**3GPP TSG-RAN WG4 Meeting # 98-e R4-21**

Electronic Meeting, Jan. 25-Feb. 5, 2021

**Agenda item:** 9.22

**Source:** Moderator (Huawei)

**Title:** Email discussion summary for [98e][121] NR\_FR1\_35MHz\_45MHz\_BW

**Document for:** Information

# Introduction

The scope of this email discussion is to discuss the contributions submitted at agenda 9.22 on introduction of channel bandwidths 35MHz and 45MHz for NR. The following topics are discussed in the email discussion.

* Topic#1: General part
  + Sub-topic 1-1: Work plan
* Topic#2: Spectrum utilization
  + Sub-topic 2-1: Channel raster and PRB grid alignment
  + Issue 2-2: Spectrum utilization
* Topic#3: UE RF requirements
  + Sub-topic 3-1: n1 45MHz REFSENS
  + Sub-topic 3-2: n3 35MHz and 45 MHz REFSENS
  + Sub-topic 3-3: n8 and n71 REFSENS
  + Sub-topic 3-4: n25 35MHz and 45MHz REFSENS
  + Sub-topic 3-5: n2 and n25 A-MPR
  + Sub-topic 3-6: n1 A-MPR
* Topic #4: UE CRs
* Topic#5: BS CRs

# Topic #1: General part

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2101501 | Huawei, HiSilicon | Proposal 1: it is proposed to provide formal Rel-17 CRs at RAN4#98-e as long as the requirements are finalized at least for one band. If RAN accepts the WI will be extended for the remaining work for other bands if any. |
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## Open issues summary

### Sub-topic 1-1

**Issue 1-1: Work plan**

* Proposals
  + Option 1: technical endorse the CR for the band(s) which the requirements are finalized and extend the WI
  + Option 2: approve the CR for some band finalized in this meeting and the CRs for remaining band(s) will come in future meeting.
* Recommended WF
  + It is proposed to agree one of the options above at 1st round discussion

## Companies views’ collection for 1st round

### Open issues

**Comments on work plan**

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| **Company** | **Comments** |
| China Telecom | We have slightly preference to agree the CR’s for some completed bands in this meeting in order to make progress according to the WI timeline, and then continue discuss the remaining bands in next meeting. |
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## 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** |
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*Recommendations on WF/LS assignment*

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

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

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
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## 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*

# Topic #2: Spectrum utilization

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2102192 | ZTE Corporation | Remove [] for the SU values for 35MHz and 45MHz in the table.   |  |  |  | | --- | --- | --- | | SCS (kHz) | 35MHz | 45MHz | | NRB | NRB | | 15 | 188 | 243 | | 30 | 92 | 119 | | 60 | 44 | 58 | |
| R4-2100753 | Nokia, Nokia Shanghai Bell | *Observation 1: The PRB grid alignment between new and legacy channel bandwidths is important.*  *Observation 2: The PRB grid alignment can be maintained by reducing the number of PRBs in either the legacy or the new channel bandwidth.*  *Observation 3: Applying a 5 kHz channel raster for the legacy UEs' channel bandwidth (similar to a bandwidth part) can also solve the PRB grid alignment.*  *Proposal 1: The UE support of all NR-ARFCN with 5 kHz granularity for FR1 bands with 100 kHz channel raster shall be assumed for a smaller UE channel bandwidth operating inside a wider channel bandwidth, and this understanding shall be clarified in TS 38.101-1, e.g. in the subclauses 5.3.1 and 5.4.2.3.* |

## Open issues summary

### Sub-topic 2-1

**Issue 2-1: Channel raster and PRB grid alignment**

* Proposals

To maintain the channel raster and PRB grid alignment between the new and legacy channel bandwidths,

* + Option 1: adjust the number of PRBs for 45 MHz， e.g. NRB=242.
  + Option 2: configure NRB=215 for 40 MHz CBW for the legacy UE
  + Option 3: Apply a 5 kHz channel raster for FR1 bands with 100 KHz channel raster
* Recommended WF
  + TBD

### Sub-topic 2-2

**Issue 2-2: Spectrum utilization**

* Proposals
  + Remove [] for the SU values for 35MHz and 45MHz
* Recommended WF
  + Approve the proposal to remove [].

## Companies views’ collection for 1st round

### Open issues

**Comments on Issue 2-1: Channel raster and PRB grid alignment**

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| **Company** | **Comments** |
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**Comments on Issue 2-2: Spectrum utilization**

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| **Company** | **Comments** |
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## 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** |
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## Discussion on 2nd round (if applicable)

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| **Company** | **Comments** |
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## Summary on 2nd round (if applicable)

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# Topic #3: UE RF requirements

## Companies’ contributions

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| **T-doc number** | **Company** | **Title** |
| R4-2100516 | Apple Inc. | A-MPR Proposal for n1 and 45MHz CBW |
| R4-2100517 | Apple Inc. | A-MPR Proposal for n2 and 35MHz CBW |
| R4-2100518 | Apple Inc. | A-MPR Proposal for n25 and 45MHz CBW |
| R4-2100703 | Murata Manufacturing Co Ltd. | REFSENS of n8 and n71 for 35MHz channel bandwidth |
| R4-2100705 | Murata Manufacturing Co Ltd. | REFSENS of n25 for 45MHz channel bandwidth |
| R4-2101159 | Mediatek India Technology Pvt. | REFSENS evaluation of n8 and n71 for 35MHz channel bandwidth |
| R4-2101177 | Qualcomm Incorporated | 35MHz 45MHz AMPR, MPR, REFSENS for n8, n71, and n25. |
| R4-2101502 | Huawei, HiSilicon | UE REFSENS for 35 MHz and 45 MHz |
| R4-2102592 | Apple Inc. | MSD considering asymmetric UL/DL for bands n8 and n71 |
| R4-2102927 | Skyworks Solutions Inc. | 35MHz 45MHz REFSENS |

Summary of REFSENS proposals from companies:

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| REFSENS (15 KHz SCS) | | | | | | | | | | | | | |
| Company | n1 | n2 | n3 | | n8 | | | n25 | | | n71 | | |
| 45 | 35 | 35 | 45 | 35 | | | 35 | 45 | | 35 | | |
| worst | Mid | Best | worst | Best | worst | Mid | Best |
| Murata |  |  | -86 | -84.2 | -64 |  | -85.2 | -85.4 | -77.4 |  | -69.1 |  | -87.7 |
| Mediatek |  |  |  |  | -67.6 |  | -87.8 |  |  |  | -67.6 |  | -88 |
| Qualcomm |  |  | -85.2 | -80.2 | -69.9 | -78.5 |  | -81.7 | -76.4 |  | -69.9 | -82.7 |  |
| Huawei | -90.1 |  | -86.1 | -82 | -71.5 |  |  |  |  |  | -71 |  |  |
| Apple |  |  |  |  |  | -76.7 |  |  |  |  |  | -77 |  |
| Skyworks | -90.1 | -87.1 | -87.5 | -85 | -70.6 |  | -85.1 | -86.1 | -81 | -84.4 | -71.6 |  | -85.5 |
| Average | -90.1 |  | -86.2 | -82.9 | -68.7 | -77.6 | -86 | -84.4 | -78.3 |  | -69.8 | -79.9 | -87 |

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| UL Config (15 KHz SCS) | | | | | | | | |
| Company | n1 | n2 | n3 |  | n8 | n25 |  | n71 |
| 45 | 35 | 35 | 45 | 35 | 35 | 45 | 35 |
|  |  |  |  |  |  |  |  |  |
| Murata |  |  | 50 |  | 20 | 40 | 40 | 20 |
| Mediatek |  |  |  |  | 20 |  |  | 20 |
| Qualcomm |  |  | 50 |  | [20] | 45 | 40 | [20] |
| Huawei | 128 |  | 50 | 50 | 20 |  |  | 20 |
| Apple |  |  |  |  | 20 |  |  | 20 |
| Skyworks | 128 | 40 | 50 | 50 | 25 | 40 |  | 25 |

## Open issues summary

### Sub-topic 3-1

**Issue 3-1: n1 45MHz REFSENS**

* Proposals summary

See clause 3.1.

* Tentative agreements
* **Table 3.2.1-1: Two antenna port reference sensitivity QPSK PREFSENS**

| **Operating Band** | **SCS kHz** | **45**  **MHz (dBm)** |
| --- | --- | --- |
| n1 | 15 | -90.1 |
| 30 | [-90.2] |
| 60 | -90.3 |

* **Table 3.2.1-2: Uplink configuration**

| **Operating Band** | **SCS kHz** | **45**  **MHz** |
| --- | --- | --- |
| n1 | 15 | 1281 |
| 30 | 641 |
| 60 | 301 |

* Recommended WF
  + Agree on reference sensitivity and UL configuration in Table 3.2.1-1 and Table 3.2.1-2.

### Sub-topic 3-2

**Issue 3-2: n3 35MHz and 45 MHz REFSENS**

* Proposals summary

See clause 3.1.

* Tentative agreements
* Table 3.2.2-1: Two Antenna Port Reference Sensitivity QPSK PREFSENS

| Operating Band | SCS kHz | 35 MHz (dBm) | 45 MHz (dBm) |
| --- | --- | --- | --- |
| n3 | 15 | [-86.2] | [TBD] |
| 30 | [-86.3] | [TBD] |
| 60 | [-86.4] | [TBD] |

* Table 3.2.2-2: Uplink Configuration for Reference Sensitivity

| Operating Band | SCS kHz | 35 MHz (dBm) | 45 MHz (dBm) |
| --- | --- | --- | --- |
| n3 | 15 | 501 | 501 |
| 30 | 241 | 241 |
| 60 | 101 | 101 |

* Recommended WF
  + Agree on UL configuration in Table 3.2.2-2 and check whether the REFSENS in Table 3.2.2-1 is acceptable.

### Sub-topic 3-3

**Issue 3-3: n8 and n71 REFSENS**

* Proposals summary

See clause 3.1.

* Potential agreements
  + Channel locations
    - Option 1: Worst case
    - Option 2: Middle case (centre)
    - Option 3: Worst case and best case
  + Refsens

Table 3.2.3-1: Two Antenna Port Reference Sensitivity QPSK PREFSENS for n8 35MHz CBW.

| Operating Band | SCS kHz | **Channel bandwidth (DL)**  (MHz) | **Channel bandwidth (UL)**  (MHz) | **FC (DL)**  (MHz) | **FC (UL)**  (MHz) | **UL**  allocation (LCRB) | REFSENS  (dBm) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| n8 | 15 | 35 | 20 | 942.5 | 890.0 | 252 | [-86] |
| 30 | 102 | [-86.1] |
| 60 |  |  |
| n8 | 15 | 35 | 20 | 942.5 | 905.0 | 252 | [-68.7] |
| 30 | 102 | [-68.8] |
| 60 |  |  |

Table 3.2.3-2: Two Antenna Port Reference Sensitivity QPSK PREFSENS for n71 35MHz CBW.

| Operating Band | SCS kHz | **Channel bandwidth (DL)**  (MHz) | **Channel bandwidth (UL)**  (MHz) | **FC (DL)**  (MHz) | **FC (UL)**  (MHz) | **UL**  allocation (LCRB) | REFSENS  (dBm) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| n71 | 15 | 35 | 20 | 634.5 | 688.0 | 252 | [-87] |
| 30 | 102 | [-87.1] |
| 60 |  |  |
| n71 | 15 | 35 | 35 | 634.5 | 673.0 | 252 | [-69.8] |
| 30 | 102 | [-69.9] |
| 60 |  |  |

* Recommended WF
  + Option 3 is recommended for UL channel locations
  + Discussion on the above potential agreements and check whether the REFSENS in Table 3.2.3-1 and Table 3.2.3-2 are acceptable.

### Sub-topic 3-4

**Issue 3-4: n25 35MHz and 45MHz REFSENS**

* Proposals summary

See clause 3.1.

* Potential agreements
  + Channel locations 40/45 MHz case
    - Option 1: Worst case
    - Option 2: Middle case (centre)
    - Option 3: Worst case and best case
  + n25 Refsens

Table 3.2.4-1: Two Antenna Port Reference Sensitivity QPSK PREFSENS for n25 35 MHz

| Operating Band | SCS kHz | 35 MHz (dBm) |
| --- | --- | --- |
| n25 | 15 | [-84.4] |
| 30 | [-84.5] |
| 60 | [-84.6] |

Table 3.2.4-2: Uplink Configuration for Reference Sensitivity

| Operating Band | SCS kHz | 35 MHz (dBm) |
| --- | --- | --- |
| n25 | 15 | 401 |
| 30 | 201 |
| 60 | 101 |
|  |  |

Table 3.2.4-3: Two Antenna Port Reference Sensitivity QPSK PREFSENS for n25 35 MHz

| Operating Band | SCS kHz | **Channel bandwidth (DL)**  (MHz) | **Channel bandwidth (UL)**  (MHz) | **FC (DL)**  (MHz) | **FC (UL)**  (MHz) | **UL**  allocation (LCRB) | REFSENS  (dBm) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| n25 | 15 | 45 | 40 | 1972.5 | 1890.0 | 401 | TBD |
| 30 | 201 | TBD |
| 60 | 101 | TBD |
| n25 | 15 | 45 | 40 | 1972.5 | 1895.0 | 401 | [-78.3] |
| 30 | 201 | [-78.4] |
| 60 | 101 | [-78.5] |

* + n2 Refsens
    - further check on more inputs
* Recommended WF
  + Option 3 is recommended for UL channel locations
  + Discussion on the above potential agreements and check whether the REFSENS in Table 3.2.4-1~ Table 3.2.4-3 are acceptable.

### Sub-topic 3-5

**Issue 3-5: n2 and n25 A-MPR**

* Proposals
* A-MPR for NS\_03 35MHz CBW in R4-2100517,
* Table 3.2.5-1: A-MPR for NS\_03 35MHz CBW

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| --- | --- | --- | --- | --- | --- |
| Channel BW | Carrier Frequency  Fc | Waveform | Modulation | Outer | Inner |
| 35MHz | 1867.5<=Fc <= 1892.5 | DFT-s-OFDM | PI/2 BPSK | 2.5 | 0.5 |
| QPSK | 3.0 | 0.5 |
| 16QAM | 3.0 | 1.0 |
| 64QAM | 3.5 | 2.5 |
| 256QAM | 5.5 | 4.5 |
| CP-OFDM | QPSK | 4.5 | 2.0 |
| 16QAM | 4.5 | 2.5 |
| 64QAM | 4.5 | 3.5 |
| 256QAM | 7.5 | 6.5 |

* A-MPR for NS\_03 45MHz CBW in R4-2100518,
* Table 3.2.5-2: A-MPR regions for NS\_03 45MHz CBW

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| --- | --- | --- | --- | --- |
| Channel BW | Carrier Frequency  Fc | RBend\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 45 MHz | 1872.5<=Fc <= 1892.5 MHz | >=38.16 | >0 | A1 |
| >=19.44, <38.16 | >=15.48 | A2 |
| <19.44 | >=max(0,RB\_end\_Hz-3.96e6) | A3 |

* Table 3.2.5-3: A-MPR for NS\_03 45MHz CBW

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Waveform | Modulation | A1 | A2 | A3 |
| Outer / Inner | Outer / Inner | Outer / Inner |
| DFT-s-OFDM | PI/2 BPSK | 3.5 | 2.5 | 2.0 |
| QPSK | 4.0 | 3.0 | 2.5 |
| 16QAM | 4.5 | 3.0 | 3.0 |
| 64QAM | 4.5 | 3.5 | 3.5 |
| 256QAM | 5.5 | 5.5 | 5.5 |
| CP-OFDM | QPSK | 5.5 | 4.5 | 5.0 |
| 16QAM | 5.5 | 4.5 | 5.0 |
| 64QAM | 5.5 | 4.5 | 5.0 |
| 256QAM | 7.5 | 7.5 | 7.5 |

Note: in the WF approved in RAN4#97-e, the following tentative agreements were reached,

* + Agree on the updated NS\_03 requirement for 35MHz and 45MHz
  + Agree to use same NS\_03 AMPR for 35MHz and 45MHz as specified in TS38.101-1
* Recommended WF
  + TBD

### Sub-topic 3-6

**Issue 3-6: n1 A-MPR**

* Proposals
* A-MPR Regions for NS\_48 and NS\_49 in R4-2100517,
* Table 3.2.6-1: Regions for NS\_48

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| --- | --- | --- | --- | --- |
| Channel BW (MHz) | Carrier Frequency  Fc (MHz) | RBend\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 45 | 1942.5 ≤ Fc ≤1957.5 | >=0, <5.76 | >0 | A2 |
| >=5.76, <19.44 | >=max(0,12\*RB\_end\*SCS-3.6) | A4 |
| >=5.76, <19.44 | <max(0,12\*RB\_end\*SCS-3.6)  >=max(0,12\*RB\_end\*SCS-5.76) | A3 |
| >=19.44, <38.16 | >=14.4 | A2 |
| >=30.24, <38.16 | <1.08 | A5 |
| >=38.16 | >0 | A1 |

* Table 3.2.6-2: Regions for NS\_49

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| --- | --- | --- | --- | --- |
| Channel BW (MHz) | Carrier Frequency  Fc (MHz) | RBend\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 45 | 1942.5 ≤ Fc ≤1957.5 | >=7.74, <14.4 | <max(0,RB\_end-7.74) | A5 |
| >=30.96, <35.28 | <1.08 | A5 |
| <35.28 | >=15.12  <max(0,RB\_end-7.74) | A2 |
| <35.28 | <15.12  >=11.52  < max(0,RB\_end-7.74) | A3 |
| <35.28 | >=max(0,RB\_end-7.74) | A1 |
| >=35.28 | >0 | A1 |

* Recommended WF
  + TBD

## Companies views’ collection for 1st round

### Open issues

**Issue 3-1: n1 45MHz REFSENS**

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| **Company** | **Comments** |
| China Telecom | -90.1dBm for 30kHz is more preferred. But we are ok to add the bracket to -90.2 as recommended by moderator. |
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**Issue 3-2: n3 35MHz and 45 MHz REFSENS**

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| **Company** | **Comments** |
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**Issue 3-3: n8 and n71 REFSENS**

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| **Company** | **Comments** |
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**Issue 3-4: n25 35MHz and 45MHz REFSENS**

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| **Company** | **Comments** |
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**Issue 3-5: n2 and n25 A-MPR**

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| **Company** | **Comments** |
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**Issue 3-6: n1 A-MPR**

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| **Company** | **Comments** |
| China Telecom | Thanks for the inputs on the a-mpr simulations for Band n1. In general we are fine with the regions assignment and corresponding a-mpr values. The a-mpr values for 45MHz seemingly have a little bit improvement by comparing to the cases for 50MHz. Just wonder if there are any other updates or inputs for double check on this requirement? |
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## 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** |
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*Suggestion on WF/LS assignment*

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

# Topic #4: UE CRs

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Title** |
| R4-2101503 | Huawei, HiSilicon | CR for TS 38.101: introduction of channel bandwidths 35MHz and 45MHz |
| R4-2102193 | ZTE Corporation | Introduction of 35MHz and 45 MHz bandwidths to TS38.101-1 |
| R4-2102606 | Apple | CR for TS 38.101-1: UE RF requirements table simplification |

## Companies views’ collection for 1st round

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| R4-2101503 |  |
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| R4-2102193 |  |
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| R4-2102606 |  |
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## Summary for 1st round

### CRs/TPs

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

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
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## Discussion on 2nd round (if applicable)

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| **Company** | **Comments** |
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## Summary on 2nd round (if applicable)

# Topic #4: BS CRs

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2101504 | Huawei, HiSilicon | CR for TS 38.104: introduction of channel bandwidths 35MHz and 45MHz |
| R4-2101505 | Huawei, HiSilicon | CR for TS 37.141: introduction of channel bandwidths 35MHz and 45MHz |
| R4-2101506 | Huawei, HiSilicon | CR for TS 37.145-2: introduction of channel bandwidths 35MHz and 45MHz |
| R4-2101559 | Ericsson | CR to TS 37.105: Introduction of CBWs 35 MHz and 45 MHz |
| R4-2101560 | Ericsson | CR to TS 38.141-1: Introduction of CBWs 35 MHz and 45 MHz |
| R4-2101986 | ZTE Corporation | CR to TS 38.141-2: Introduction of 35MHz and 45MHz |
| R4-2101987 | ZTE Corporation | CR to 37.145-1: Introduction of 35MHz and 45MHz |
| R4-2102484 | Nokia, Nokia Shanghai Bell | CR to 37.104: Introduction of requirements for 35 and 45MHz channel bandwidths |

## Companies views’ collection for 1st round

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| R4-2101504 |  |
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| R4-2101505 |  |
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| R4-2101506 |  |
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| R4-2101559 |  |
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| R4-2101560 |  |
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| R4-2101986 |  |
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| R4-2101987 |  |
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| R4-2102484 |  |
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## Summary for 1st round

### CRs/TPs

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

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
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## 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*