**3GPP TSG-RAN WG4 Meeting #102-e R4-22xxxxx**

**Electronic Meeting, 21 February – 3 March 2022**

**Agenda item:** 9.2

**Source:** Moderator (Apple Inc)

**Title:** Email discussion summary for [102-e][106] NR\_6GHz\_unlic\_full

**Document for:** Information

# Introduction

3GPP Rel-16 NR-U WI specified how the NR technology can be used on the unlicensed spectrum thus offering more resources in frequency bands, such as 5GHz and 6GHz. 5GHz is a well-known band for the unlicensed operation, but 6GHz is a relative new band usage of which was approved recently in different regulatory regions. While the 6GHz band for the US is already part of the Rel-16 core functionality, current 3GPP specifications do not support it for other countries, such as South Korea and Canada, which have finalised their regulatory requirements only recently. Thus, RAN#92 meeting approved a new WI aim of which is to enable support of the 6GHz unlicensed band for those countries and regions that have finalised recently the corresponding regulatory requirements.

# Topic #1: Introduction of operation in full unlicensed band 5925-7125MHz for NR

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2205562 | Nokia, Nokia Shanghai Bell | Proposal 1: Modify Note 14 in 38.101-1 to “This band is only applicable subject to regional and/or country specific restrictions”. |
| R4-2203661 | Apple | Proposal 1: Since it is already clarified that band n96 is the shared access band, we prefer adopting simplified wording such as "*This band is only applicable subject to regional and/or country specific restrictions*".Proposal 2: Change the NOTE starting from Rel-16. |
| R4-2203662 | Apple | Proposal: Consider the VLP mode in a new spectrum Rel-18 WI for the 6GHz band. |
| R4-2204091 | Skyworks Solutions Inc. | Proposal: Since there is no benefit in using type 1 partial allocations for cases where A-MPR is dictated by in-band PSD we propose that release 17 PC5 NR-U MPR and A-MPR is only based on fully allocated waveforms, type 2 interlace waveforms and wideband operation full and partial allocated sub-band operation. Partial type 1 waveforms MPR and A-MPR may be studied in a later release if justified by cases without in-band PSD limitations.MODERATOR NOTE: This paper relates to the A-MPR issues raised last meeting under the 6GHz EU WI. |
| R4-2204733 | LGE | Proposal 1: Specify A-MPR without considering edge CH and non-edge CH.Proposal 2: Define PC5 A-MPR in Table 2 for VLP in South Korea. |
| R4-2206066 | Skyworks Solutions Inc. | Proposal for QPSK PC5 A-MPR for LPI and VLP modes in Korea:* Specific NS are allocated to Korea LPI and VLP modes for PC5
* A-MPR for channels where OOB requirements are not limiting should be specified with:
	+ 9dB AMPR for VLP mode 20MHz CBW partial allocations
	+ 6.5 dB AMPR for VLP mode 20MHz CBW full allocations
	+ 6dB A-MPR for VLP full and partial allocations for CBW>20MHz
	+ For PLI mode:
		- A-MPR is max(MPR , A-MPR)
		- AMPR for 20MHz CBW is 5.5 dB for full and 8dB for partial allocations
		- AMPR for 40MHz CBW is 2.5 dB for full and 5dB for partial allocations
		- AMPR for 60MHz CBW is 0 dB for full and 3dB for partial allocations
		- AMPR for CBW > 60MHz is 0 dB for full and partial allocations.

Proposal for VLP power class target if introduced: * 0dB MPR for 20MHz 100RB0 DFT-s-OFDM QPSK waveform
* <1.5dB MPR for 20MHz 100RB0 CP-OFDM QPSK waveform
* A-MPR should be based on this PA calibration.
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| R4-2203663  | Apple | CR for TS 38.101-1MODERATOR NOTE: Comments are provided under section 1.3.2. |
| R4-2204991  | LGE | Draft CR for TS 38.101-1MODERATOR NOTE: Comments are provided under section 1.3.2. |
| R4-2203664 | Apple | TP for 38.849 with changes in the proposed NS valuesMODERATOR NOTE: Comments are provided under section 1.3.2. |
| R4-2205179 | Apple | TP for 38.849 with background results for existing A-MPR valuesMODERATOR NOTE: Comments are provided under section 1.3.2. |
| R4-2204733 | LGE | TP for 38.849 with A-MPR values for PC5 VLP considering regulatory parameters in KoreaMODERATOR NOTE: Comments are provided under section 1.3.2. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1 (Overview and updates of regulatory requirements)

In this sub-topic the general regulatory related aspects are handled. Since not all the countries share same regulatory parameters for the 6GHz unlicensed band, this sub-topic aims at analyzing which countries have same parameters and which parameters are different.

No issues this meeting.

### Sub-topic 1-2 (System related aspects)

In this sub-topic system level aspects are considered, such as band plan, frequency ranges, channelization, etc.

Input from the following papers is considered: R4-2205562 (Apple), R4-2203661 (Nokia).

**Issue 1-2-1: Band n96 applicability and starting release**

- Option 1:

- The NOTE 14 is kept but the wording is changed to "*This band is only applicable subject to regional and/or country specific restrictions*".

- The same change is applied to band n96 in Rel-16 and Rel-17.

* Option 2 (proposed last meeting):

- The NOTE 14 is kept but the wording is changed to "*This band is applicable only in countries/regions designating this band for shared-spectrum access use subject to country-specific conditions* ".

- The same change is applied to band n96 in Rel-16 and Rel-17.

* Recommended WF
	+ Discuss during the meeting whether we can conclude on simple wording acceptable for all companies.

### Sub-topic 1-3 (UE RF aspects)

**Issue 1-3-1: VLP mode**

* Proposals
	+ Option 1: Consider the VLP mode in a new spectrum Rel-18 WI for the 6GHz band.
	+ Option 2: Define PC5 VLP A-MPR values for South Korea in Rel-17 (see also Issue 1-3-2).
* Recommended WF
	+ To be further discussed during the meeting.

**Issue 1-3-2: PC5 VLP A-MPR values for South Korea**

* Proposals
	+ Proposal 1: Add A-MPR values for PC5 VLP in South Korea based on input from R4-2204733 (LGE).
	+ Proposal 2: Consider A-MPR values for PC5 VLP in South Korea based on input from R4-2206066 (Skyworks).
* Recommended WF
	+ Check proposed A-MPR values and, if agreeable, consider adding them as technical input to TR 38.849.

**Issue 1-3-3: A-MPR/MPR for type 1 partial waveforms**

* Proposals
	+ Partial type 1 waveforms MPR and A-MPR may be studied in a later release if justified by cases without in-band PSD limitations.
* Recommended WF
	+ To be further discussed during the meeting how to handle partial type 1 waveforms.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | THIS IS A TEMPLATE, DO NOT CHANGE IT, ADD A NEW ROW BELOWIssue 1-2-1 (Band n96 applicability and starting release)Issue 1-3-1 (VLP mode)Issue 1-3-2 (PC5 VLP A-MPR values for South Korea)Issue 1-3-3 (A-MPR/MPR for type 1 partial waveforms) |
| Nokia | Issue 1-2-1 (Band n96 applicability and starting release)We support option 1 and would like to note that a proposal on this note is also included in the discussion summary for [102-e][102] R16\_Maintenance as R4-2204602 |
| Charter Communications Inc. | Issue 1-2-1 Option 2: "*This band is applicable only in countries/regions designating this band for shared-spectrum access use subject to country-specific conditions* ".Issue 1-3-1Option 1: Option 1: Consider the VLP mode in a new spectrum Rel-18 WI for the 6GHz band.Issue 1-3-3 Let’s further discussed during the meeting how to handle partial type 1 waveforms.  |
| Ericsson | Issue 1-2-1 (Band n96 applicability and starting release)Option 2. We have provided a Rel-16 CR against 38.101-1 in R4-2204602 (thread #102) updating the existing note for n96 according to Option 2: provides information that this band is designated for shared spectrum access by some countries and that the band is subject to country-specific usage conditions similar to the existing note. The same general note can be used for all shared-spectrum bands.Issue 1-3-3 (A-MPR/MPR for type 1 partial waveforms)Resource allocation type 1 is also supported for NR-U without capability (except for configured grant like for non-shared spectrum access). While recognizing the virtues of type 2, there may be other reasons for using type 1. We recognize that the SEM is tighter for NR-U compared to that for NR. RAN4 specifications should cover both type 1 and type 2. The work could be carried out as part of Rel-17 maintenance. |
| Apple | Issue 1-2-1 (Band n96 applicability and starting release)Our original preference is to remove the NOTE completely. If we keep it, then simplified wording of Option 1 is preferred. Issue 1-3-1 (VLP mode)Accounting for the reasons presented in our discussion paper R4-2203662, we suggest considering the VLP mode in the corresponding Rel-18 6GHz WI.Issue 1-3-2 (PC5 VLP A-MPR values for South Korea)We simulated A-MPR values for South Korea, whereupon we simulated separately “inner” channels starting from 5945MHz and “edge” channels starting from 5925MHz. For the inner channels the A-MPR values are close to the results from LGE. See below simulation results and the summary table.

|  |  |  |
| --- | --- | --- |
| Pre-coding | Modulation | Channel bandwidth (Sub-band allocation) / RB Allocation |
| 20 MHz | 40 MHz | 60 MHz | 80 MHz |
| Full (dB) | Partial (dB) | Full (dB) | Partial (dB) | Full (dB) | Partial (dB) | Full (dB) | Partial (dB) |
| DFT-s-ODFM | QPSK | ≤ 7.5 | ≤ 10.0 | ≤ 6.5 | ≤ 6.5 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 |
| 16 QAM | ≤ 7.5 | ≤ 10.0 | ≤ 6.5 | ≤ 6.5 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 |
| 64 QAM | ≤ 7.5 | ≤ 10.0 | ≤ 6.5 | ≤ 6.5 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 |
| 256 QAM | ≤ 7.5 | ≤ 10.0 | ≤ 6.5 | ≤ 6.5 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 |
| CP-OFDM | QPSK | ≤ 7.5 | ≤ 10.0 | ≤ 6.5 | ≤ 6.5 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 |
| 16 QAM | ≤ 7.5 | ≤ 10.0 | ≤ 6.5 | ≤ 6.5 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 |
| 64 QAM | ≤ 7.5 | ≤ 10.0 | ≤ 6.5 | ≤ 6.5 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 | ≤ 6.0 |
| 256 QAM | ≤ 7.5 | ≤ 10.0 | ≤ 7.0 | ≤ 7.0 | ≤ 7.0 | ≤ 7.0 | ≤ 7.0 | ≤ 7.0 |
| NOTE 1: Full allocation A-MPR applies when all RB’s in a 20 MHz channel or all RB’s in all sub-bands for wideband operation are fully allocated and all sub-bands are transmitted. Partial allocation A-MPR applies when one or more RB’s in one or more sub-bands are not allocated but when all sub-bands within the channel are transmitted. When not all sub-bands within the channel are transmitted, the A-MPR associated with the channel bandwidth according to the bandwidth of the contiguously transmitted sub-bands and according to the allocation type applies. |

As for the channels residing right at the band n96 edge, i.e. right at 5925MHz, we naturally observe higher A-MPR values (which is inline with A-MPR values for the EU/CEPT PC5 VLP).

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| --- | --- | --- |
| Pre-coding | Modulation | Channel bandwidth (Sub-band allocation) / RB Allocation |
| 20 MHz | 40 MHz | 60 MHz | 80 MHz |
| Full (dB) | Partial (dB) | Full (dB) | Partial (dB) | Full (dB) | Partial (dB) | Full (dB) | Partial (dB) |
| DFT-s-ODFM | QPSK | ≤ 8.5 | ≤ 11.5 | ≤ 7.0 | ≤ 9.0 | ≤ 6.5 | ≤ 7.5 | ≤ 6.5 | ≤ 7.0 |
| 16 QAM | ≤ 8.5 | ≤ 11.5 | ≤ 7.0 | ≤ 9.0 | ≤ 6.5 | ≤ 7.5 | ≤ 6.5 | ≤ 7.0 |
| 64 QAM | ≤ 8.5 | ≤ 11.5 | ≤ 7.0 | ≤ 9.0 | ≤ 6.5 | ≤ 7.5 | ≤ 6.5 | ≤ 7.0 |
| 256 QAM | ≤ 8.5 | ≤ 11.5 | ≤ 7.0 | ≤ 9.0 | ≤ 6.5 | ≤ 7.5 | ≤ 6.5 | ≤ 7.0 |
| CP-OFDM | QPSK | ≤ 11 | ≤ 12.5 | ≤ 9.0 | ≤ 11.0 | ≤ 7.5 | ≤ 9.5 | ≤ 7.0 | ≤ 8.5 |
| 16 QAM | ≤ 11 | ≤ 12.5 | ≤ 9.0 | ≤ 11.0 | ≤ 7.5 | ≤ 9.5 | ≤ 7.0 | ≤ 8.5 |
| 64 QAM | ≤ 11 | ≤ 12.5 | ≤ 9.0 | ≤ 11.0 | ≤ 7.5 | ≤ 9.5 | ≤ 7.0 | ≤ 8.5 |
| 256 QAM | ≤ 11 | ≤ 12.5 | ≤ 9.0 | ≤ 11.0 | ≤ 7.5 | ≤ 9.5 | ≤ 7.0 | ≤ 8.5 |
| NOTE 1: Full allocation A-MPR applies when all RB’s in a 20 MHz channel or all RB’s in all sub-bands for wideband operation are fully allocated and all sub-bands are transmitted. Partial allocation A-MPR applies when one or more RB’s in one or more sub-bands are not allocated but when all sub-bands within the channel are transmitted. When not all sub-bands within the channel are transmitted, the A-MPR associated with the channel bandwidth according to the bandwidth of the contiguously transmitted sub-bands and according to the allocation type applies. |

Issue 1-3-3 (A-MPR/MPR for type 1 partial waveforms)If there is a need to define A-MPR for type 1 partial waveforms, 3GPP can do this work, but we need to discuss how to structure it. It can be Rel-17 maintenance works – which would not be our main preference – or it can be done under the 6GHz Rel-18 WI if we plan to have the one because of e.g. VLP.  |
| LGE | Issue 1-3-1: VLP modeWe support Option2. We should not assume that there will be a Rel-18 NR-U VLP work item to do this work. As a priority for countries where regulatory requirements have been completed, such as South Korea. Related contributions have already been submitted in this meeting.We prefer to discuss and define the RF core requirements & PC5 VLP A-MPR values for the VLP mode of South Korea in Rel-17.Issue 1-3-2: PC5 VLP A-MPR values for South KoreaWe prefer to option1. but open to further discussion. |
| Qualcomm | Issue 1-2-1: Neither option. We don’t think any note is needed. Country specific restrictions apply to all bands, not just a subset of them. The fact that the band is for shared spectrum access is already specified. Issue 1-3-1: Option 2. Agree with the comment from LGE.Issue 1-3-2: R4-2204733 claims that there is no significant difference between edge and non-edge allocations, but there does seem to be a difference for wider channel bandwidths. Otherwise, for PSD and EIRP limited waveforms, the A-MPR between R4-2204733 and R4-2206066 are not too different but R4-2204733 is slightly more relaxed. We suggest to adopt the values in R4-2204733.Issue 1-3-3: Agree with the observations and proposals in Skyworks R4-2204091. |
| CableLabs | Issue 1-2-1 (Band n96 applicability and starting release): we prefer option 2.Issue 1-3-1 (VLP mode): we support Option 1. |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2203663 (CR for TS 38.101-1, Apple) | Nokia – We support using this CR as baseline to introduce n102 to 38.101-1. A revision might be needed to captured agreements during this meeting. |
| Qualcomm: Suggest to collapse the -27 dBm/MHz requirement for NS\_60 into subclause 6.5F.3.3.5 rather than to create a new subclause. References to 6.5F.3.3.x would need to be changed to 6.5F.3.3.5 as well. Also need to consider the addition of VLP as proposed by LGE. |
|  |
| R4-2204991 (draft CR for TS 38.101-1, LGE) | Apple: Our main preference is to consider VLP in Rel-18 if there is an interest from companies to introduce support for that mode. From that perspective adding PC5 VLP for South Korea now is a bit premature because we anyway need to discuss which NS values to assign and/or whether we can re-use same A-MPR values for different regions.  |
| Qualcomm: Generally supportive, but some minor changes to A-MPR may be needed. |
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| R4-2203664(TP for 38.849, Apple) |  |
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| R4-2205179(TP for 38.849, Apple) |  |
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| R4-2204733 (TP for 38.849, LGE) | Apple: We can harmonize A-MPR results from LGE and Apple and, if agreeable, include them into the updated TP for TR 38.849. |
| Qualcomm: R4-2204733 claims that there is no significant difference between edge and non-edge allocations, but there does seem to be a difference for wider channel bandwidths. Can clarification be provided? |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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| --- | --- |
|  | **Status summary**  |
| **Sub-topic #1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on introduction of the full unlicensed band | Apple |  |
|  |  |  |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-2205562 | On band definition for 6GHz NR unlicensed operation | Nokia, Nokia Shanghai Bell |  |  |
| R4-2203661 | Applicability of band n96 | Apple |  |  |
| R4-2203662 | On the VLP mode for the NR-U operation | Apple |  |  |
| R4-2204091 | Discussion on NR-U MPR and A-MPR for type 1 waveforms | Skyworks Solutions Inc. |  |  |
| R4-2204733 | A-MPR analysis results for NR-U(VLP) considering regulatory parameters in Korea | LGE |  |  |
| R4-2206066 | A-MPR related to in-band PSD for n96 UE in Korea | Skyworks Solutions Inc. |  |  |
| R4-2203663  | CR for introduction of operation in full unlicensed band 5925-7125MHz | Apple  |  |  |
| R4-2204991  | Draft CR\_NR-U A-MPR for PC5 VLP in South Korea | LGE |  |  |
| R4-2203664 | TP for TR 38.849 | Apple |  |  |
| R4-2205179 | Text proposal for TR 38.849 (background results for the existing A-MPR values) | Apple |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
| Qualcomm Incorporated | Gene Fong | gfong@qti.qualcomm.com |

Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)