**3GPP TSG-RAN WG4 Meeting # 96-e R4-2011539**

**Electronic Meeting, 17 – 28 August 2020**

**Agenda item:** 7.1.1 & 7.1.3

**Source:** Moderator (Ericsson)

**Title:** Email discussion summary for [96e][106] NR\_unlic\_SysParameters

**Document for:** Information

# Introduction

This document summarizes the email discussion on topics related to NR-U system parameters in AI 7.1.1 and band combinations related AI 7.1.3. However, there were no contribution on AI 7.1.3 in this meeting .

The contributions presented in this AI cover the following topics:

* Introduction of 6GHz band,
* System parameters
  + 100MHz CBW in NR-U
  + Spectrum Utilization
* wideband operation and LS reply to RAN1

Documents R4-2009934, R4-2010671 on NR-U CA BW Classes and R4-2011330 on LO Leakage and NRU Mask Measurement are moved to [96e][107] NR\_unlic\_UE\_RF thread.

# Topic #1: Introduction of 6GHz band for NR-U operation

## Companies’ contributions summary

|  |  |  |
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| **T-doc number** | **Company** | **Proposals / Observations** |
| **R4-2010459** | LG Electronics Finland | The proposed rules for Korea are close but not entirely matching with ongoing RAN4 NR-U work and therefore more detailed analysis needs to be carried to properly support the Korea’s 6GHz band with RAN4 specifications covering the Shared spectrum channel access. In addition, as public consultation period in Korea will last until August 24, it is proposed that this work will be covered in future |
| **R4-2010495** | Huawei, HiSilicon | **Observation 1**: whether Further Notice of Proposed Rulemaking need to be considered in 3GPP specification should be discussed.  **Observation 2**: The limit and request for standard-power operation (sub-band U-NII-5 and U-NII-7) and indoor operation (the entire band) is different and need to define separate classes.  **Observation 3:** It is challenge to provide the needed attenuation for a BS filter covering the entire 5925-7125 MHz.  **Proposal 1:** It is proposed to further discuss the band plan for 6GHz. 3 bands for 6GHz considering current FCC regulatory requirements is proposed for further consideration.   * Standard-power operation: Band x: 5925 - 6425 MHz, Band z: 6525 - 6875 MHz * In door operation: Band y: 5924 - 7125 MHz   ***Observation 4:*** Reusing the same channel allocation as 802.11ax will result in resource waste.  **Proposal 2:** Revised channelization on top of 802.11ax should be considered for 6GHz band in NRU. |
| **R4-2010744** | *Nokia, Nokia Shanghai Bell* | ***Proposal 1: It is proposed to include band n96 for NR-U with 5925 – 7125 MHz range.***  ***Proposal 2: It is proposed to introduce at least 20 MHz, 40 MHz, 60 MHZ, and 80 MHz channel bandwidths for NR-U band in 6 GHz unlicensed band.***  ***Proposal 3. It is proposed to align channel raster for NR-U in band n96 with Wi-Fi channels in 6 GHz.***  ***Proposal 4. It is proposed to set 60 MHz channels only within 80 MHz channel i.e. to adopt channel bonding rule for 60 MHz CBW.***  ***Proposal 5: It is proposed to introduce 15 kHz as global frequency raster for band n96 and NREF numbers for respective CBW as in table 1.***  ***Proposal 6: It is proposed to introduce band n46 principles for synchronization raster for band n96 and GSCN numbers for respective CBW as in table 2.***  ***Proposal 7: It is proposed to reuse for band n96 as a baseline band n46 unwanted emission masks for both Local Area and Medium Range BS included on non-transmitted and two non-transmitted channels.***  ***Proposal 8: It is proposed to reuse band n46 other general BS Tx and Rx requirements for band n96 that are not depends on frequency.*** |
| **R4-2010958** | *ZTE Corporation* | **Observation 1: 3GPP didn’t discuss how to define AFC functionality for NR-U operation at 6GHz which is crucial for NR-U operation at 6GHz in certain regions.**  **Observation 2: coexistence** **between 6GHz and ITS band n47 is not discussed for safety usage of V2X service.** |

## 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

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 1-1: 6GHz Band plan**

* Proposals
  + Option 1: Consider following bands for 6GHz: (Huawei)
    - Standard-power operation: Band x: 5925 - 6425 MHz, Band z: 6525 - 6875 MHz
    - In door operation: Band y: 5924 - 7125 MHz
  + Option 2: To include band n96 for NR-U with 5925 – 7125 MHz range. (Nokia)
* Recommended WF
  + Collect companies’ views in the 1st round.

### Sub-topic 1-2

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 1-2: Channelization**

* Proposals
  + Option 1: Do not reuse the same channel allocation as 802.11ax. Revised channelization on top of 802.11ax should be considered for 6GHz band in NRU. (Huawei)
  + Option 2: Adopt the following proposals: (Nokia)
    - It is proposed to introduce at least 20 MHz, 40 MHz, 60 MHZ, and 80 MHz channel bandwidths for NR-U band in 6 GHz unlicensed band.
    - It is proposed to align channel raster for NR-U in band n96 with Wi-Fi channels in 6 GHz.
    - It is proposed to set 60 MHz channels only within 80 MHz channel i.e. to adopt channel bonding rule for 60 MHz CBW.
    - It is proposed to introduce 15 kHz as global frequency raster for band n96 and NREF numbers for respective CBW as in table 1in R4-2010744.
    - It is proposed to introduce band n46 principles for synchronization raster for band n96 and GSCN numbers for respective CBW as in table 2, R4-2010744.
* Recommended WF
  + Collect companies’ views in the 1st round.

### Sub-topic 1-3

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 2-1: AFC functionality and coexistence with ITS (ZTE)**

* Define AFC functionality for NR-U operation
* Study coexistence between NR-U operation in 6GHz and ITS in band n47
* Proposals
  + Agreeable
  + Not agreeable
* Recommended WF
  + Collect companies’ views in the 1st round

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Charter Communications, Inc. | Sub topic 1-1:  **Issue 1-1: 6GHz Band plan**  Option 2: To include band n96 for NR-U with 5925 – 7125 MHz range. (Nokia)  In option 1, R4-2010495 makes an observation that, *“It is challenge to provide the needed attenuation for a BS filter covering the entire 5925-7125 MHz.”*  We have verified with RF F/E filter vendors that this is not the case. Fractional bandwidth for 5925-7125 MHz is 18.5%. There are filters today that can provide 24% of fractional bandwidth. An example is 3.3-4.2 GHz  Sub topic 1-2:  **Issue 1-2: Channelization**  Option 2   * It is proposed to introduce at least 20 MHz, 40 MHz, 60 MHZ, and 80 MHz channel bandwidths for NR-U band in 6 GHz unlicensed band. * It is proposed to align channel raster for NR-U in band n96 with Wi-Fi channels in 6 GHz. * It is proposed to set 60 MHz channels only within 80 MHz channel i.e. to adopt channel bonding rule for 60 MHz CBW. * It is proposed to introduce 15 kHz as global frequency raster for band n96 and NREF numbers for respective CBW as in table 1in R4-2010744. * It is proposed to introduce band n46 principles for synchronization raster for band n96 and GSCN numbers for respective CBW as in table 2, R4-2010744.   Sub topic 2-1:  **Issue 2-1: AFC functionality and coexistence with ITS (ZTE)**  Not agreeable  In R4-1011344 Qualcomm shows how to address emission requirements for n96 with the introduction of NS\_53 and NS\_54.  With regards to co-existence with b47, this issue was discussed in the FCC Report of Order and Further Notice of Proposed Rulemaking FCC 20-51 where in paragraph 197 the report states, “*We believe that a limit of -27 dBm/MHz is necessary to protect services outside the U-NII-5 and U-NII-8 bands, including the Intelligent Transportation Service below the U-NII-5 band and federal government operations above the U-NII-8 band”*  And in paragraph 198, the 5GAA ( Global Automakers Association) further clarifies the following, *“To protect Intelligent Transportation Services in the band below 6 GHz, 5GAA states that the -27 dBm/MHz standard we are adopting, when based on a root-mean-square (RMS) measurement is sufficient to protect those services from indoor device OOBE.517 RLAN proponents agree that the OOBE should be verified using an RMS detector or other appropriate techniques for measuring average power.518 We agree and will provide guidance to the test labs and telecommunications certification bodies which conduct equipment approval measurements and oversight that 6 GHz unlicensed device measurements may be conducted based on using an RMS detector”*  The FCC provided guidance to the test labs and telecommunication bodies to adopt this method of testing. |
| Skyworks | **Issue 1-1: 6GHz Band plan**  Option 2 is preferred, indoor/standard power are covered by NS53/54 and NS should clarify applicable frequency range  **Issue 1-2: Channelization**  In the scope of Release 16 we should focus on Option 2. In release 17, more channel bandwidths and channel locations can be added  **Issue 2-1: AFC functionality and coexistence with ITS (ZTE)**   * Define AFC functionality for NR-U operation: is this needed since NRU UE should have the same frequency precision as BS within 0.1ppm and BS can know which channels are usable.   Study coexistence between NR-U operation in 6GHz and ITS in band n47: is there regulation requiring this in the US (can be introduced later via NS if required for other regions)? In any case n46 does not protect n47 so why should this apply to n96? |
| Qualcomm | Issue 1-1: Support Option 2: To include band n96 for NR-U with 5925 – 7125 MHz range. A single band is consistent with regulatory rules so far and enables the greatest commonality and flexibility for deployments in the band and for support in devices.  Issue 1-2: Support option 2 on channelization. This provides the greatest compatibility with 802.11ax for effective coexistence. While there may be some lost efficiency in some U-NII bands as pointed out by Huawei for standard power deployments, defining a different channelization could degrade coexistence not only with 802.11ax but also with NR-U indoor deployments.  Issue 2-1: Not agreeable. AFC for standard power operation is not defined in 3GPP and is not needed for low power operation. Coexistence with ITS has already been studied by regulatory bodies in coming up with the technical rules. |
| Nokia | **Sub topic 1-1:**  **Issue 1-1:** Any regional power constrains are covered by the general regulatory output power statement e.g. as given in 38.104 *“In addition, for operation with shared spectrum channel access operation, the BS may have to comply with the applicable BS power limits established regionally, when deployed in regions where those limits apply and under the conditions declared by the manufacturer.”*. Furthermore, if specific regional regulations provide a need for additional UE requirements, these are included under NS. Therefore, Option 2 is proposed from our side (with both Local Area and Medium Range BS classes as allowed by FCC regulation).  **Sub topic 1-2:**  **Issue 1-2:** We propose Option 2 to align with 11ax as this would ensure better co-existence, as also done for the 5Ghz band (n46).  **Sub topic 1-3:**  **Issue 2-1:** Similarly, as Dynamic Channel Selection for LAA or SAS for CBRS, AFC shall be out of discussion in 3GPP. The intention of 3GPP is to define RF requirements for this band only as ITS has already been studied by regulatory bodies in coming up with the technical rules. |
| Huawei | Sub topic 1-1: 6GHz Band plan  Basically it will need more discussion to consider the regional regulations. Whether or not FNPRM need to be considered? Whether or not other regions such as Korea should be considered? The feasibility need to be studied before the conclusion.  Sub topic 1-2: Channelization  Option 1: Revised channelization on top of 802.11ax should be considered for 6GHz band in NRU. It is clear the channelization of current 802.11ax is not optimized, e,g, channels will cross the sub-band boundaries.  Sub topic 1-3: AFC functionality and coexistence with ITS  We agree 1. AFC is a new function and may need more time to study. 2. co-existence with ITS and/or n46 need to be addressed |
| MediaTek | **Issue 1-1: 6GHz Band plan**  Work on requirements first  Just to note that the decision here is conditioned on the fact that RAN4 can finalize corresponding requirements in Rel-16 in this meeting. We suggest to work on the detail requirement first and then visit this issue later.  **Issue 1-2: Channelization**  In order to align the WiFi channel, we need to first clarify which version of 802.11ax we are referring to. Maybe we also need to consider the coexistence with 802.11be?  **Issue 2-1: AFC functionality and coexistence with ITS (ZTE)**  AFC sets some additional rules for AP (BS) only, not for STA (UE). RAN4 can check if current BS requirements should be intervened by AFC. |
| LG Electronics | **Issue 1-1: 6GHz Band plan**  Option 2, new regions can be addressed later  **Issue 1-2: Channelization**  Option 2  **Issue 2-1: AFC functionality and coexistence with ITS (ZTE)**  Not agreeable |
| CHTTL | **Issue 1-1: 6GHz Band plan**  We support MTK and Huawei’s view.  **Issue 1-2: Channelization**  For clarification that if we focus on option 2 only now, it is still possible to add new channel location in the future?  **Issue 2-1: AFC functionality and coexistence with ITS (ZTE)**  Support to check the co-existence issues. |
| ZTE | **Issue 1-1: 6GHz Band plan**  For Rel-16, NR-U BS core requirements is left with lots of open issues and conformance testing is not started yet at this meeting, we could see big risk even for 5GHz. For 6GHz, lots of issues needs further discussion which is not easily concluded e.g. font-end of filter for NR-U BS as 6GHz is spanning over 1.2GHz which is much larger than the existing NR maximum 900MHz.  Power limitation of AFC for NR-U BS at 6GHz also still further discussion.  **Issue 1-2: Channelization**  The channelization of current 802.11ax still needs some further improvement to resolve the cross sub-band issues. For NR-U, alignment between NR-U and 802.11ax should also be up to that decision.  **Issue 2-1: AFC functionality and coexistence with ITS (ZTE)**  For AFC functionality, it should be defined by technical group instead of regulator. Due to FCC request on specific AFC system and testing method, then wifi alliance triggered the work for AFC, we think this should be applied for 3GPP group, we need to define our OWN AFC functionality. I think it should be not RAN4 work, maybe it should be RAN plenary discussion, otherwise these feature is not feasible to work due to missing functionality requested by regulator.  For coexistence with ITS bands, we think this work should also be conducted in 3GPP group instead of regulatory bodies only, currently 3GPP has defined NR-U and V2X techniques, then we have 3GPP coextensive scenarios, some evaluation work is essential. |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## 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.*

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

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

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

|  |  |
| --- | --- |
| **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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: NR-U system parameters

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **R4-2009901** | Charter Communications Inc. | **Observation 1: It can be noticed that for 60 MHz channel bandwidth configurations, the channel rasters were defined to fall inside the 80 MHz channel bonding configurations in Wi-Fi. This assures fair co-existence with both technologies.**  **Observation 2: There are several co-existence issues with the proposed channel rasters for 100 MHz channel bandwidth in [1] and [2].**  **Observation 3: Wideband multi-channel access operations for 100 MHz channel bandwidth needs to consider multiple CAT4 LBT procedures to insure fair co-existence with Wi-Fi.**  **Proposal 1: RAN4 should not define** **100 MHz channel bandwidth for NR-U in 5 GHz (n46) in Release 16.** |
| **R4-2010499** | Huawei, HiSilicon | **Observation 1: If using Type A multi LBT sub-band channel access, there is no issue for 100MHz CBW in band n46.**  **Proposal 1: Channel raster for 100MHz CBW in NRU as listed in Table.1 should be supported**  **Proposal 2: The spectrum emission mask for 100MHz channel bandwidths in NRU should be supported as below:**  **- for full bandwidth transmission, the general spectrum emission mask in NRU is applied.**  **- for single punctured channel in the middle, the emission mask of the puncture center is limited at -23dBr.**  **- for multiple punctured channels in the middle, the emission mask in the middle is floored at -25dBr.**  **- for punctured channel(s) at the edge, the emission mask edge is floored at -28dBr.** |
| **R4-2009933** | Apple Inc. | **Proposal 4:** **For 60kHz SCS, adopt alternative 1 for intra-carrier guard bands (i.e. 5 RBs for in-carrier guard band with 23-5-23 pattern).** |
| **R4-2010498** | Huawei, HiSilicon | ***Proposal 1: 25PRB for 20 MHZ channel bandwidth should be mandatory for a UE supporting 60 kHz SCS.***  ***Proposal 2: Alt.2 for 60kHz intra-carrier guardbands should be supported.*** |

## 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 2-1: 100 MHz channel bandwidth for NR-U in 5 GHz

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 2-1-1:**

* Proposals
  + Option 1: Define 100 MHz channel bandwidth for NR-U in 5 GHz (Huawei)
  + Option 2: Do not define 100 MHz channel bandwidth for NR-U in 5 GHz (n46) in Release 16 (Charter)
* Recommended WF
  + Collect companies’ views in the 1st round

**Issue 2-1-2:**

“If 100 MHz channel bandwidth is defined for NR-U in 5 GHz, the spectrum emission mask for 100MHz channel bandwidths should be specified as in document R4-2010499”. (Huawei)

* Proposals
  + Agreeable
  + Not Agreeable
* Recommended WF
  + Collect companies’ views in the 1st round

### Sub-topic 2-2: Spectrum utilization

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 2-2:**

* Proposals
* Option 1: (Huawei)
  + 25 PRB for 20 MHZ channel bandwidth should be mandatory for a UE supporting 60 kHz SCS.
  + 25 PRBs for 60kHz intra-carrier guard bands should be supported.
* Option 2 (Apple)
  + 24 RBs for 20MHz channel with 5 RBs for in-carrier guard band
* Recommended WF
  + Collect companies’ views in the 1st round

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Charter Communications, Inc. | Sub topic 2-1:  **Issue 2-1-1:**  Option 2: Do not define 100 MHz channel bandwidth for NR-U in 5 GHz (n46) in Release 16 (Charter)  In our paper R4-2009901 we showed fundamental challenges that need to be resolved before including 100 MHz channel bandwidth in n46.  **Issue 2-1-2:**  Not agreeable. As indicated above 100 MHz channel bandwidth inclusion requires further study before addressing other technical aspects such as emission mask  Sub topic 2-2:  Option 2: 24 RBs for 20MHz channel with 5 RBs for in-carrier guard band  As indicated in previous meetings, we are deeply concerned about shortening the guard bands and creating potential interference |
| Skyworks | **Issue 2-1-1:**  At this time it seems that we won’t have all the requirement in place for the UE for 100MHZ in this meeting. 100MHZ mat be postponed to rel17 for both n46 and n96.  **Issue 2-1-2:** See above |
| Qualcomm | Issue 2-1-1: Option 2, do not define 100 MHz channel bandwidth. However, for clarification, the proposal from Charter was not to define 100 MHz in Rel-16. It is not precluded to introduce it in a later release if agreed.  Issue 2-1-2: While we don’t think 100 MHz channel bandwidth should be specified in Rel-16, the emission mask from Huawei is ok if 100 MHz is added in the future.  Issue 2-2: Support option 2 from Apple for 24 RB’s at 60 kHz SCS in a 20 MHz channel |
| Huawei | Sub topic 2-1:  We still think 100MHz should be defined for NRU in R16, larger bandwidth is obviously benefit for NRU. The standard effort for 100MHz is relatively small. The only concern from some companies is the coexistence with WiFi when 100MHz is used, however, as analyzed in our paper, if type A multi-channel LBT is performed, there is no coexistence issue.  Sub topic 2-2:  Option 1. We understand that 60kHz SCS is optional for UE, however, the logic here is that in NRU, if 60kHz is supported, 25PRB for 20MHz should be supported, which has been agreed for a long time. Accordingly guardband defined based on 25PRB should be adopted, since anyway intra-carrier guardband is only specified for NRU. |
| LG Electronics | Issue 2-1-1: Option 2: Do not define 100 MHz channel bandwidth for NR-U in 5 GHz (n46) in Release 16 |
| CableLabs | Issue 2-1-1:  Option 2: Do not define 100 MHz channel bandwidth for NR-U in 5 GHz (n46) in Release 16.  There are many technical concerns presented in R4-2009901 co-sourced by Charter and CableLabs. The 100 MHz bandwidth could be discussed in R17 once all our concerns are addressed.  Issue 2-1-2:  Huawei’s SEM is not agreeable since it only specifies power level, the corresponding frequency points are missing in Proposal2 of R4-2010499. We have expressed our concerns about interior punctured SEM in the May meeting R4-2006141, and proposed alternative SEMs. Again, we would exclude the 100 MHz bandwidth from R16. Let us discuss this topic in R17 meetings.  Issue 2-2:  We support option 2 with 24 PRBs. |
| ZTE | Issue 2-1-1:  We support option 1 to introduce 100MHz in Rel-15. this could benefit NR-U system performance close to licensed band 100MHz.  Issue 2-2:  We support option 1with 25 PRBs. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## 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.*

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

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

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

|  |  |
| --- | --- |
| **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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: Wideband capabilities and LS reply to RAN1

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **R4-2010310** | *MediaTek inc.* | **Observation 1: UE’s Rx RF setting is actually the same for Cases 2a, 2b, 3 and 4 for the all receptions during a COT.**  **Observation 2: When one of the configured subband is occupied by other non-serving transmissions, UE is not able to suppress it via the RF filter which already assumes WB. AGC setting will be not accurate and the reception performance is going to be bad.**  **Observation 3: There is no any RF requirements for subbands with partial LBT success nor any RRM requirements which allows UE some spare time to adopt the DL RF filter setting.**  **Observation 4: When the LBT is done by UE, only UL WB operation Case 3 is practical for UE implementation.**  **Observation 5: When the LBT is not done by UE, UL WB operation Case 3 remains the baseline UE behavior, while capabilities can be introduced for Cases 1 and 2.**  **Proposal 1: DL WB operation Case 4 (Mode 1) is supported in Rel-16 with capability signaling.**  **Proposal 2: DL WB operation Cases 2a, 2b and 3 are not supported in Rel-16**  **Proposal 3: UL WB operation Case 3 is supported in Rel-16 with UE capability signaling.**  **Proposal 4: UL WB operation Cases 1 and 2 are supported with UE capability signaling in Rel-16, only if UE does not need to perform LBT before UL transmission.** |
| **R4-2011447** | Nokia, Nokia Shanghai Bell | **Proposal 1: Define additional UE capabilities for NR-based access to unlicensed spectrum as given in section 4.**  **Proposal 2: Respond to the RAN1 LS on UE capability on wideband carrier operation for NR-U as given in the draft LS provided in section 5.** |
| **R4-2009933** | Apple Inc. | **Proposal 1a:** **Clarify that DL wide-band transmission mode 1 assumes that LBT is successful in all LBT sub-bands *irrespective* of which sub-bands are scheduled with data.**  **Proposal 1b:** **Clarify whether UL wide-band transmission mode 1 assumes that LBT is successful in all LBT sub-bands *irrespective* of which sub-bands are scheduled with data or only in those LBT sub-bands where UL data is scheduled.**  **Proposal 2a:** **Wide-band transmission modes should have separate UE capabilities.**  **Proposal 2b:** **It can be discussed further whether we need to have strict differentiation between all three modes / sub-modes or whether transmission mode 1 can be construed as the baseline NR-U functionality.**  **Proposal 3:** **Wide-band transmission modes should be differentiated between DL and UL.** |

## Open issues summary

RAN4 received a LS from RAN1 (R1-2004965). The LS includes several questions regarding whether to add UE capabilities for Mode 1, Mode 2 and Mode 3.

### Sub-topic 3-1: Considerations on wideband operation, R4-2009933 (Apple)

**Issue 3-1-1:**

Proposal 1a: Clarify that DL wide-band transmission mode 1 assumes that LBT is successful in all LBT sub-bands irrespective of which sub-bands are scheduled with data.

* Proposals
  + Agreeable
  + Not Agreeable

**Issue 3-1-2:**

Proposal 1b: Clarify whether UL wide-band transmission mode 1 assumes that LBT is successful in all LBT sub-bands irrespective of which sub-bands are scheduled with data or only in those LBT sub-bands where UL data is scheduled.

* Proposals
  + Agreeable
  + Not Agreeable

**Issue 3-1-3:**

Proposal 2a: Wide-band transmission modes should have separate UE capabilities.

* Proposals
  + Agreeable
  + Not Agreeable

**Issue 3-1-4:**

Proposal 2b: It can be discussed further whether we need to have strict differentiation between all three modes / sub-modes or whether transmission mode 1 can be construed as the baseline NR-U functionality.

* Proposals
  + Agreeable
  + Not Agreeable

**Issue 3-1-5:**

Proposal 3: Wide-band transmission modes should be differentiated between DL and UL.

* Proposals
  + Agreeable
  + Not Agreeable
* Recommended WF
  + Collect companies’ views in the 1st round

### Sub-topic 3-2: LS reply to RAN1 on DL operation to add UE capabilities

*Open issues and candidate options before e-meeting:*

**Issue 3-2:**

Question 1: Is there any difference in DL reception among DL Cases 1, 2a, 2b, 2, and 3 with respect to AGC when at least one of the sub-bands of a [BW or carrier] is not part of gNB’s acquired channel occupancy and contains interference from devices other than the UE’s serving gNB e.g. near-by WiFi AP? Does RAN4 think AGC issues may prevent UE to meet RAN4 requirements for Mode 2 and Mode 3?

* Proposals:
  + Option 1: UE implementation for AGC is the same, but the performance is different between Case 2a/2b/3 and Case 4. For Case 2a/2b/3, UE is not able to suppress it via the WB RF filter. AGC setting will be inaccurate, and the reception performance is going to be bad. RAN4 does not introduce RF requirements for Mode 2 and Mode 3 in Rel-16. (MediaTek)
  + Option 2: The question is dependent on the chosen implementation approach. In principle, there is no difference in between DL case 1, 2a, 2b and 3 in regards to AGC levels. Sufficient dynamic range of the AGC is needed but this is no different as compared to Rel-15 NR and for that case LAA intra-band CA for DL case 1, 2a and 2b. (Nokia)
  + Option 3: Other

Question 2a: Is there a difference in UE capability between any of DL Cases 2a/2b and DL Case 3?

* Proposals:
  + Option 1: UE capability should be different for DL Case 1 and DL Case 4. Due to no requirement, Case 2a/2b/3 are not considered In Rel-16 (MediaTek)
  + Option 2: Difference between a UE supporting DL case 2a/2b and DL case 3 is the capability of receiving in the intra-cell guardband(s). This capability is discussed further within RAN4. (Nokia)
  + Option 3: Other

Question 2b: Is there a difference in UE capability between any of DL Cases 2a/2b/3 and DL Case 4?

* Proposals:
  + Option 1: UE capability should be different for DL Case 1 and DL Case 4. Due to no requirement, Case 2a/2b/3 are not considered In Rel-16 (MediaTek)
  + Option 2: Difference between DL case 2a/2b/3 and DL case 4 is that UE for DL case 4 needs to support the entire configured bandwidth as a single carrier. As the mandatory support of an NR band is 100MHz and no bandwidth above 80 MHz is currently defined then all NR UEs should be able to operate in DL case 4 with no additional UE capability. Further, a UE operating in DL case 4 does not have to expect or cope with potential interference in the LBT sub-bands which have failed CCA as it is only considering ‘all-or-nothing’. That implies that If DL case 4 is supported then DL case 1, 2a, 2b and 3 should also be supported if the UE is capable of coping with potential interference on failed LBT sub-bands. (Nokia)
  + Option 3: Other

Question 2c: Is there a difference in UE capability between any of DL Cases 2a/2b/3/4 and DL Case 1?

* Proposals:
  + Option 1: UE capability should be different for DL Case 1 and DL Case 4. Due to no requirement, Case 2a/2b/3 are not considered In Rel-16 (MediaTek)
  + Option 2: As mentioned in relation to question 1 only DL case 3 and 4 is different from DL case 1, 2a and 2b as they rely on the capability of the UE being able to receive in the intra-cell guard bands. (Nokia)
  + Option 3: Other

Question 3: From RAN4 point of view, does “all LBT sub-bands” for Mode 1 refer to LBT sub-bands of configured carrier or BWP?

* Proposals:
  + Option 1: From UE implementation point of view, all LBT subbands for Mode 1 refer to the BWP. From RAN4 requirement point-of-view, BWP is always configured the same the carrier BW. (MediaTek)
  + Option 2: It is RAN4 understanding that per RAN1 design the configured carrier could be e.g. 80 MHz but the BWP could be chosen as a subset e.g. 40 MHz. This means that some ambiguity could be related to the statement “all LBT sub-bands”. However, as current NR considers requirements related to the carrier and not the BWP, RAN4 are of the understanding that it shall be all LBT sub-bands per configured carrier. (Nokia)
  + Option 3: Other
* Recommended WF
  + Collect companies’ views in the 1st round

### Sub-topic 3-3: LS reply to RAN1 on UL operation to add UE capabilities

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 3-3:**

Question 4: Is change of transmit filtering required (as shown in Figure 1 for WB Mode 2B) to meet RAN4 requirements for any of UL Cases 1-3?

* Proposals:
  + Option 1: Yes for Case 1 and 2. No for Case 3. (MediaTek)
  + Option 2: There should be no need for filter adaptation for UL case 1, 2 and 3. (Nokia)
  + Option 3: Other

Question 5: Is there any difference if intra-cell GBs between scheduled contiguous sub-bands are scheduled or not?

* Proposals:
  + Option 1: There is no significant difference in RF requirement and UE’s RF implementation. Only UE’s baseband processing will be different. (MediaTek)
  + Option 2: There is no difference in filter adaptation dependent on scheduled intra-cell guardband(s) or not. For UL case 2 and 3 this is dependent on the UE capability of transmitting in the intra-cell guardband(s). This capability is discussed further within RAN4. (Nokia)
  + Option 3: Other
* Recommended WF
  + Collect companies’ views in the 1st round

### Sub-topic 3-4

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 3-4:**

If the answer to any of Questions 2a/2b/2c/4/5 is yes and capabilities for any of the cases are deemed needed, RAN1 would like to request RAN4 to define the corresponding UE capabilities**.**

* Proposals:
  + Option 1: DL WB operation Case 4 (Mode 1) and UL WB operation Case 3 are supported in Rel-16 with capability signaling. DL WB operation Cases 2a/2b/3 are not considered in Rel-16. UL WB operation Cases 1/2 are supported with capability signaling, only if UE does not need to perform LBT before UL transmission. (MediaTek)
  + Option 2: Define additional UE capabilities for NR-based access to unlicensed spectrum as given in section 4 in R4-2011447 (Nokia)
  + Option 3: Other
* Recommended WF
  + Collect companies’ views in the 1st round

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Charter Communications, Inc. | Sub topic 3-1:  **Issue 3-1-1:**   * Agreeable   **Issue 3-1-2:**   * Agreeable   **Issue 3-1-3:**   * Agreeable   **Issue 3-1-4:**   * Agreeable   **Issue 3-1-5:**   * Agreeable   **Sub topic 3-2**  **Issue 3-2-: LS reply to RAN1 on DL operation to add UE capabilities**   * Question 1: option 2 * Question 2a: option 2 * Question 2b: option 2 * Question 2c: option 2 * Question 3: option 2   **Sub topic 3-3:**  **Issue 3-3: LS reply to RAN1 on UL operation to add UE capabilities**   * Question 4: option 2 * Question 5 : option 2   **Sub topic 3-4:**  **Issue 3-4:**  If the answer to any of Questions 2a/2b/2c/4/5 is yes and capabilities for any of the cases are deemed needed, RAN1 would like to request RAN4 to define the corresponding UE capabilities**.**  Option 2: |
| Skyworks | **Issue 3-1-2:** Clarification that for release 16 the assumption on the UL side was that LBT needed to be successful in all scheduled sub-bands for the UE to transmit and that only contiguous sub-bands could be scheduled.  **Issue 3-1-3:** Capability will be needed to cover future cases in UL  **Issue 3-1-5:** At least in release 16 wide-band transmission modes are different in DL and UL. |
| Qualcomm | Issue 3-1-1: Do not agree. If a sub-band is not scheduled in DL, it should not have any bearing on whether scheduled sub-bands should be received.  Issue 3-1-2: Do not agree. Same as 3-1-1 but for the UL.  Issue 3-1-3 to 3-1-5: Needs further discussion. The UE is required to support all bandwidths defined for the band, including the wideband channel 40, 60, and 80 MHz. However, for Rel-16 the receiver requirements have so far been defined with all sub-bands within the channel fully allocated. Therefore, it may not be meaningful to define capabilities for a mode in which there are not requirements. One possibility is not to define the capability now, but only after requirements are defined perhaps in a future release. Another possibility is to define the capability now, but to restrict it to Mode 1 until requirements for other modes are defined in the future.Issue 3-2-1: The performance will depend on the blocking requirements. For Rel-16, there are no blocking requirements defined to differentiate Mode 1, 2, and 3 so the performance will be the same.  Issue 3-3: For Rel-16, UL is assumed to occur only in contiguously allocated sub-bands within the wideband channel. ACS and SEM requirements are defined without filter adaptation to the sub-band configuration (only to the channel).  Issue 3-4: Needs further discussion. If we define capabilities, there should be requirements associated with them in order for them to be meaningful. In the event that requirements are not available, then either the capability should not be defined or it should be forced to a particular value for Rel-16 to reflect the capabilities supported by the current version of the RAN4 specifications. |
| Xiaomi | Issue 3-1-1 and 3-1-2:  Not sure about the necessity of the clarification. At least from our view, these seems to be already stated in Mode 1 description.  Issue 3-1-3: and 3-1-4:  These two issues have some overlap with the reply LS. We believe that the capability will be different at least the mode 3 non-contiguous transmission should be differentiated.  Issue 3-1-5:  Agreeable since the behavior will be different for UE or BS who does the LBT.  Issue 3-2:  Question 1: option 2  The performance degradation will need to consider both the in-band and out-of-band blocking requirement depending on the interference signal frequency. For the in-band interference, the baseband filter and digital AGC can help for different cases.  Issue 3-3  Question 4: Option 2  Question 5: Option 2 |
| Nokia | **Sub topic 3-1:**  **Issue 3-1-1:** We are of the understanding that mode 1 assumes LBT to be successful in all LBT sub-bands of a given wideband carrier which is also discussed further in our R4-2011447. That said, even if LBT passes in all sub-bands that does not necessarily protect the DL transmission for the LBT sub-bands which is not scheduled, due to e.g. low load traffic, as other stations/gNBs could find these sub-bands unused and initiate transmission. This is a mechanism which can not be avoided when operating in opportunistic spectrum. In other words, irrespective of Mode 1 or Mode 2/3, certain degree of Adjacent channel rejection at the UE is required.  **Issue 3-1-2:** Similar as above - Here it can be emphasized that we should also clarify the difference between per BWP or per carrier as further discussed in our R4-2011447.  **Issue 3-1-3:** It is a bit unclear if all the modes are referred to here. In our understanding Case 4 (Mode 1) should be supported by default for a NR UE in DL and for UL a capability is already defined per RAN1 design. Case 2a/b (Mode 2/3) should be supported if also intra-band CA is supported for NR-U and a capability already is defined for this so in our opinion they could be linked. The main difference is the possibility scheduling og intra-cell guardbands (Case 3) but for this separate optional capability are already proposed. It can be discussed if mode 3 should have its own separate capability.  **Issue 3-1-4:** We are open to this discussion. However, perhaps a better baseline is Mode2 as this is similar to intra-band CA when intra-cell guardbands are not scheduled. Mode 2/3 allows for more flexible gNB operation (from LBT point of view), similar to (e)LAA, compared to Mode 1, and as argued above, Mode 1 does not guarantee zero co-channel interference.  **Issue 3-1-5:** Yes, as further discussed in our R4-2011447.  **Sub topic 3-2:**  Our understanding as provided in the summary.  **Sub topic 3-3:**  Our understanding as provided in the summary.  **Sub topic 3-4:**  We support Option 2  **Issue 3-4:** In our opinion there is no need for capability signalling for DL WB operation Case 4 (Mode 1) and UL WB operation Case 3 besides support for NR-U as this is fundamental NR operation. It can be noted that in our opinion mode 1 is sub optimal and therefore we should perhaps focus on mode 2 which is in principal similar to UL intra-band CA operation when no scheduling of intra-cell guard bands is performed. Further, DL case 2 (Mode 2) is similar to intra-band CA. There are already capability signalling for intra-band CA and if this is signalled supported then DL case 2 should also be supported. In principal DL case 3 should also be supported but this is dependent on capability of scheduling in intra-cell guardbands as also discussed further in our R4-2011447. To our understanding there is already capability signalling for UL WB operation Case 3 in RAN1 design and as this UL case req. LBT passes for all sub-bands no further capability is needed defined. And finally, for UL we think that transmission within one RB-set in the UL BWP should be baseline here. i.e. Case 1.  **Question to MediaTek –** Regarding Proposal 4 in your contribution. Not sure this proposal is understood; how can a transmission happen in unlicensed spectrum without LBT? Is this in a BS initiated COT or only ‘short LBT’? |
| Huawei | Agree with Issue 3-1-1 and 3-1-2.  For issue 3-1-3, we don’t think that wide-band transmission modes should have separate UE capabilities, if we reuse the terminology in the LS(R1-2004965/ R4-2009509), only separate UE capabilities for DL case 2 and case 3 should be defined.  For issue 3-1-4, generally, we don’t think there is strict differentiation among these modes, but we are open to discuss.  Agree with issue 3-1-5.  Sub topic 3-2:  Q1: option 2  Q2a: option 2  Q2b: case 4 is not UE capability, if the bandwidth is supported, then it should be mandatory for UE, no capability signaling is needed.  Q2c: CA is an independent UE capability.  Q3: we understand that from RAN1’s perspective, it should be BWP, but from RAN4’s perspective, it should be carrier.  Sub topic 3-3:  Q4: No difference  Q5: No difference  sub topic 3-4:  Only single UE capability “reception in intra-carrier guardband” should be defined, which is intended to differentiate the DL case 2 and case 3. |
| MediaTek | **Issue 3-1-1:**  Not Agreeable.  From UE perspective, this is just like licensed DL transmission: Even if the channel bandwidth is 20MHz, network does really have to transmit data on every RBs to a single UE. If UE#1 is only scheduled with a subset of RBs, the reception behaviour is irrelevant to whether the remaining RBs are empty or used by other purpose. (although the performance may be different.)  **Issue 3-1-2:**  The proposal should be revised to 1) irrespective of which sub-bands are scheduled with data or 2) only in those LBT sub-bands where UL data is scheduled.  From our view, 2) is more reasonable. If a certain subband has actually no UL data to be transmitted, performing LBT on that subband jointly with other subbands is only to decrease the chance of UL transmission.  **Issue 3-1-3:**  Need more discussion.  At least in our view, UE capabilities for some WB transmission modes without requirements are not needed in Rel-16.  **Issue 3-1-4:**  Need more discussion  In our view, the UE behaviour is the same for all sub-modes, it is only the outcome of LBT results different (single or multiple successful subbands). But we would like to hear more views from companies.  **Issue 3-1-5:**  Agreeable.  At least whether the behavior on guard band transmission is already different between DL and UL. For DL whether to receive on intra-carrier guardband is configured by network, while for UL, the transmission on intra-carrier guardband is mandatory.  **Issue 3-2: question 1**  Option 1.  We should consider the requirement from 2 aspects. One is the static requirement (the DL scheduling is always the same), and the other is dynamic (LBT results on different subbands change from COT to COT.) We do not think the current requirements are really ready from both aspects for Case 2a/2b/3.  Regarding AGC, Case 2a/2b/3 definitely have an issue when a subband is occupied by WiFi, which could be extremely closed to UE. The situation is the same as Case 4 where all signals are transmitted by the same node (UE’s serving cell).  **Issue 3-2: question 2a/2b/2c**  Option 1.  Same comment as question 1. The requirements are not ready.  **Issue 3-2: question 3**  Option 1.  Open to discuss.  **Issue 3-3: question 4**  Option 1  At least from current running CR, the SEM is based on the remaining transmitted channels. Therefore filter adaptation is needed for UL WB operation Case 1/2.   |  | | --- | | 6.5F.2.2.1 Spectrum emission mask for non-transmitted channels In the case of non-transmitted 20 MHz channel(s) on the edges of an assigned channel bandwidth the spectrum emission mask for operation with shared spectrum channel access, specified in Table 6.5F.2.2-1, is applied by using the total bandwidth of the remaining transmitted channels. The spectrum emission mask for non-transmitted channels is floored at -28dBr. |   **Issue 3-3: question 5**  Both Options are fine.  **Issue 3-4:**  Option 1.  As we mentioned in **Issue 3-2: question 1**, if the requirements (both static and dynamic) are not ready, introducing UE capability is only to cause coexistence problem with WiFi or LAA and to confuse the market. We should not define UE capabilities for those features without corresponding requirements. |
| LG Electronics | **Issue 3-4:**  Option 2: |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## 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.*

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

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

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

|  |  |
| --- | --- |
| **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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |