of these locations, the spec applies equally to the new 52.5-71GHz range, but some locations, we may need distinction. Even though we prefer the alternative the extend current FR2 to cover up to 71GHz, introduce some sub-categories may help to reduce the RAN1 spec impact |
| vivo | Agree | We’d like to echo the comment from Qualcomm as we see benefits to distinguish bands from existing FR2.Furthermore, wondering if RAN1 can mention the motivation (i.e. benefits) to allow easy distinction of bands as the recommendation to RAN plenary and other WG groups. |
| Samsung | Agree | If other WGs didn’t see the need for further distinguishing the frequency range, RAN1 can still come up with solutions within RAN1 specifications (e.g. up to Editors) without explicit distinguishing.  |
| Futurewei | Agree | Adding categories and sub-categories is beneficial as Qualcomm suggested. |
| AT&T | Agree | Prefer to have FR2 refer to the entire frequency range 24.25-71GHz. Utilization of specific sub-categories within FR2 (e.g. FR2-1, FR2-2, etc.) to provide distinction could be introduced to help reduce RAN1 spec impact. |
| Ericsson | Disagree | Since the WID states to leverage FR2 to the extent possible, we envision little need to do such distinction in the RAN1 specifications since most FR2 functionality will apply to the full frequency range. Specific functionality to the extended range can be tied to the frequency band, similar to SSB patterns in Rel-15. Hence, we think FR2 should be extended to the full frequency range and see no need to for sub-labels. |
| Apple | Agree | We think this is quite important for the UE features and capabilities.  |
| Nokia | Agree | We can further discuss which of the frequency ranges listed above will be assigned the label FR2, but the most important issue is to allow the specifications to refer to those sub-ranges whenever needed, for example regarding UE features and capabilities.  |
| InterDigital | Agree | We do see benefits by distinguishing the frequency range especially for UE features and capabilities.  |
| Charter | Agree | It can be helpful in decision making if companies could list the features, capabilities and characteristics that benefit from such distinction from RAN1’s perspective. |
| LG Electronics | Agree | We agree that an easy distinction, if possible, may be helpful to RAN1 work especially UE features and capabilities. However, we don’t think new FR notation is the only way to such distinction. As Intel and Ericsson already said, another methods can be considered to make such distinction and RAN1 can live well without any new FR notation. We agree with Intel that such distinction is not absolutely necessarily from RAN1 perspective. |
| CATT | Agree in the principle  | Not sure the third sub-bullet (24.25~71) is needed if the first two already have distinction.  |
| ZTE | Agree | We think it is beneficial to distinguish the frequency range for the features that are different from the existing FR2. However, we also agree that RAN1 could still deal with this if the final decision is not to have specific qualifying notation. |
| DOCOMO | Neutral | Although we are not so sure if sub-labelling of FR could be the only solution since it may result in the same disadvantage as new FR notation introduction, we agree the issue raised by Qualcomm. As Samsung mentioned, this solution can be WG-specific. So not sure if we can “recommend” it to RAN.  |
| MediaTek | Agree in the principle | We support that at least 24.25-52.6 GHz(legacy FR2) and 52.6-71 GHz should have clear distinguishable notions to serve the purpose of specifying some procedures or UE feature applied to only one of the frequency ranges. Regarding the range 24.25 GHz-71GHz, it has benefit to have a notion for this range but the range can simply be represented by FR2+the notation for 52.6-71 GHz in RAN1 specification. We also don’t prefer to change the definition of “FR2” to avoid confusion across Releases and other literatures which use FR2 for the range 24.25-52.6 GHz. |
| Huawei, HiSilicon | Disagree | While it might be convenient to distinguish sub-ranges of 24.25-71 GHz for UE capability differentiation, when FR differentiation was not sufficient in the past then the UE capability was simply defined “per band” instead of “per UE with FR differentiation”. So we agree with others who commented that a FR notation specific for 52.6-71 GHz is not the only solution. It might be equally feasible to differentiate the UE capability based on SCS, since 480 kHz and 960 kHz will only be supported in 52.6-71 GHz. For 120 kHz SCS all FR2 features should extend to 71 GHz, and if FR2 is extended to 71 GHz then there is no need to redefine those UE capabilities. Which bands a UE supports in 52.6-71 GHz is anyway separately reported. That being said, we are not against stating the possible benefits of a specific notation for 52.6-71 GHz from RAN1 perspective, e.g. in terms of simplifying L1 capability differentiation. But we don’t think this is a requirement (“should”) for the decision on the FR notation for 52.6-71 GHz. |
| OPPO | Agree in principle | We support that the FR notation should allow an easy distinction between features, capabilities and other characteristics, and we think the first two bullets are clear enough to cover the range of 24.25-71GHz while the third bullet is not needed. |
| Lenovo, Motorola Mobility | Agree | We agree that it is beneficial to distinguish the frequency range based on essential features that are different across different ranges. FR distinction is probably a simple way to do that. Therefore, for 52.6 – 71 GHz, a different frequency range terminology is slightly preferred.  |

**FL Summary:**

**Continue with a 2nd discussion round to arrive at an agreeable conclusion.**

### Second round discussion

Do you agree on the following:

Proposed Conclusion 3a:

From RAN1's perspective, an easy distinction between features, capabilities and other characteristics in the specifications that apply specifically to the following ranges may be useful:

* 24.25-52.6 GHz (NOTE: this is the current definition of FR2)
* 52.6-71 GHz
* 24.25-71 GHz

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| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional Comment** |
| Samsung | Agree | A note could be added for clarification: Note: the distinction may not have to rely on different frequency range definitions.  |
| LG Electronics | Agree | Adding a note suggested by Samsung is also fine |
| Lenovo, Motorola Mobility | Agree | Fine with the note suggested by Samsung |
| Intel | Agree | Also ok with Samsung’s note |
| vivo | Prefer different wording | We prefer “is beneficial and useful” instead of “may be useful”. |

## UE capabilities and their applicability to the frequency range from 52.6 to 71 GHz

Do you agree on the following:

Proposed Conclusion 4: Regardless of if the frequency range 52.6 to 71 GHz is an extension of FR2 or a new FR, the related UE capabilities and their applicability to the frequency range 52.6 to 71 GHz will have to be analyzed

### First round discussion

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional Comment** |
| Intel | Agree |  |
| Qualcomm | Agree | Case by case investigation is needed. Most of the features are per band already.  |
| Vivo | Agree |  |
| Samsung | Agree |  |
| Futurewei | Agree |  |
| AT&T | Agree |  |
| Ericsson | Agree |  |
| Apple | Agree |  |
| Nokia | Agree | Case by case investigation is needed. Even for features that are per band one needs to check whether there are limits that apply jointly for all reported bands within (current) FR2.  |
| InterDigital | Agree |  |
| Charter | Agree |  |
| LG Electronics | Agree |  |
| CATT | Agree |  |
| ZTE | Agree |  |
| DOCOMO | Agree | Agree to have case-by-case study.  |
| MediaTek | Agree | Agree to have case by case study. |
| Huawei, HiSilicon | Agree |  |
| OPPO | Agree |  |
| Lenovo, Motorola Mobility | Agree |  |

**FL Summary:**

**The GTW session on 21 May 2021 arrived at the following:**

Conclusion:

Regardless of if the frequency range 52.6 to 71 GHz is an extension of FR2 or a new FR, the related UE capabilities and their applicability to the frequency range 52.6 to 71 GHz will have to be analyzed on a case by case basis

FL NOTE: If you feel that any other conclusion or observation should be agreed in RAN1, please add these hereunder with a corresponding suggested wording and discussion section.

## [TO BE ADDED]

Do you agree on the following:

[TO BE ADDED]

### First round discussion

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional Comment** |
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# Contribution Details

The following sections show extracted discussion and proposals from the contributions submitted to AI 8.2.7 traeting the frequency range definition from RAN1's perspective.

### R1-2104352 (vivo)

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| Several approaches can be taken for bands in the 52.6-71GHz frequency range which are not defined in existing FR2. One possible approach is to introduce a new frequency range (e.g. FR3), which will require introduction of new RF specification(s). An alternative approach is to extend the existing FR2 to cover 52.6 – 71GHz range, which would require an update of all FR2 relevant specifications. During RAN#91e plenary meeting discussion [2], a variation of the latter approach was proposed: extending the exiting FR2 to cover 24.25 - 71 GHz, and introducing FR2a for 24.25 - 52.6GHz and FR2b for 52.6 - 71GHz.- Alt.1: Keep the existing FR2 for 24.25 - 52.6 GHz, and introduce FR3 for 52.6-71 GHz;- Alt.2: Extend the existing FR2 for 24.25 - 71 GHz;- Alt.3: Extend the exiting FR2 to cover 24.25~71 GHz, and introduce FR2a for 24.25 - 52.6GHz and FR2b for 52.6 - 71GHz.As reviewed in the above sections 2.1 and 2.2, if we were to extend FR2 to include bands in the 52.6-71GHz frequency range, it is obvious that operating bands in the 52.6-71GHz frequency range will be defined with different and new SCS for data and potentially SSB comparing to all the existing operating bands in current FR2. It is expected that operating bands in the 52.6-71GHz frequency range will have much more commonalities among their own rather than to share common things with operating bands in existing FR2. To us, the convention to include bands in the 52.6-71GHz frequency range to FR2 may cause potential confusion as the SCS/bandwidth supported in the 52.6-71GHz frequency range shall not be assumed for bands in exiting FR2. **Observation 1: include bands in the 52.6-71GHz frequency range to existing FR2 may cause potential confusion as the SCS/bandwidth supported in the 52.6-71GHz frequency range shall not be assumed for bands in exiting FR2.** Besides the SCS/bandwidth, when looking at RAN1 specifications, there are other aspects which need design differentiation between different frequency ranges, e.g. Point A definition (Section 4.4.4.2 in [4]), RO configuration (Section 6.3.3.2 in [4]), Cell search (Section 4.1 in [5]), Type 0 PDCCH (Section 13 in [5]) and etc. Most of these aspects are related to initial access design which is most likely different with that in FR2 as discussed in our companion contribution [6]. If FR2 were extended to include 52.6-71GHz, the design needs to be differentiated by band number within the same frequency range, which means RAN1 specifications need to mention specific band instead of frequency range. It is possible to avoid the above-mentioned confusion by adding notes/clarifications to all FR2 relevant specifications whenever features supported by bands in the 52.6-71GHz frequency range do not apply to other bands below 52.6 GHz in FR2. As discussed above, for example, design for initial access can be differentiated by band number within the same frequency range, which means RAN1 specifications need to mention specific band instead of frequency range. However, this seems not a right way to go since it changes current specification writing style and introduce more dependency between different RAN groups. Furthermore, it requires a tremendous effort updating all FR2 relevant specifications. In general, from RAN1 specification perspective, we feel defining a new frequency range (e.g. FR3 as in Alt. 1 or FR2b as in Alt.3) for bands in the 52.6 – 71GHz range would lead to a clear naming convention: Proposal 1: it is preferred to introduce a new (or sub-) frequency range (e.g. FR3 or FR2b if extending FR2 to cover up to 71 GHz) for bands in 52.6-71GHz from RAN1 perspective. However, as we reviewed and discussed in section 2.1, there’re likely more impact to RAN4’s specification rather than to RAN1’s part. We think the decision at RAN plenary meeting may take more consideration on RAN4’s recommendation.  |

### R1-2104456 (Nokia, Nokia Shanghai Bell)

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| From the above observations, both just extending FR2 frequency definition and introducing FR3 would have pros and cons with conflicting impacts to each of the WGs. Hence, instead of a just selecting between extension of FR2 or FR3, we need rather to focus on finding ways to address foreseeable issues that might arise. For instance, we may be able to find a middle ground combining both approaches. That means that the existing FR2 definition and its specification can be extended up to 71GHz while we newly define a new frequency range of 52.6 - 71 GHz as part of FR2. Another example would follow what has been done in FR1 when we extended FR1 frequency range from 6 to 7.15GHz as well as introduced a new Clause suffix, that is “Shared spectrum channel access”. When looking for such compromise approach, it is useful to consider what kind of relationship is expected between the existing FR2 and the upcoming functionalities and requirements for frequency range of 52.6 - 71 GHz. For the sake of discussion, henceforth we will refer to the frequency range of 52.6 - 71 GHz as FR2x. Tables 1-3 below describe the possible options on how to treat the relationship between FR2x and existing FR2.Table 1: Option 1 for definition of frequency ranges

|  |  |
| --- | --- |
| Frequency range designation | Corresponding frequency range  |
| FR1 | 410 MHz – 7125 MHz |
| FR2 | 24250 MHz – 71000 MHz |
| FR2x | 52600 MHz – 71000MHz |
| [Or NOTE: FR2x is defined as 52600 MHz – 71000MHz as sub-frequency range of FR2.] |

Table 2: Option 2 for definition of frequency ranges

|  |  |
| --- | --- |
| Frequency range designation | Corresponding frequency range  |
| FR1 | 410 MHz – 7125 MHz |
| FR2-part1 | 24250 MHz – 52600 MHz |
| FR2-part2 | 52600 MHz – 71000 MHz |
| FR2 | 24250 MHz – 71000MHz |

Table 3: Option 3 for definition of frequency ranges

|  |  |
| --- | --- |
| Frequency range designation | Corresponding frequency range  |
| FR1 | 410 MHz – 7125 MHz |
| FR2 | 24250 MHz – 52600 MHz |
| FR2x | 52600 MHz – 71000MHz |
| NOTE: 38.101-2 covers both FR2 and FR2x |

Table 2: Option 4 for definition of frequency ranges

|  |  |
| --- | --- |
| Frequency range designation | Corresponding frequency range  |
| FR1 | 410 MHz – 7125 MHz |
| FR2 | 24250 MHz – 52600 MHz |
| FR2x | 52600 MHz – 71000 MHz |
| FR2-comb | 24250 MHz – 71000MHz |
| NOTE: 38.101-2 covers both FR2 and FR2x |

Some comments regarding the different options:* **Option 1:**
	+ Pros: works well in case majority of features, procedures, and requirements are expected to be the same for current FR2 and FR2x.
	+ Cons: it will require significant work on noting the exceptions for FR2x if significant differences arise.
* **Option 2:**
	+ Pros: clean separation of the existing FR2 and FR2x, still maintaining the possibility of using the FR2 label to address the common aspects.
	+ Cons: it requires modification of all current specifications to replace FR2 with FR2-part1 before it can be implemented. It can create conflict with non-3GPP product documentation that refers to FR2 already.
* **Option 3:**
	+ Pros: clean separation of the existing FR2 and FR2x.
	+ Cons: no label to identify the full range available, hence specification may contain several references as “(…) for FR2 and FR2x (…)”.
* **Option 4:**
	+ Pros: clean separation of the existing FR2 and FR2x, still maintaining the possibility of using a single label to address the common aspects. Requires special handling only to existing FR2 features that are applicable to the whole frequency range from 24250 MHz – 71000 MHz.
	+ Cons: requires definition of two new labels to identify FR2x and the whole FR2+FR2x frequency range, respectively.

It is clear that Option 2 can cause significant work inside and outside 3GPP and it risks confusion, and hence it should not be pursued. As for the remaining options, the current work is still in initial stages in RAN1/2/4, and hence there is not enough information to answer with certainty which of the options is more appropriate. In that case it is more prudent to take a cautious approach where there is a clean separation of which aspects of the specification apply to legacy FR2 and new frequency range FR2x. In our view, Option 4 is the most suitable one, given that it provides means to identify all possible frequency ranges without causing ambiguity.**Proposal: RAN1 to further consider the recommendation to provide to RAN#92-e taking into account the pros and cons for the options listed above.** |

### R1-2104464 (Ericsson)

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| It should be emphasized that the WID already states that the design for the frequency range 52.6 to 71 GHz should leverage the already existing FR2 design. Hence the starting point should be that the FR2 functionality applies also to the frequency range of 52.6 to 71 GHz and any exceptions should be limited. Keeping the functionality the same in the full frequency range is also beneficial for the ecosystem.1. Based on the WID, the starting point is that the same functionality applies to FR2 and the frequency range of 52.6 to 71 GHz

In general, the RAN1 specification have been written in a frequency agnostic way and only when needed, different functionality was specified.Where different functionality has been specified, it has mainly to do with resource grid definitions, functionality related to initial access and NR-DC. This means that the impacted specifications are 38.211 and 38.213 with most differences found in the latter. Based on the goal to strive for commonality, it assumed that most FR2 functionality will also be applicable to the frequency range of 52.6 to 71 GHz.1. Most FR2 functionality will be applicable also to the frequency range of 52.6 to 71 GHz.

The main changes expected from frequency range 52.6 to 71 GHz are related to initial access and a way of distinguishing this new functionality is needed. However, creating a new FR just for this purpose has much wider implications, also to the RAN1 specifications. A better way is to tie the new functionality to the new band(s). For band-specific functionality, the RAN1 specification could specify the functionality, but which bands different functionality belongs to could be included in RAN4 specifications to keep the RAN1 specifications band agnostic. An already existing example of such is the SS Block pattern which are defined in 38.213, while the patterns that are appliable in a given band are given by 38.101-2 for FR2 (Table 5.4.3.3-1). 1. It needs to be possible to limit some new functionality as only applicable to the frequency range 52.6 to 71 GHz. Such limitations can be captured in RAN4 specifications and tied to the frequency band; defining a new FR is not warranted for this reason.

RAN1 has defined through the previous NR releases defined many UE capabilities, some of which are specific to FR2 or might contain FR-dependent signalling values. The discussion has been that if FR2 is extended, RAN1 needs to go through these to make sure they are applicable to the frequency range 52.6 to 71 GHz. However, this is a discussion that is needed anyway since even if the frequency range 52.6 to 71 GHz is a new FR, given that most of the functionality in this new FR will need to be inherited from FR2. The alternatives are then to discuss which features are not applicable for the new bands in FR2 or to discuss which features from FR2 that also apply to FR3. Hence, either way, this discussion needs to take place and should not decide whether FR2 is extended or a new FR is introduced. 1. Regardless of if the frequency range 52.6 to 71 GHz is an extension of FR2 or a new FR, the related UE capabilities and their applicability to the frequency range 52.6 to 71 GHz will have to be analyzed
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### R1-2104511 (CATT)

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| The study of supporting NR operation in 52.6-71 GHz in [1] triggers the enhancement of the physical layer design in extending the maximum system bandwidth with new 480 kHz and 960 kHz subcarrier spacing (SCS), initial access, PDCCH monitoring, PDSCH/PUSCH, PUCCH, beam management, and channel access schemes. The work would also depend on the frequency range specified for 52.6-71 GHz in the RAN specification, in particular, in RAN1 and RAN4 specifications. The support of new 480 kHz and 960 kHz SCS would trigger new specification works of SCS related issues. The additional enhancement of initial access, PDCCH monitoring, PDSCH/PUSCH, PUCCH, beam management and channel access defined in the objectives [2] would also require specification works to capture the agreements of each enhancement. NR has separated specifications to characterize the operation in different frequency range; they are radio frequency in frequency range 1 (FR1) and mm-wave in frequency range 2 (FR2). FR1 is based on the conductive radio characteristic. FR2 is based on radiated radio characteristic. FR1 and FR2 are defined as below and above 7 GHz respectively. Some specifications for FR1 and FR2 are set differently for different SCS. However, several RAN1 and RAN4 existing specifications [3], [4], [5], [6], and [7]had been specified individually for each frequency range in general. TS38.101 has partition the specification of UE radio characteristic of transmission and reception specific for FR1 ,FR2, and FR1-FR2 CA, and general as part 1, 2, 3, 4 in [4]. The UE procedures in receiving PDSCH and DL RS, such as PT-RS in [6] have dedicated specification for FR2. The requirements of measurements, mobility procedure, timing, radio link monitoring, SCell activation and interruption, link recovery, BWP switching latency, and TCI state switching in [3] are specified with separated values for FR1 and FR2. The BWP switching procedure, Type0-PDCCH CSS set, and timing delta of IAB node operation in [7] also had separated specifications for FR1 and FR2. Specifications are individually specified for FR1 and FR2 due to difference in the radio channel characteristic and its variation and the processing time at the UE/gNB. Different specifications for FR1 and FR2 are not only for basic NR feature from Rel-15 but also advance features in Rel-16, such as eMIMO, mobility enhancement, MR DC, and UE positioning. Since Rel-16 features had been captured in the specification, any Rel-17 feature should be specified based on the Rel-16 specification with additional enhancement. It implies that Rel-17 feature of extending NR operation to 71 GHz would support or be compatible with Rel-15 NSA and SA NR and all Rel-16 NR features. If frequency range 52.6-71 GHz is categorized as FR2, all Rel-16 specifications for FR2 could directly apply to it without any further study on Rel-15 NSA/SA NR and Rel-16 additional features. The specification works for extending NR operation to 71 GHz would only focus on those additional enhancements, such as larger maximum system BW, 480 kHz and 960 kHz SCS, etc.. However, companies during the email discussion in RAN#90-e support the new frequency range FR3 for the frequency range 52.6-71 GHz to distinct different radio characteristic and its variance and larger channel BW comparing to those in FR2. If frequency 52.6-71 GHz is specified as FR3, Rel-15 NSA and SA NR features and Rel-16 NR application/enhancement features would need to be specified one by one for FR3 since the characteristic of radio channel and system operation in FR3 is deemed to be different to those in FR2. Additional specifications in UE transmission and reception for FR3 and CA with FR3 needs to be created. The standardization works would increase exponentially to examinate whether each function and value in the specifications could apply to FR3 or require new specifications function and/or value. During the email discussion in RAN#91-e, there were proposals to have general functions and values specified for FR2 applied to FR3 directly as default. Applying functions and values specified for FR2 applied to FR3 is based on the assumption that the characteristics of radio channel variation and system operation in FR3 are similar to those of FR2. If the general function of FR2 and FR3 are similar, there is no reason to define them at different frequency range in the specification. **Proposal 1: Frequency range 52.6 – 71 GHz should be defined as extension of FR2. All functions and values in the existing specifications in FR2 could be directly applied to those for NR operation in 52.6-71 GHz.** |

### R1-2104837 (ZTE, Sanechips)

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| According to the analysis in Table 1, we can find the following observations.* If the features of 52.6~71 GHz are the same as the existing FR2, extending the existing FR2 to cover the new frequency range from 52.6~71 GHz has the least impact on RAN1 specs.
* However, due to not all features designed for 52.6-71 GHz are the same as the existing FR2, e.g. PRACH and reference SCSs, thus a new notation, e.g. FR3/FR2x/FR2b, is needed for defining the frequency range from 52.6~71 GHz to distinguish the existing FR2 and 52.6~71 GHz.
* Alt 1 and Alt 2 have the same impacts on RAN1 specs, which are simple and clear mainly brought by adding new words/sentences/sub-clauses for FR3/FR2x. But Alt 1/2 will cause some text redundancy in the RAN1 specs.
* For Alt 3, if FR2 and FR2x have same designs, the current FR2 in RAN1 specs could be replaced by term FR2-e. Otherwise, new values / descriptions for FR2x should be specified.
* For Alt 4, whether there are RAN1 spec impacts depends on whether FR2a and FR2b can share the same designs. If same designs are supported for FR2a and FR2b, there is no RAN1 spec impacts. Otherwise, specify FR2a (instead of FR2) and FR2b respectively. However, it should be noted that even though there is little RAN1 spec impacts if most designs are the same for FR2a and FR2b, it requires modification of all current specs to replace current FR2 with FR2a if FR2b and FR2a have different features.
* In fact, no matter which alternative is adopted, the impact on RAN1 specs is relatively small (as summarized in Table 2). Therefore, we think RAN plenary should mainly refer to RAN4's analysis/conclusion to make the final decision.

**Table 2: Comparison between four alternatives**

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| **Schemes** | **RAN1 spec impacts** |
| **Alt 1:** Maintain the existing FR2 for 24.25~52.6 GHz, and introduce FR3 for 52.6-71 GHz | Alt 1 and Alt 2 have the same impacts on RAN1 specs.FR3/FR2x for defining 52.6-71GHz need to be specifically described in all parts involving the frequency range in RAN1 specs, e.g. transition time of RX/TX, Point A, k\_ssb, SSB pattern, PRACH, UL PC, reference SCS configuration, BWP, etc., as analyzed in Table 1. |
| **Alt 2:** Maintain the existing FR2 for 24.25~52.6 GHz, and introduce FR2x for 52.6-71 GHz |
| **Alt 3:** Maintain the existing FR2 for 24.25~52.6 GHz, introduce FR2x for 52.6-71 GHz and FR2-e for 24.25~71 GHz | If FR2 and FR2x have same designs, the current FR2 in RAN1 specs could be replaced by term FR2-e. Otherwise, new values / descriptions for FR2x should be specified in RAN1 specs. |
| **Alt 4:**  Extend the exiting FR2 to cover 24.25~71 GHz, and introduce FR2a for 24.25~52.6GHz and FR2b for 52.6-71GHz.  | Whether there are spec impacts depends on whether FR2a and FR2b can share the same designs. If same designs are supported for FR2a and FR2b, there is no RAN1 spec impacts. Otherwise, specify FR2a and FR2b respectively. Some examples are given below.* At least in Point A, UL PC, and BWP in RAN1 specs, the description of FR2 can be reused for 52.6-71GHz.
* For PRACH and reference SCS configuration, some features of them should be specified for FR2a (instead of FR2) and FR2b respectively.
* For transition time of RX/TX, k\_ssb, and SSB pattern, whether the description of FR2 can be reused depends on Rel-17 final decision (i.e. if FR2a and FR2b can share the same design).
 |

**Observation 1: There are four options for defining the frequency range of 52.6-71 GHz. Among the options below, the impact on RAN1 specs is relatively small no matter which option is adopted.*** **Alt 1: Maintain the existing FR2 for 24.25~52.6 GHz, and introduce FR3 for 52.6-71 GHz;**
* **Alt 2: Maintain the existing FR2 for 24.25~52.6 GHz, and introduce FR2x for 52.6-71 GHz;**
* **Alt 3: Maintain the existing FR2 for 24.25~52.6 GHz, introduce FR2x for 52.6-71 GHz and FR2-e for 24.25~71 GHz;**
* **Alt 4: Extend the exiting FR2 to cover 24.25~71 GHz, and introduce FR2a for 24.25~52.6GHz and FR2b for 52.6-71GHz. The extended FR2 comprises FR2a and FR2b.**

**Proposal 1: RAN1 can adapt to other groups decision on FRx notation for 52-71 GHz. No critical dependency in RAN1.** |

### R1-2104898 (Intel)

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| Contribution submitted in last RAN Plenary meeting [1] highlights some aspects that would be affected by frequency range definition for NR operating in 52.6 GHz to 71 GHz. The following table is a more comprehensive list features that leverage FR1/FR2 differentiation in the RAN1 specifications.Table 1. List of RAN1 specification impact from any changes to frequency range definition or creation of new frequency range

|  |  |
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| **Specification Number** | **RAN1 Specification dependent on FR1/FR2 definition** |
| TS38.201 | None |
| TS38.202 | * DL reception type combination
 |
| TS38.211 | * Random access configuration
* Rx-Tx and Tx-Rx transition period
* OffsetToPointA unit
 |
| TS38.212 | None |
| TS38.213 | * cell search (including SSB pattern)
* power control (for dual connectivity)
* BWP switching in RA procedure
* BWP switching (in relation to bwp-InactivityTimer)
* Type0-PDCCH configuration in MIB
 |
| TS38.214 | * PDSCH and SI-PDSCH reception handling (when overlapped)
* TRS configuration
* PT-RS configuration
* PDSCH and PUSCH processing capability
* Resource allocation restrictions for UL (“almost” contiguous allocation)
 |
| TS38.215 | * Measurement reference point for RSRP/RSRQ/SINR/RSSI/RSTD/Rx-Tx Time Difference/RSARP/SSS Transmit Power
 |
| TS38.306, TS38.331(PHY UE capability) | * Several UE capabilities have FR1/FR2 differentiation.
* Several UE capabilities were intended for only FR1 or FR2.
 |

As you can see, other than the impact to UE capability, RAN1 specification impact from any changes to frequency range definition or creation of new frequency range is fairly small. Most issues are very localized and does not need correction that span different specification and/or sections within a specification. The number of issues is very limited. The majority of the problem is focused on UE capabilities as many UE capabilities are defined for specific frequency range and mandatory/optionality of some UE capabilities are dependent on frequency range.For generic capabilities that may be applicable for either FR1 and FR2, RAN1 need to perform the review and check whether we would like to enable support the capability to 52.6 GHz to 71 GHz. To our understanding the any change to existing definition of frequency range or creation of new frequency range, will require RAN1 and RAN2 to comb over all existing UE capabilities and update the specification accordingly. This work needs to be done regardless of which approach is taken for frequency range definition for 60 GHz band.There are set of capabilities that are dedicated for FR2, that require further check on whether capability should be applied or not. The following is a list of FR2 only capability currently supported in Rel-15 and Rel-16.* tdd-MPE-P-MPR-Reporting-r16
* beamCorrespondenceCSI-RS-based-r16
* beamCorrespondenceSSB-based-r16
* beamCorrespondenceWithoutUL-BeamSweeping
* beamSwitchTiming
* beamSwitchTiming-r16
* defaultQCL-PerCORESETPoolIndex-r16
* defaultQCL-TwoTCI-r16
* maxNumberRxTxBeamSwitchDL
* maxUplinkDutyCycle-FR2
* mpr-PowerBoost-FR2-r16
* pdsch-256QAM-FR2
* simultaneousReceptionDiffTypeD-r16
* spatialRelations
* spatialRelationsSRS-Pos-r16
* uplinkBeamManagement
* intraBandFreqSeparationDL, intraBandFreqSeparationDL-v1620
* intraBandFreqSeparationDL-Only-r16
* timeDurationForQCL
* type1-3-CSS
* intraBandFreqSeparationUL, intraBandFreqSeparationUL-v1620
* defaultSpatialRelationPathlossRS-r16
* maxNumberSRS-PosSpatialRelationsAllServingCells-r16
* pCell-FR2
* pdsch-RE-MappingFR2-PerSymbol/pdsch-RE-MappingFR2-PerSlot
* simultaneousSpatialRelationMultipleCC-r16
* spatialRelationUpdateAP-SRS-r16

While there is a number of capabilities that require RAN1 check, the number of capabilities is still quite limited. Based on this we conclude that all RAN1 related impact including UE capabilities are quite limited in scope and number of issues is small and managable for RAN1. Therefore, we believe the amount of work that is needed for RAN1 is similar regardless of how frequency range definition is handled for 60GHz band.**Observation 1:** * Overall RAN1 specification impact from changes or creation of frequency range is minimal.
* Work needed in RAN1 to update specification is about the same regardless of approach taken to handle frequency range definition.

Base on this, we propose that RAN1 concludes specification impact for RAN1 is the same regardless of frequency range determination for frequencies between 52.6 GHz and 71 GHz. Furthermore, recommend that RAN4 determine the frequency range for frequencies between 52.6 GHz and 71GHz.**Proposal 1:** * RAN1 concludes specification impact for RAN1 is limited and the amount of effort needed to update the specification is the same regardless of how frequency range is determined for frequencies between 52.6 GHz and 71 GHz.
* RAN1 recommends that RAN4 determine the frequency range for frequencies between 52.6 GHz and 71 GHz.
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### R1-2105096 (Apple)

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| In this section, the pros and cons of different options are outlined

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|  | Pros | Cons |
| Option 1: extend FR2 to cover the new frequency range 52.6-71GHz | * Easy for spec maintenance if majority of existing FR2 requirements and features can be reused.
 | * It is difficult to handle the existing FR2 requirements which may not be extended to 52.6-71GHz. These include the Layer 1 UE features that are directed at FR2 only, Layer 1 UE features that have FR1/FR2 differentiation and parameters in the specifications (38.xxx) that have been hard-coded for FR2. Major revisions may be needed.
 |
| Option 2: introduce a new range, FR3, for the new frequency range 52.6-71GHz | * No impact on existing spec
* Flexibility to either reuse FR2 or introduce 60GHz-specific features and requirements
 | * Duplication is expected for the features and requirements which can be extended from the existing FR2 band
* Need to identify additional band differentiations including FR1/FR3, FR2/FR3, and FR1/FR2/FR3 in the Layer 1 UE features.
 |
| Option 3a: introduce a new FR2a and FR2b notation for 24.25-52.6GHz and 52.6-71GHz respectively | * Need editorial modification of existing specifications for FR2a.
* Flexibility to either reuse FR2 or introduce 60GHz-specific features and requirements
 | * Revisions are needed for the existing FR2 features and requirements which cannot be extended to FR2b. Those that can be extended will just be re-labelled.
 |
| Option 3b: keep FR2 notation for 24.25-52.6GHz and introduce a new notation FR2a notation for 52.6-71GHz | * No impact on existing spec
* Flexibility to either reuse FR2 or introduce 60GHz-specific features and requirements
 | * Need to define if FR2a is part of FR2. If yes, the issues with Option 1 may occur here. If no, issues of Option 2 apply.
 |

In general, options 3a and 3b seem to be a middle ground between the option 1 and 2 and there will need to be a detailed analysis of the UE layer 1 features which ever option is chosen. Options 2 and 3 allow for differentiation between the new band and existing FR2 band. Given the need for a decision on the negatives of option 3b, RAN1 should down-select to Option 2 and Option 3a for discussion. ***Proposal 1: it is proposed to narrow down the list of options to Option 2 and 3a for further discussion.*** ***Proposal 2: the following principles should be considered to define the frequency range of 52.6 GHz to 71 GHz**** ***Ensure flexibility to either reuse FR2 or introduce 60GHz-specific features and requirements***
* ***Ensure that Layer 1 UE features are considered***
* ***Minimize the need for a specifications update***

In addition to the Layer 1 UE features, in the RAN1 specification, a variety of concepts such as subcarrier spacing restrictions, timing, SSB pattern and offset, power control, MR-DC operation and SRS configuration are dependent on the band [10]. Some of these have parameters that have been hard-coded in the specifications and as such will need modifications especially if they are specific to the new band. In the following table, we refer to a few of them:Table 1: Summary of UE Features affected

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| Section | Details and Discussion |
| Section 4.4.4.2 of 38.211 | Defines Point A, the offset is expressed in units of resource blocks assuming 15 kHz subcarrier spacing for FR1 and 60 kHz subcarrier spacing for FR2. This will need to be adjusted |
| Section 4.3.2 of 38.211 | Defines a transition time (NRx-Tx and NTx-Rx) with a specific time for FR2. This also may need to be adjusted given the change in slot duration |
| Section 6.3.3.2, of 38.211 | Random access configurations specified for FR2 and unpaired spectrum in Table 6.3.3.2-4. Additional tables may need to be defined for the new band that differ from the existing parameters. |
| Section 4.1 of 38.213 | Defines cell search, patterns have been defined specifically for FR2. Given that additional SCSs and patterns are under discussion that may differ greatly from the existing FR2 patterns, a simple band extension may require multiple changes to the existing FR2 specification. |
| Section 7.6 of 38.213 | Defines power control for dual connectivity with band specific behavior |
| section 12 of 38.213 | Defines the bandwidth part inactivity timer for FR2 operation based on a half a subframe duration. Given that there may be a substantial change in this duration for higher sub-carrier spacings, there may be a need to revisit this number during the 60 GHz design. |
| Section 6.2 of 38.214 | Defines band specific SRS configurations  |

In summary, based on both the Layer 1 UE features and the RAN1 NR specifications, we see that a simple extension of FR2 to the new band may need to careful consideration before making any decisions. ***Observation 1: At least for the Layer 1 FR2 UE features, it may be not straightforward to reuse the FR2 choices for the frequency range from 52.6GHz to 71GHz******Observation 2: Multiple RAN1 specifications may need to be modified from hard-coded values to incorporate the new band.*** |

### R1-2105301 (Samsung)

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| From RAN1 perspective, the technical difference between using FR2 or a new FR to define 52.6 to 71 GHz is really limited, and the most impact is the specification writing. Considering the work of Rel-17 52.6 to 71 GHz uses FR2 as a baseline, the specification change can be minimized if reusing the same name of frequency range. It can be expected that, if a new frequency range is introduced, a corresponding change could be needed whenever the wording “FR2” shows up in the RAN1 specification, if such specification is also applicable to the new frequency range. This will cause lots of work from the editor point of view, and reusing the same name of frequency range seems the best way to avoid duplicated specification effort.Regarding the UE feature, we believe anyway all the features for Rel-17 52.6 to 71 GHz should be discussed again at the end of the WI, and reusing FR2 to define NR 52.6 to 71 GHz doesn’t imply all the UE features from FR2 will be automatically carried over to NR 52.6 to 71 GHz. In this sense, the impact is not essential. Meanwhile, as explained in our contribution to RAN#91e [1], the frequency range was introduced in the RAN4 specifications considering fundamentally whether conductive or OTA requirements is defined for different frequency bands, and introducing a new frequency range will cause tremendous amount of work in RAN4 and RAN5 specifications. Hence, we propose to reuse FR2 to define NR 52.6 to 71 GHz. ***Observation: The impact of defining NR 52.6 to 71 GHz to RAN1 is not as significant as the one to RAN4.*** **Proposal: From RAN1 perspective, we prefer to reuse FR2 for defining NR 52.6 to 71 GHz.**  |

### R1-2105424 (MediaTek)

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| First of all, from RAN1 perspective, Option 2, 3, and 4 all achieve a similar frequency range distinction between legacy FR2 frequency range and >52.6GHz. In particular, for Option 2, 3, and 4, the common part of specifications applied to <52.6GHz and >52.6GHz will be duplicated for each frequency range and the part of specification applied explicitly to only one frequency range can be easily managed by using different naming. The difference among Option 2, 3, and 4 might be whether <52.6GHz can reuse the FR2 naming or not, which seems to have minor specification impact compared to using other naming for <52.6GHz from RAN1 perspective.Observation 1: In terms of specification impact, Option 2, 3, and 4 have similar specification impact from RAN1 perspective. If the above observation is not aligned among companies, then a clarification should be made in RAN1.**Proposal 1: If Observation 1 is not the common understanding among companies, clarification for the difference among Option 2, 3, and 4 should be discussed in RAN1.** On the other hand, Option 1 has the advantage of handling the common part of specifications applied to <52.6GHz and >52.6GHz and less efforts on maintaining the specifications. However, for the part of specification applied explicitly to only one frequency range, Option1 needs some editorial efforts to distinguish these two frequency ranges.In our view, the specification impact of each option depends on the similarity and difference between <52.6GHz and >52.6GHz, which is difficult to foresee at this stage since many features introduced in >52.6GHz are not finalized yet. However, based on the discussion in RAN1 # 104bis-e meeting, RAN1 specification impact from different naming options seems to be relatively smaller than the RAN4 specification impact.Observation 2: In terms of specification impact, RAN1 has smaller specification impact compared to RAN4. In Rel-15/16, one discussion point on UE feature list is the dependence on FR1/FR2, i.e., the need of FR1/FR2 differentiation is specified for each UE feature. The same exercise should be performed again since the notion of FR2 might change depends on the naming options. In particular, for each UE feature introduced for legacy FR2 (and FR1, if applicable), RAN1 should discuss whether and how to support the UE feature for >52.6GHz with the acknowledgement of the discrepancy, e.g. new SCSs and larger bandwidth, between legacy FR2 and >52.6GHz. For example, mandatory PDCCH monitoring UE feature FG 3-1 assumes per slot monitoring, which is not the consensus for the basic PDCCH monitoring feature for >52.6GHz when 480/960 kHz are configured. In fact, the applicability of many UE features for legacy FR2 have been discussed in this WI, e.g., maxNumberRxTxBeamSwitch, timeDurationForQCL, etc., and the same discussion should be considered for every UE feature when determining the UE feature list applied for >52.6GHz, regardless of which naming option is adopted. With this principle, Option 1 seems to cause more concerns and confusion when a UE feature is only applied to >52.6GHz or only applied to legacy FR2. Moreover, if Option1 is adopted, it might cause confusion that all the features introduced for >52.6GHz are also supported for <52.6GHz if FR2 notion is the only labelling to use. **Proposal 2: Regardless of which naming option is adopted for >52.6 GHz, to consider an existing FR1/FR2 UE feature for >52.6GHz, it should be discussed whether and how to support the feature for >52.6GHz.** **Proposal 3: Regardless of which naming option is adopted for >52.6 GHz, each UE feature introduced for operations in >52.6GHz should not be assumed to be supported in <52.6GHz.**  |

### R1-2105424 (LG)

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| Before selecting one from above lists, it is necessary to analyse how much impacts there are on the existing RAN1 specification. In the last RAN1 meeting, several companies have well enumerated the parts that need to be checked among the existing RAN1 specifications. Some of them may be simple works such as adding parameters for the newly introduced SCSs (e.g., unit of offsetToPointA), and other parts may require somewhat complicated changes related to the newly introduced operations (e.g., multi-PDSCH scheduling). However, overall there are not many, and all issues seem to be localized. In terms of UE feature/capability, we should also look at the impact of FR definition. If most UE features/capabilities defined for the current FR2 frequency range (i.e., <52.6 GHz) can be applied directly to a new frequency range (i.e., >52.6 GHz), the Alt 1 series would be a good choice because they necessitate less specification work than Alt 2 series. However, for the Alt 2 series, it may require additional work of redundant documentation. For the opposite case, i.e., when the UE features/capabilities cannot be applied directly to a new frequency range, they must be described separately for the new frequency range, however, the amount of specification work seems to be the same regardless of Alt 1 or Alt 2 series.One more aspect to be considered is that whenever a new frequency range is added, similar issues may have to be discussed. For example, if a frequency range above 71 GHz is introduced into NR in the future, it may be necessary to determine the FR definition suitable for that frequency range. Considering these aspects, we believe that extending FR2 to cover the frequency range 52.6-71 GHz will be an easy way to introduce the frequency range 52.6-71 GHz and introducing the new FR definition/notation (e.g., FR3) should be prudent.**Proposal #1: Extend FR2 to cover the frequency range 52.6-71 GHz.**Meanwhile, most features and procedures in the frequency range 52.6-71 GHz are still under discussion. Depending on the results of the discussion, it may be necessary to explicitly separate the operation of the new frequency range from the operation of the existing FR2 frequency range. So, while Alt 1-1 is the most straightforward way, in some cases Alt 1-2 or Alt 1-3 may be more useful. Therefore, we propose to narrow down the alternatives to the Alt 1 series (i.e., Alt 1-1, Alt 1-2 and Alt 1-3).**Proposal #2: Down-select to one of the following alternatives that cover the 52.6-71 GHz frequency range by extending the FR2.*** + **Alt 1-1: FR2 (24.25-71 GHz) without introducing new FR definition/notation**
	+ **Alt 1-2: FR2 (24.25-71 GHz) with FR2x (52.6-71 GHz)**
	+ **Alt 1-3: FR2 (24.25-71 GHz) with FR2a (24.25-52.6 GHz) and FR2b (52.6-71 GHz)**
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### R1-2105533 (Huawei, HiSilicon)

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| The naming convention of TS 38.101-2, TS 38.101-3 and TS 38.141-2 directly refers to FR2 (and FR1), while other specification names are worded in a general way without frequency range indication. Based on the above observation where 38.101-2 and 38.101-3 will be reused to incorporate 52/6-71 GHz, “FR3” and a denomination like FR2x outside FR2 shall be ruled out from the discussions. RAN5 has been using the frequency sub-range designations of FR2a, FR2b and FR2c already, so reusing such designations should be ruled out. Referring to the RAN5 CR to TS38.521-2 (R5-210731), the following was already agreed for the MU and TT purposes:

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**Observation 1: the following options should be precluded:*** **Definition for 52.6-71 GHz outside FR2, such as FR3 or FRx (defined outside FR2)**
* **Denominations for 52.6-71 GHz such as FR2a or FR2b (already used in RAN5)**

This leaves 3 options for further discussion based on their specification impact:

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|  | **Denomination for 24250 – 71000 MHz** | **Denomination for 52600 – 71000 MHz** | **Notes** |
| **Option 1** | FR2 | FR2 | FR2 is defined as 24250 MHz – 71000MHz |
| **Option 2** | FR2.1 (or FR2-part1) | FR2.2 (or FR2-part2) | FR2 is defined as 24250 MHz – 71000MHz |
| **Option 3** | FR2 | FR2x | FR2 is defined as 24250 MHz – 71000MHz FR2x is defined as a sub-part of FR2 |

One obvious drawback of option 3 is that when referring to FR2, it would be unclear whether this refers to 24250-71000 MHz or 24250-71000MHz. Thus either option 1 or 2 seems preferable from a logical standpoint.One possible drawback of option 2 is that current references to FR2 may need to be updated to FR2.1. On the other hand, many such references may still apply to the entire new FR2 and thus may not actually need to be updated. Basically, current requirements for FR2 would extend up to 71 GHz, and additional requirements specific to FR2.2 would be introduced, with perhaps a few instances of FR2 needing to be changed to FR2.1.An example of the definition of the sub-ranges according to option 2 would be the following:

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| Frequency range designation | Corresponding frequency range  |
| FR1 | 410 MHz – 7125 MHz |
| FR2 | FR2.1: 24250 MHz – 52600 MHz |
| FR2.2: 52600 MHz – 71000 MHz |

Note also that RAN2 has concluded at its April 2021 meeting that:* RAN2 can adapt to other groups decision on FRx notation for 52-71 GHz. No critical dependency in RAN2.
* From RAN2 TS point of view the impact will be smaller if it is chosen to re-use FR2 for 52-71 GHz.

Dependencies on FR1 and FR2 in RAN1 specifications are as follows. Differences in RA configuration, transition time, SSB pattern, power control, CORESET#0 monitoring, single-slot TRS (Rel-15) are mostly originated from analog beamforming at both gNB and UE.

|  |  |
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| **RAN1 spec** | **FR1/FR2 differentiation** |
| **TS 38.211** | Random access configuration |
|  | Transition times RX🡪TX and TX🡪RX |
|  | OffsetToPointA unit |
| **TS 38.213** | SSB pattern and cell search |
|  | Power control aspects for dual connectivity |
|  | BWP switching in RA procedure |
|  | Actions related to bwp-InactivityTimer in BWP switching |
|  | Type0-PDCCH monitoring behaviour |
| **TS 38.214** | Different behaviour w.r.t. overlapping reception of unicast PDSCH and SI-PDSCH |
|  | In Rel-15, only FR2 supports TRS in single slot |
|  | PT-RS support is only optional for FR1 |
|  | PDSCH and PUSCH processing capability 2 is only defined for FR1 |
|  | FR1 supports almost contiguous allocation for UL CP-OFDM while FR2 does not |

In case of FR3 introduction, the differentiation would have to be extended to FR1/FR2/FR3 differentiation. This would be artificial since FR2 and FR3 would appear functionally equivalent from a RAN1 perspective. Therefore such complexity should preferably be avoided in RAN1 specifications.Specification impact related to the introduction of new features for 52.6 – 71 GHz, such as new SCS, would be applicable to RAN1 specifications irrespective of the selected naming convention (i.e. FR2 extension, or FR3 introduction). In case of extension of FR2 up to 71 GHz, the minimum impact on the RAN1 specifications for the new SCS would mostly consist of adding new values to already defined timelines such as transition times, switching times, and processing times. Other RAN1 impact from the WID (enhancements of PT-RS, PDCCH monitoring, PDSCH/PUSCH scheduling) are not dependent on extending FR2 or creating FR3.The introduction of new subcarrier spacing values of 480 kHz and 960 kHz will require changes to the specifications, and the support of the new SCS values is expected to apply only in 52.6-71 GHz. Some way to refer to these frequencies may be needed in the RAN1 specifications, or alternatively the limitations to the support of the new SCS values may just need to be defined in RAN4 band-specific definitions and requirements, similar to how the support of 15, 30, 60, 120 and 240 kHz SCS is already band-dependent. In this case, it would be sufficient in RAN1 specifications to define procedures directly linked to the new SCS values, and the relation to the supported frequencies comes from the RAN4 specifications only.Therefore, from RAN1 perspective, extension of FR2 is feasible and is preferable, and the precise denomination of the frequencies between 52.6 and 71 GHz may be left for decision at RAN plenary considering the input from all WGs, in particular from RAN4.***Observation 2: from RAN1 perspective, extension of FR2 or use of a new label (e.g. FR2x) within FR2 for 52.6-71 GHz would incur less specification impact than creating FR3 or introducing a new denomination for 52.6-71 GHz outside FR2. The introduction of 480 and 960 kHz SCS would mostly impact the value range of specific parameters (adding new values to already defined timelines such as transition times, switching times, and processing times), which can be handled by RAN1 under any of the options.******Proposal: send an LS to RAN plenary to provide the analysis and recommendation from RAN1 perspective:**** ***Extension of FR2 up to 71 GHz incurs less RAN1 specification impact than introducing FR3 or a new denomination for 52.6-71 GHz outside FR2 such as FR2x***
	+ ***A new denomination for sub-ranges of FR2 can be accommodated from the perspective of RAN1 specifications, while common requirements can continue referring to FR2***
* ***Specification impact for the introduction of 480 kHz and 960 kHz SCS is similar under all options***
* ***All features supported by 120 kHz SCS will remain supported and unchanged in 52.6-71 GHz***
* ***RAN1 recommendation is that 52.6-71 GHz becomes part of FR2***
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### R1-2105692 (NTT DOCOMO)

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| According to the guidance provided at RAN#91e, some RAN WGs, including RAN1, are asked to provide its analysis or recommendation to RAN#92e on how to introduce the 52.6 – 71 GHz frequency range. There are currently two frequency ranges in NR, i.e., FR1 and FR2, which are spanning from 410 MHz to 7.125 GHz and from 24.25 GHz to 52.6 GHz, respectively. For the 52.6 – 71 GHz, two potential approaches were discussed at the last RAN plenary: one is to extend FR2 to cover the new frequency range, and the other is to introduce a new notation. In our view, from RAN1 perspective, at least the relationship with UE features, especially the ones defined for FR2 only or defined per FR, should be considered. * If FR2 is extended to cover the 52.6 – 71 GHz, all the existing UE features defined for FR2 may also be applicable to 52.6 – 71 GHz by default. RAN1 would need to check if some of them are not applicable to the operation in 52.6 – 71 GHz, or if some of them require separate capabilities from existing ones. It may consume much time for the discussion in 3GPP if such discussion will happen for many of features currently defined for FR2. On the other hand, if large number of UE features currently defined for FR2 are also applicable to the 52.6 – 71 GHz without any further modifications, it could largely reduce the amount of effort required to introduce the 52.6 – 71 GHz to NR, and may achieve more efficient definition of UE features for 52.6 – 71 GHz.
* Else if a new notation is introduced to cover the 52.6 – 71 GHz, nothing can be reused from FR1 or FR2 by default. For UE features currently defined for FR2, every feature may need to be discussed/specified for the 52.6 – 71 GHz as new capabilities, which may also consume significant amount of time in 3GPP. However, it will not cause any changes on existing UE features defined for FR2, which may be safer than extending FR2 for the 52.6 – 71 GHz.

Considering above, whether to extend FR2 or to introduce a new notation depends on how many UE features currently defined for FR2 need to be separately defined for the NR operation in 52.6 – 71 GHz. **Observation 1**: *Whether FR2 is extended to cover 52.6 – 71 GHz or new frequency range is introduced to cover 52.6 – 71 GHz would impact to RAN1 work on defining UE features/capabilities for the NR operation in 52.6 – 71 GHz.* |

### R1-2105787 (Charter)

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| In our view, Options 1 and 3b can be eliminated from consideration. Option 3b can cause further confusion whether FR2a is a part of FR2 or not. In addition, Option 3b can fall into Option 2 or Option 3a depending on the exclusion or inclusion of FR2a from FR2, respectively. Option 1 seems infeasible since various enhancements are introduced for the frequency range 52.6-71GHz compared with the current FR2. One of the major changes from the RAN1 perspective is the introduction of the new subcarrier spacings (SCS) of 480 kHz and 960 kHz only for the 52.6-71GHz frequency range which is not supported in the existing FR2 band. With such a major difference, and also considering other enhancements and modifications introduced for the 52.6-71GHz frequency range, it is not possible to simply extend FR2 to cover this new frequency range.**Proposal 1: Only consider Options 2 and 3a for further evaluations.** Option 2 is a straightforward choice from the RAN1 perspective which provides flexibility to either reuse the current specs in FR2 for FR3 or introduce new FR3-specific requirements and functionalities. However, if a big portion of current specs in FR2 is expected to be duplicated for FR3, then, the complexities of adding FR3, e.g., RAN4 RF specifications, outweigh its benefits. Since various proposals are being evaluated for consideration in the frequency range 52.6-71GHz, it is not clear at this time how many enhancements/modifications will be introduced for FR3 compared to FR2. Option 3a, which defines FR2 as 24.25-71GHz, FR2a and FR2b subsets as 24.25-52.6GHz and 52.6-71GHz, respectively, provides a reasonable trade-off between duplicated and modified specs. By defining FR2 as 24.25-71GHz, all the common specs between the existing FR2 (24.25-52.6GHz) and the new range 52.6-71GHz remain unchanged and do not need to be repeated for the new range. The down side is a large volume of literature outside 3GPP that refers to the range 24.25-52.6 GHz as FR2, however, a change to the generic frequency name is not expected to affect product implementations since new NR bands will be introduced for 52.6-71 GHz. On the other hand, any enhancement or modification introduced for frequency range 52.6-71GHz can be differentiated from range 24.25-52.6GHz by using FR2a and FR2b notions. In addition, this option can alleviate possible RAN4 RF complications regarding TSs 38.101-1/2/3, by defining FR2 as 24.25-71GHz. This also facilitates the application of features introduced in 52.6-71 GHz to new shared spectrum bands such as 37 GHz.**Observation 1: Our views favor Option 3a over Option 2 for further evaluations. We believe Option 3a provides a good compromise between defining a new FR3 range or extending FR2 to 52.6-71GHz.** |