**3GPP TSG-RAN WG4 Meeting # 104-e R4-22XXXXX**

**Electronic Meeting, 15 – 26 Aug 2022**

**Agenda item:** 11.7

**Source:** Moderator(Nokia, Xiaomi)

**Title:** Email discussion summary for [104-e][133] FR2\_enh\_req\_Ph3

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round: TBA
* 2nd round: TBA

It is appreciated that the delegates for this topic put their contact information in the table below.

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|  |  |  |
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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)

# Topic #1: UL 256QAM

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2211813](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2211813.zip) | Nokia, Nokia Shanghai Bell | **Proposal 1**: Approve the simulation assumptions provided above in section 2 for FR2 UL 256QAM MPR simulations.  For the uplink 256QAM MPR study a simulator with the following impairments should be used [2]:   * Transceiver noise -38.5 dBc * Modulator I/Q imbalance -33.7 dBc * Modulator CIM3 -60 dBc * Carrier suppression 25 dB * Phase noise -35 dBc   The EVM contributions of error sources should be according to Table 1   |  |  |  | | --- | --- | --- | | **TX EVM source** | **EVM** | | |  | **%** | **C/N [dBc]** | | PA | 1.85 | 34.7 | | Transmitter | 1.19 | 38.5 | | Phase noise | 1.78 | 35.0 | | I/Q image | 2.06 | 33.7 | |  |  |  | | Total | 3.5 | 29.1 | |
| [R4-2212187](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212187.zip) | LG Electronics | **Proposal 1**: Consider CPE compensation for EVM of UL 256QAM in FR2-1.  **Proposal 2**: Define the same MPR of 256QAM for PC2 and PC5 in FR2-1. |
| [R4-2212330](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212330.zip) | Qualcomm Incorporated | **Observation 1**: Additional MPR compared to UL 64QAM is expected to help a legacy UE become EVM compliant at the high end of the EIRP range.  **Observation 2:** An elevated minimum EIRP level compared to UL 64QAM is expected to help a legacy UE become EVM compliant at the low end of the EIRP range.  **Proposal 1**: The DMRS based channel estimate in the PTRS-ready EVM calculator shall utilize CPE-corrected DMRS symbols  **Proposal 2:** The PTRS extraction and correction stage in the PTRS-ready EVM calculator is the final refinement of the received signal.  **Proposal 3:** (PTRS Configuration) For UL 256QAM in FR2, the PTRS configuration shall be aligned with the UE’s recommended PTRS configuration.  **Proposal 4:** (PTRS Configuration) For UL 256QAM in FR2, 2 port PTRS is configured for 2L UL.  **Proposal 5:** RAN4 to decide between the example 1 example 2 PN profiles from TR38.803 as a calibration waveform for the EVM calculator |
| [R4-2212370](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212370.zip) | Apple | **Proposal 1:** We propose to set the minimum UE EIRP for 256QAM as listed below. The values are derived for an EVM budget of 3.5% for 256QAM.   * UE EIRP for PC1: 19.5dBm * UE EIRP for PC2, PC3, PC4: 2.5dBm * UE EIRP for PC5: 9.5dBm   **Proposal 2:** In case the proposal made on UE EVM budget in [2] is accepted and the UE EVM budget is set to 4.0% the minimum UE EIRP for 256QAM would be proposed as listed below:   * UE EIRP for PC1: 18.5dBm * UE EIRP for PC2, PC3, PC4: 1.5dBm * UE EIRP for PC5: 8.5dBm   **Proposal 3:** Introduce minimum UE EIRP scaling for 256QAM according to Table 6.4.2.1-3x since thermal noise provides a stronger issue for high order modulations such as 256QAM due to the small EVM budget. The base value is from Proposal 1. In case of UE EVM budget in R4-2212371 is accepted the base value should be taken from Proposal 2.  Table 6.4.2.1-3x: Parameters for Error Vector Magnitude for power class 3 in FR2-1   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  | Level | | | | | Parameter | Unit | 50 MHz | 100 MHz | 200 MHz | 400 MHz | | UE EIRP for UL 256 QAM | dBm | ≥ 2.5 | ≥ 2.5 | ≥ 5.5 | ≥ 8.5 | | Operating conditions | Normal Conditions | | | | | | NOTE 1: PTRS is configured for 256 QAM | | | | | | |
| [R4-2212371](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212371.zip) | Apple | **Observation 1:** Due to the high phase noise in FR2 it has been necessary to improve LO leakage and IQ image assumption for 64QAM to fit all EVM sources into the 8% EVM budget.  **Observation 2**: Major performance improvements for phase noise, PA, transmitter, LO leakage and IQ Image is necessary to comply with 265QAM EVM budget of 3.5%.  **Observation 3**: FR2 phase noise performance would need to be close to FR1 EVM phase noise which is hard to achieve as performance generally degrades with increasing frequency, especially for mmW. Additionally, according to Leeson’s equation the phase noise can change up to 6.7dB from lower end to upper end of FR2-1 range.  **Proposal 1:** Due to the considerable challenges with phase noise and the other EVM contributors it is proposed to consider asymmetric EVM split for UE/handheld (power class 3) and BS. With relaxing UE budget by 1dB the EVM allowance would be 28.1dB (4%) and the BS has an EVM budget of -30.5dB (3%). For FWA/CPE devices the equal split approach can be kept. BS generally have better phase noise performance and we would like to propose a discussion whether BS can meet 3% EVM budget.  **Proposal 2**: Consider configuring PTRS for 256QAM EVM testing. |
| [R4-2212394](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212394.zip) | MediaTek Inc. | We propose the EVM budget summarized in Table 1 for FR2-1 UL 256QAM MPR simulations. It can be seen that phase noise and PA non-linearity dominate the FR2 Tx performance.   |  |  |  | | --- | --- | --- | | EVM Contributor | EVM(%) | SNR(dB) | | Transmitter | 1.32 | 37.59 | | Phase Noise | 2.09 | 33.59 | | IQ Imbalance | 0.93 | 40.63 | | PA Non-linearity | 2.29 | 32.80 | | Total | 3.5 | 29.13 | |
| [R4-2212498](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212498.zip) | Huawei, HiSilicon | From the simulation results, it is shown that support 256 QAM can provide significant performance gain over 64QAM where the UE is in good propagation condition  **Proposal 1**: it is proposed to adopt the simulation assumption in Table 2-1 in the link level simulation.   |  |  | | --- | --- | | Parameter | Value | | Carrier frequency | 29 GHz | | CBW | 50 MHz | | SCS | 120 kHz; | | Allocated RBs | Full allocation | | Propagation | TDL-D 30ns delay spread, 35Hz Doppler frequency | | Static (AWGN) | | MCS | 64QAM: MCS 23, code rate 719/1024  256QAM: MCS21, code rate 711/1024 | | Baseline: fixed MCSs | | Precoding | follow PMI | | Symbol type | CP-OFDM | | HARQ | None | | Antenna configuration | Fading channel: 2x2 for Rank1, Low correlation | | Static channel: 2x2 for Rank1 | | Channel estimation | Practical | | Receiver type | MMSE | | PUSCH configuration | Type A mapping, Start symbol 0, Duration 14 | | DMRS configuration | Type 1, Single symbol, 1 additional DMRS | | PTRS configuration | KPTRS : 2 (every 2 RBs), LPTRS : 1 (every 1 symbol) | | Phase noise compensation | Practical based on PTRS | | Phase noise model | TR 38.803 model (in section 6.1.10 and section 6.1.11)  Option a): example1  + example1  Option d):example2 (BS) + PN model config1: example1(UE) | | txEVM + rxEVM excluding phase noise for 256QAM | txEVM: 1%, 2%, 3%, 3.5%;  rxEVM: 1%, 2%, 3%, 3.5%; | |
| [R4-2212591](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212591.zip) | Xiaomi | From link level simulation results we can conclude that 256QAM performance is very sensitive to RF impairments (i.e. EVM level). And the performance gain for 256QAM compared to 64QAM could be observed below 27dB SNR.  **Proposal:** link level simulation assumption for UL 256QAM:   |  |  | | --- | --- | | **Parameter** | **Value** | | Carrier frequency | 29 GHz (n257) and 39 GHz (n260) | | CBW | 50 MHz, 100MHz | | SCS | 60kHz, 120 kHz; | | Allocated RBs | Full allocation | | Propagation | TDL-A 30ns delay spread, 35Hz Doppler frequency  TDL-D 30ns delay spread, 35Hz Doppler frequency  Static (AWGN) | | MCS | 64QAM: MCS 23, 24, 26, 28 in TS 38.214 Table 5.1.3.1-1, and other MCSs are not precluded  256QAM: MCS 21, 23, 25, 27 in TS 38.214 Table 5.1.3.1-2, and other MCSs are not precluded  Baseline: fixed MCSs | | Symbol type | CP-OFDM; DFT-S-OFDM | | HARQ | 8, None | | Antenna configuration | Fading channel: 2x2 for Rank1 and Rank2, Low correlation  Static channel: 1x2 for Rank1, 2x2 for Rank2 | | Channel estimation | Practical | | Receiver type | MMSE | | PUSCH configuration | Type A mapping, Start symbol 0, Duration 14 | | DMRS configuration | Type 1, Single symbol, 1 additional DMRS | | PTRS configuration | KPTRS : 2 (every 2 RBs), LPTRS : 1 (every 1 symbol) | | Phase noise compensation | Practical based on PTRS | | Phase noise model | TR 38.803 model (in section 6.1.10 and section 6.1.11)  modelled Phase noise for TX and RX  Option a): example1 (UE) + example1(BS)  Option b): example2 (UE) + example2(BS)  Option c): example2 (BS) + example2(BS)  Option d): example1 (UE) + example2 (BS)  Option e): Other phase noise models, e.g. ones extracted from commercially available components or published results, are not excluded | | txEVM + rxEVM excluding phase noise for 256QAM | txEVM: [1.0%-5.0%], rxEVM: [1.0%-5.0%]  Option 1: txEVM >= rxEVM; Option2: no restriction | | Other parameters | follow assumptions in TS38.104 Section 11.2.2 . | |
| [R4-2212635](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212635.zip) | ZTE Corporation | **Observation 1:** 256QAM performance gain can be expected in AWGN and TDL-D channel.  **Observation 2:** 256QAM performance gain is not obvious in TDL-A channel.  **Observation 3:** EVM assumption will impact performance gain for FR2 UL 256QAM. |
| [R4-2212790](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212790.zip) | vivo | **Observation 1a:** For AWGN in 29 GHz, UL 256QAM can archive performance gain when SNR >22 dB for EVM = 1% and when SNR >26 dB for EVM = 3%.  **Observation 1b:** For TDL-A and TDL-D in 29 GHz, UL 256QAM can archive performance gain when SNR >30 dB for EVM = 1% and when SNR >35 dB for EVM = 3%.  **Observation 2:** UL 256QAM is hard to provide performance gain in both 39GHz and 48 GHz.  **Observation 3:** DFT-s-OFDM waveform require lower operating SNR than CP-OFDM under UL 256QAM.  **Observation 4:** For PC3 UE, about 20% UE can archive 26 dB SINR at BS side in Indoor scenario, and it will be further reduced to 5% if adjacent channel interference is considered.  **Proposal 1:** Introduce UL 256QAM with DFT-s-OFDM first and further discuss the feasibility of CP-OFDM.  **Proposal 2:** Exclude PC3 from R18 UL 256QAM discussion scope and update the WID. |
| [R4-2213566](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2213566.zip) | Sony | Observation 1 The phase noise model, “Example 2”, described in TR 38.803, section 6.1.11, is best suited for simulation of FR2-1 256QAM performance.  Observation 2 High performance RF components or Compensation for Inter Carrier Interference (ICI) would possibly be needed to reach an average EVM level of 3.5 % for 256 QAM in FR2-1.  Observation 3 For 256-QAM, the spectral efficiency saturates at about 7.6 bits/s/Hz.  Observation 4 The SNR loss at high SNR values is about 7dB.  Observation 5 Better performance is possible if high performances RF component or ICI compensation techniques are deployed.  **Observation 6** There are clear benefits of introducing 256-QAM for FR2-1 in the high SNR range.  **Observation 7** 256-QAM is well suited for PC1, PC2, and PC5 where higher EIRP is assumed.  **Proposal 1** It is proposed that RAN4 continue to look into 256-QAM for PC1, PC2, and PC5. |
| [R4-2213970](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2213970.zip) | Ericsson Limited | **Observation 1**: Due to the nature of 256QAM, it is highly likely that the EVM requirement for UL 256QAM in FR2-1 is going to be tighter than the same requirement for UL 64QAM (8%).  **Observation 2**: It is very likely that the MPR requirement for 256QAM modulation will be higher than the MPR for 64QAM, given that the EVM requirement is anticipated to be tighter for 256QAM compared with 64QAM.  **Observation 3**: For power class 1, based on PASS/FAIL limit for the test on maximum output power (min peak EIRP for the main beam in beam locked mode) for 64QAM and its specified MPR, we anticipate that even for higher MPR for 256QAM, which is likely, 256QAM remains beneficial and feasible (allowing the tighter EVM compared with 64QAM).  **Observation 4**: For power classes 2 and 5, in the worst case for the MPR (edge RB allocations), despite PASS/FAIL limit being lower than for power class 1, even for the anticipated higher MPR for 256QAM compared with 64QAM, the 256QAM modulation can still be beneficial and feasible due to the very low minimum output power requirement.  **Observation 5:** For power class 3, in the worst case (edge RB allocations for band n262) the PASS/FAIL limit is already very low for 64QAM, and the anticipated MPR for 256QAM modulation is going to be even higher than for 64QAM and make the PASS/FAIL limit even lower. Thus, we conclude that 256QAM modulation may not be beneficial and feasible for all the bands for power class 3. |

## Open issues summary

### Sub-topic 1-1: EVM requirement

**Issue 1-1-1: Link level simulation assumption**

Phase noise models and other simulation parameters will be discussed in this issue.

* Proposals
  + Option 1:

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| --- | --- |
| **Parameter** | **Value** |
| Carrier frequency | 29 GHz (n257) and 39 GHz (n260) |
| CBW | 50 MHz |
| SCS | 120 kHz |
| Allocated RBs | Full allocation |
| Propagation | TDL-D 30ns delay spread, 35Hz Doppler frequency  Static (AWGN) |
| MCS | 64QAM: MCS 23, 24 in TS 38.214 Table 5.1.3.1-1  256QAM: MCS 21, 23 in TS 38.214 Table 5.1.3.1-2  Baseline: fixed MCSs |
| Symbol type | CP-OFDM; DFT-S-OFDM |
| HARQ | 8, None |
| Antenna configuration | Fading channel: 2x2 for Rank1 and Rank2, Low correlation  Static channel: 1x2 for Rank1, 2x2 for Rank2 |
| Channel estimation | Practical |
| Receiver type | MMSE |
| PUSCH configuration | Type A mapping, Start symbol 0, Duration 14 |
| DMRS configuration | Type 1, Single symbol, 1 additional DMRS |
| PTRS configuration | KPTRS : 2 (every 2 RBs), LPTRS : 1 (every 1 symbol) |
| Phase noise compensation | Practical based on PTRS |
| Phase noise model | TR 38.803 model (in section 6.1.10 and section 6.1.11)  modelled Phase noise for TX and RX  Option a): example1 (UE)  + example1(BS)  Option b): example2 (UE) + example2(BS)  Option d): example1 (UE) + example2(BS) |
| txEVM + rxEVM excluding phase noise for 256QAM | txEVM: 2%, 3%, 3.5%, 4%, rxEVM: 2%, 3%, 3.5%, 4%  Option 1: txEVM >= rxEVM; |
| Other parameters | follow assumptions in TS38.104 Section 11.2.2 . |

* + Option 2: Others. (Please list which parameters need to be modified and how modify)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX | ….  Others: |
| vivo | |  |  | | --- | --- | | Carrier frequency | 29 GHz (n257) and 39 GHz (n260) and 48 GHz(n262) |   n262 was introduced in previous release, we prefer to include it.   |  |  | | --- | --- | | PTRS configuration | KPTRS : 2 (every 2 RBs), LPTRS : 1 (every 1 symbol) |   The configuration above is ok for CP-OFDM, but for DFT-s-OFDM waveform, the PTRS pattern is quite different because it was added in time domain. The PTRS mapping parameter for DFT-s-OFDM is described in TS 38.211 as follows:    In our simulation, we use 4\*4, but we are also ok with other parameters. |
| Sony | In general, this looks good (we understand that it is based on WF R4-1907711). No problem to include n262. |
| Qualcomm | It would be good if proponents can identify the end goal of a link sim study. It is just to identify SNR range at the gNB where UL 256 QAM is beneficial? Link level EVM budget? The goal determines the simulation parameters.  Secondly, it is not possible to compare results without agreeing on a strategy on how to deal with phase noise effects using PTRS. PTRS configuration in UEs still needs to be discussed. |
| Murata | If there is a performance gain with 256QAM, what is the UE EVM requirement to achieve that link gain? 3.5% seems to be the case based on contributions and previous RAN4 documents, but this value is not presented in the options. Is this still to be determined based on agreement of link simulation parameters? If so, then a WF is required with a specific EVM and assumed PTRS configuration. |
| LGE | Considering the 48 GHz carrier frequency is good for us. |

**Issue 1-1-2: Supporting power classes**

* Proposals
  + Option 1: Only consider PC1, PC2, PC5 with equal EVM split for UE and BS
  + Option 2: Consider PC1, PC2, PC5 with equal EVM split for UE and BS and PC3 with asymmetric EVM split for UE and BS
  + Option 3: Consider PC1, PC2, PC3, PC5 with equal EVM split for UE and BS
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Apple | From system simulation results it seems that performance improvements are only obtained in a high SNR region and PC3 edge RB performance is quite limited. Comparing this marginal benefit to the considerable implementation challenges for handhelds it seems that Option 1 could be a way forward. In case it is not considered then Option 2 would also be fine. |
| OPPO | Option 1.  PC1/2/5 is the 1st priority of UL 256QAM, should focus on these power classes in the initial stage. |
| vivo | We support focus on PC1/PC2/PC5 only. Based on our simulation, if we take adjacent channel interference into consideration, only <5% PC3 UE can achieve 26 dB operating SNR at BS side under indoor scenario and it is also challenge for hardware design for PC3 UE, e.g., component linearity, heating. Regarding whether the EVM should be split equally or asymmetrically, we can further discuss it. |
| Sony | Option 1. PC1, PC2 and PC5 for sure. However, we don’t want to preclude PC3 at this moment, but it needs further analysis. |
| Qualcomm | It may be better to define what BS Rx EVM means first. We recognize that UL reception at the gNB is a relative interferer-free condition for FR2. Here, the SNR seen at the BS Rx would depend mainly on PSD of the UL. What component of this SNR is attributable to ‘BS Rx EVM’?  Alternatively, a link level sim could be used to determine total EVM budget, and that can be distributed among BS and UE depending on relative ease of achieving the split, BS Rx operating point, etc. |
| MTK | Option 1.  We prefer focus on PC1,PC2, and PC5. For PC3, we think it needs further discussions because of implementation challenges. |
| LGE | Option 1. The feasibility of PC3 is ambiguous. We should concentrate on first priority. |

**Issue 1-1-3: EVM test**

* Proposals
  + Option 1: Configuring PTRS for 256QAM EVM testing to compensate CPE
    - The DMRS based channel estimate in the PTRS-ready EVM calculator shall utilize CPE-corrected DMRS symbols
    - The PTRS extraction and correction stage in the PTRS-ready EVM calculator is the final refinement of the received signal.
  + Option 2: Introducing the compensation for Inter Carrier Interference (ICI)
  + Option 3: Others
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Apple | Option 1. Additionally, exploring Option 2 could be considered as it does not seem mutual exclusive. |
| Rohde & Schwarz | Option 1 seems good to us. This would then also match with what is discussed for FR2-2. So we could have a general approach. |
| vivo | For option 2, the PTRS can compensate both CPE and ICI under DFT-s-OFDM waveform because it is added in time domain. |
| Sony | Option 1 (first bullet) and Option 2. We think think it is good to have both CEP and ICI compensation for UE to fulfil the EVM requirement. Further analysis is required. |
| Qualcomm | As proponents of option 1:  We would like to differentiate between the ‘standardized EVM calculator’ and the strategies a real receiver would use. Just as more sophisticated receivers can improve on the legacy EVM calculator, we can see more sophisticated phase noise handling strategies can also exceed the performance of the EVM calculator.  In our view, it is not practical to try and converge on ICI cancelling strategies for both waveform types. An analog for the legacy EVM calculator case is improving it to cancel out the non-linear component of the impairment in the UL signal.  We are ok to study it, but option 1 can be chosen as a baseline if ICI cancellation cannot be agreed. |
| Murata | Option 1 but it is unclear if some residual component of IPN or implementation margin should be accounted for imperfect channel estimation. Do we assume perfect cancellation of CPE and ICI? |
| LGE | Option 1. If ICI compensation is valid, Option 2 is also OK. |

**Issue 1-1-4: PTRS configuration**

* Proposals
  + Option 1: PTRS configuration shall be aligned with the UE’s recommended PTRS configuration.
  + Option 2: Others
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Apple | Option 1 |
| OPPO | Option 1 in principle.  Question might be during conformance tests, can different UE be configured with different parameters? In our view configurations should be consistent for all UE in conformance tests. |
| vivo | OK with option 1 |
| Sony | Option 1. It is suggested the PTRS configuration shall follow the UE capability ***PTRS-DensityRecommendationUL)*** |
| Qualcomm | Option 1.  To OPPO: in our view UEs could be configured with different parameters based on their choices. Different UEs may have different phase noise characteristics, and therefore different benefit outcomes for a given PTRS configuration. It may not be practical to force the same PTRS configuration on all UEs, because it places an indirect requirement on the specific aspects of the phase noise profile. |
| LGE | Option 1 |

**Issue 1-1-5: PTRS port**

* Proposals
  + Option 1: 2 port PTRS is configured for 2L UL.
  + Option 2: 1 port PTRS is configured for 2L UL.
  + Option 3: Others.
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| XXX | ….  Others: |
| vivo | PTRS port number is also related to antenna capability, in TS 38.214 we can find:  “…If a UE has reported the capability of supporting full-coherent UL transmission, the UE shall expect the number of UL PT-RS ports to be configured as one if UL-PTRS is configured…” |
| Sony | Option 2. However, further analysis is needed. |
| Qualcomm | Simply put: single port PTRS means there is only one independent source of phase, and that it is shared between across the layers.  To make a general and future-proof EVM calculator, RAN4 must accommodate the case when the UE uses independent LOs for each layer. Forcing a shared PTRS port will penalize the UE because at least one layer will get incorrect ‘corrections’. Alternatively, single-port PTRS can be viewed as placing an indirect requirement on the UE that it shall always use the same LO for both layers (otherwise it runs the risk of inflated EVM).  We agree that UEs that declare support for coherent UL MIMO are mandated by the standard to use a single PTRS port for both layers because the LOs are ‘coherent’ or shared. |
| LGE | Option 3, 1 port PTRS is configured for 1 layer uplink for RF requirement setting. |

### Sub-topic 1-2: MPR

**Issue 1-2-1: MPR simulation assumption**

* Proposals
  + Option 1: Consider following impairments, the detail value can be further discussion
    - Transceiver noise -38.5 dBc
    - Modulator I/Q imbalance -33.7 dBc
    - Modulator CIM3 -60 dBc
    - Carrier suppression 25 dB
    - Phase noise -35 dBc
  + Option 2: Others
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Apple | This sub-topic depends on EVM budget from Issue 1-2-2 as some of the values are reused from breakdown. |
| Sony | Option 1. Is this based on R4-165408? We think that the values are good enough for a starting point, but better performance may be possible to achieve for PC1/2/5 and thus further analysis is needed. |
| Qualcomm | This is a good start, but also agree that we may need to revisit these numbers. For example:   1. A legacy carrier suppression level of 25 dBc may make UL256QAM a non-starter for real world applications that do not have LO cancellation at the receive end. Is this ok?   Phase noise impact cannot be one number – it has to be whatever the standardized calculator determines. |
| Murata | The phase noise is based on FR1 assumptions. It contradicts the derived SSB IPN from TR38.803 models. It is possible to include if we state that this phase noise is from imperfect compensation of CPE. |
| LGE | Some parameter of this issue overlap with Issue 1-2-2. So we should firstly clarify some parameters at Issue 1-2-2. |

**Issue 1-2-2: EVM budget in MPR simulation**

* Proposals
  + Option 1:

|  |  |  |
| --- | --- | --- |
| **TX EVM source** | **EVM** | |
|  | **%** | **C/N [dBc]** |
| PA | 1.85 | 34.7 |
| Transmitter | 1.19 | 38.5 |
| Phase noise | 1.78 | 35.0 |
| I/Q image | 2.06 | 33.7 |
|  |  |  |
| Total | 3.5 | 29.1 |

* + Option 2:

|  |  |  |
| --- | --- | --- |
| EVM Contributor | EVM(%) | SNR(dB) |
| Transmitter | 1.32 | 37.59 |
| Phase Noise | 2.09 | 33.59 |
| IQ Imbalance | 0.93 | 40.63 |
| PA Non-linearity | 2.29 | 32.80 |
| Total | 3.5 | 29.13 |

* + Option 3: Discuss it after EVM is defined
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Option 3: It depends on outcome of Issue 1-1-2. In case Option 2 from Issue 1-1-2 is selected we would like to propose a relaxation of the UE budget by 1dB to obtain EVM of -28.1dB (4%). The BS would have an EVM budget of -30.5dB (3%). Our paper discussed an example EVM breakdown for handhelds where the relaxation of 1dB would result into a phase noise relaxation of roughly 4dB. |
| vivo | No strong view on this issue, but we slightly prefer option 3 for now. |
| Sony | Option 3 (We understand this is based on **R4-166954)** However, more analysis is needed. |
| Qualcomm | Option 3.  It may be too intrusive to line all impairments up across different companies and their different accounting. |
| Murata | Option 3 |
| MTK | Option 3 is ok for us.  EVM should be determined first. |
| LGE | Option3  Question to Apple: Can we get the same results between 3.5%(UE) + 3.5%(BS) case and 4%(UE)+3%(BS) case? If so, is it possible to apply asymmetric EVM like 4.5%(UE)+ 2.5%(BS)? |

**Issue 1-2-3: MPR requirements**

* Proposals
  + Option 1: Define the same MPR of 256QAM for PC2 and PC5 in FR2-1.
  + Option 2: Decide the MPR values for different power classes based on the simulation result or further analysis.
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | ….  Others: |
| vivo | Both options are ok for us, PC2/PC5 have same MPR requirement in current spec. |
| Sony | Option 2. |
| Qualcomm | Option 1  The original MPR analysis (Rel-15) depended only on TRP limits of each power class, since emissions limits were also TRP. Accordingly two sets of MPR were defined, one for UEs with TRPmax of 35 dBm (PC1) and one for UEs with TRPmax of 23 dBm (PC3, and then co-opted by PC2 Pc4 and PC5). Option 1 is consistent with the legacy reasoning. We would be ok to discuss different MPRs if the technical justification is agreeable. |
| Murata | If option 1 is chosen, then what is the EVM requirement? Since the MPRs are dominated by a function of EVM, so is the 256QAM requirement 3.5%? |
| LGE | Option 1.  PC2/PC5 have same MPR requirement. This approach can simplify the spec requirements.  To Murata: Since PC2 and PC5 have the same TRP in the spec, we think that if PC2 and PC5 have the same EVM requirements, the same MPR criteria can be applied. |

### Sub-topic 1-3: Minimum EIRP

**Issue 1-3: minimum EIRP**

* Proposals
  + Option 1: Consider 0 dBm min EIRP for PC3 tentatively
  + Option 2: Agree the values proposed in R4-2212370:
    - 3.5% for 256QAM.
      * UE EIRP for PC1: 19.5dBm
      * UE EIRP for PC2, PC3, PC4: 2.5dBm
      * UE EIRP for PC5: 9.5dBm
    - 4.0% for 256QAM
      * UE EIRP for PC1: 18.5dBm
      * UE EIRP for PC2, PC3, PC4: 1.5dBm
      * UE EIRP for PC5: 8.5dBm
    - Introduce minimum UE EIRP scaling for 256QAM according to Table 6.4.2.1-3x

Table 6.4.2.1-3x: Parameters for Error Vector Magnitude for power class 3 in FR2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Level | | | |
| Parameter | Unit | 50 MHz | 100 MHz | 200 MHz | 400 MHz |
| UE EIRP for UL 256 QAM | dBm | ≥ 2.5 | ≥ 2.5 | ≥ 5.5 | ≥ 8.5 |
| Operating conditions | Normal Conditions | | | | |
| NOTE 1: PTRS is configured for 256 QAM | | | | | |

* + Option 3: Discuss it after EVM and operating SNR are defined
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | We prefere option 2 but would consider to wait until EVM budget is finalized. |
| OPPO | Option 2 is ok and it is simple way to assume linear between power and SNR ratio among different modulations. |
| vivo | Option 3, we prefer focus on EVM first. |
| Sony | Option 3 |
| Qualcomm | Option 3.  In our view min EIRP is derived as an offset from Pmin for each power class, so it is not clear why PC3 would get lumped in with PC2/5 |
| Murata | Option 3 |
| MTK | Option 3 |
| LGE | Option 3, we need clarification of EVM budget and power class.  I think there is a typo in this issue number, so I correct it.(Issue 1-2 🡪 issue 1-3) |

## Companies views’ collection for 1st round

### Open issues

*One of the two formats, i.e. either example 1 or 2 can be used by moderators.*

**Example 1**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |

**Example 2**

Sub topic 1-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

Sub topic 1-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

### 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.*

|  |  |
| --- | --- |
| **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:* |

### 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)

# Topic #2: BC

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
| [**R4-2211915**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2211915.zip) | Beam correspondence for RRC\_INACTIVE and initial access | Apple | **Observation 1: The only SSB-based beam correspondence requirement is applicable for initial access.**  **Observation 2:** **For Random Access SDT and Configured Grant SDT in RRC\_INACTIVE, UEs need to measure SSBs to determine its suitable TX beam for transmitting data over RACH or PUSCH, both of which have a resource mapping to SSB beam index and SS-RSRP measurement.**  **Observation 3: The current only SSB-based requirement is also applicable for RA-SDT and CG-SDT.**  **Proposal 1: It is proposed that the current SSB based beam correspondence requirement are reused for Initial access, Random Access SDT and Configured Grant SDT.**  **Proposal 2: To save test effort, beam correspondence requirement is only tested for initial access.**  **Proposal 3: It is proposed to further discuss the following points in Oct. meeting**   * **How to achieve the maximum output power condition in initial access.** * **How to balance testing time and test performance, e.g. whether it is feasible to use sparse grid.** * **New test procedures and test settings** |
| [**R4-2211992**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2211992.zip) | FR2 beam correspondence for RRC\_INACTIVE and initial access | Samsung | **Observation 1: spherical coverage is the prime metric for beam correspondence**  **Observation 2: open loop power control mechanism leads to varying uplink power configuration in spherical coverage measurement**  **Proposal 1: it is proposed to enable the maximum output power in the beam correspondence of initial access and RRC\_INACTIVE.**  **Proposal 2: in order to achieve maximum output power in initial access and RRC\_INACTIVE state, RAN4 to discuss and down-select among following options**   * **Option 1: multiple times test along with decreasing DL RS power level** * **Option 2: hold RAR message to enable power ramp until maximum output power** * **Option 3: adopt a test mode to force UE transmit with maximum output power**   **Observation 3: it is difficult for many test systems to measure one of the component EIRP without beam lock when the component EIRP PolMeas is different from PolLink.**  **Proposal 3: a compensation approach can be considered to address the testability limitation. RAN4 can further discuss how to determine the compensation value at each measurement grid point:**  **EIRP = maximum (EIRP(PolMeas=PolLink=), EIRP(PolMeas=PolLink=)) +**  **Proposal 4: beam correspondence for initial access or RRC\_INACTIVE can be verified only at the 50%-tile direction obtained from connected mode to save test time.** |
| [**R4-2212070**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212070.zip) | UE beam correspondence requirements for RRC\_INACTIVE and initial access | Nokia, Nokia Shanghai Bell | **Observation 1**: For supporting new UE beam correspondence requirements for RRC\_INACTIVE and initial access UE needs to support both *beamCorrespondenceWithoutUL-BeamSweeping* and *beamCorrespondenceSSB-based-r16* UE capabilities  **Proposal 1:** Define DRX cycles for UE beam correspondence requirements for RRC\_INACTIVE and initial access in IDLE mode to ensure that UE performs beam correspondence well also in these UE power saving modes.  **Proposal 2:** Reuse the existing SSB based UE beam correspondence requirement scenarios for RRC\_INACTIVE with some updates in the assumptions (e.g. RRC\_INACTIVE, DRX cycles for DRX operations and Random Access SDT and Configured Grant SDT for UL transmission)  **Proposal 3:** Reuse the existing SSB based UE beam correspondence requirement scenarios for initial access in IDLE with some updates in the assumptions like IDLE mode, DRX cycles for DRX operations, UL transmission using msg1 in RACH procedure and only defining requirements for spherical coverage. |
| [**R4-2212306**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212306.zip) | Beam correspondence requirements for initial access | CMCC | **Observation 1: Legacy specified tolerance requirements only make sense for UE with UL beam sweeping to avoid very bad BC performance to reduce beam management complexity. There is no minimum tolerance requirement for UE supporting BC without UL sweeping.**  **Observation 2: for UEs at cell edge, better BC capability could help UE achieve better UL EIRP towards gNB and enhance UL coverage.**  **Proposal 1: it is suggested to define new tolerance requirement for UE at initial access with smaller tolerance limit between the best-matched beam and automatically chosen beam.** |
| [**R4-2212331**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212331.zip) | On initial access beam correspondence | Qualcomm Incorporated | **Proposal 1: The Rel-18 beam correspondence requirement applicability can therefore be summarised as:**   |  |  |  | | --- | --- | --- | |  | UE that supports ***beamCorrespondenceWithoutUL-BeamSweeping*** and ***beamCorrespondenceSSB-based-r16*** | Other UEs | | MSG1/MSGA | Needs new requirement, mandatory | Needs new requirement, mandatory | | MSG3 | No need for dedicated requirement due to overlap with PUSCH requirement | Needs new requirement, mandatory |   **Proposal 2: MSG1 EIRP (peak and spherical) requirements are the same as those for single CC DFT-s-QPSK** |
| [**R4-2212592**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212592.zip) | Discussion on beam correspondence requirements for RRC\_INACTIVE and initial access | Xiaomi | **Issue 1: How should the beam correspondence requirements be verified based on the associated SSB?**  **Issue 2: Does the UE need to indicate support beam correspondence without UL beam sweeping for RRC\_inactive and initial access?**  **Issue 3: How does the UE indicate the capability of supporting beam correspondence without UL beam sweeping for RRC\_inactive and initial access?**  And we proposed:  **Proposal 1: The beam correspondence for non-SDT, RA-SDT in initial access and CG-SDT in RRC\_inactive should be verified based on radiated preamble power pattern.**  **Proposal 2: The UE need indicate support beam correspondence without UL beam sweeping for RRC\_inactive and initial access.**  **Proposal 3: Send LS to RAN1 and RAN2 to ask them consider how to indicate the capability of supporting beam correspondence without UL beam sweeping for RRC\_inactive and initial access.** |
| [**R4-2212788**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212788.zip) | Beam correspondence for RRC\_INACTIVE and initial access | Ericsson, Sony | **Proposal 1: introduce a BC test for initial access as shown in Section 3 of this contribution for verification of the correspondence between the TX and RX beams during the RACH procedure, a relevant test to add to the existing connected-mode tests.** |
| [**R4-2212791**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212791.zip) | Discussion on verification of beam correspondence during initial access | vivo | **Observation 1:** It is feasible to force the UE to continuously send msg1 by prohibiting the SS from sending RAR (msg2) to the UE during the test.  **Observation 2:** UE may change its Tx beam of msg1 if RAR is always not received.  **Observation 3:** Defining the spherical coverage as an exact power level will restrict the beam choice during initial access which is not expected.  **Proposal 1:** Whether the corresponding Tx beam will be changed and how to avoid this behavior during the test should be further discussed.  **Proposal 2:** The min peak EIRP for initial access should be defined and can be 7 dB lower than the requirement in connected state.  **Proposal 3:** Further discuss following options for spherical coverage in initial access:   * **Option 1**: Define a specific EIRP value at N% of the distribution of radiated power. * **Option 2:** Define the gain drop difference between Rx and corresponding Tx beam at N% of the distribution of radiated power. * **Option 3:** Define the N% of all test point can finish access procedure successfully with corresponding Tx beam. |
| [**R4-2213313**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2213313.zip) | R18 Discussion on FR2 beam correspondence in initial access | OPPO | ***Observation 1: There is no common understanding in RAN4 whether the beam correspondence requirements defined up to now are only applied for RRC connected mode.***  ***Observation 2: UE beam selection behavior under initial access and connected mode are same for UE which both are based on SSB RSRP measurement.***  ***Observation 3: There is no limitation of beam width used in initial access, but in test the fine beam will be used which is same as connected mode since max power is scheduled in test.***  ***Observation 4: Beam correspondence requirement is defined under max power, and PRACH max power can be achieved by power ramping.***  ***Proposal 1: Initial access beam correspondence can be verified via PRACH minimum peak EIRP and spherical coverage requirement.***  ***Observation 5: There is no different in Beam correspondence requirement for initial access and RRC Inactive.***  ***Proposal 2: Same beam correspondence requirements are applied for initial access and RRC Inactive.***  ***Observation 6: The intention and value of RAR measurement is unclear, and seems out of scope of Beam correspondence.***  ***Observation 7: RAR measurement may change UE’s UL beam management strategy and then change the*** ***relationship to existing EIRP performance requirements.***  ***Proposal 3: Initial access beam correspondence can focus on PRACH power measurement, and FFS the intention and value of RAR measurement and also impact to UE beam management if RAN4 pursue it.***  ***Proposal 4: Study harmonizing beam correspondence for initial access and connected to reduce test time.*** |
| [**R4-2213374**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2213374.zip) | On beam correspondence requirement in RRC\_IDLE or RRC\_INACTIVE for Rel-18 NR FR2 | Huawei, HiSilicon | **Observation 1: A UE could be considered as meeting the ‘Beam correspondence’ requirements if the UE could meet the EIRP CDF requirements without UL sweeping.**  **Observation 2: UL sweeping process is based on SRS configuration in RRC\_CONNECTED mode.**  **Observation 3: In RRC\_IDLE and RRC\_INACTIVE mode, there is no effective process to request the UE to do UL sweeping.**  **Proposal 1: In RRC\_IDLE and RRC\_INACTIVE mode, 2nd approach could be adopted to verify UE’s beam correspondence requirements based on EIRP CDF requirements without UL sweeping.**  **Proposal 2: EIRP CDF requirements in RRC\_IDLE and RRC\_INACTIVE mode are expected to be different from existing requirements in RRC\_CONNECTED mode, taking into consideration the difference of ‘rough beam’ and ‘fine beam’.** |
| [**R4-2213761**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2213761.zip) | Workplan for NR RF requirements enhancement for frequency range 2 (FR2), Phase 3 | Nokia, Xiaomi | **Work plan** |

## Open issues summary

### Sub-topic 2-1: Work Plan

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

**Issue 2-1-1: Approve workplan in R4-2213761**

* Proposals
  + Option 1: Yes
  + Option 2: Modification is needed
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Option 1: Agree with the work plan |
| YYY |  |
| XXX |  |

### Sub-topic 2-2: Rel-16 RRC\_Connected Beam Correspondence applicability to Rel-18 RRC\_Inactive Beam Correspondence

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

**Issue 2-2-1: Reuse existing SSB-based beam correspondence requirement**

* Proposals
  + Option 1: Yes(Apple)
  + Option 2: No
  + Option 3: Other
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1 is ok. |
| vivo | Prefer option 2 for now. Reuse SSB-based BC requirements means the UE need to meet same requirement for both connected state and inactive state, but at least the beam pattern is quite different. It is hard for UE to meet connected state requirement with rough beam. |
| Sony | We would like to ask for clarification on what exactly would be re-used here. Does it mean the minimum requirement on peak EIRP and spherical EIRP is re-used or Msg1 transmission? We think it is a bit premature to determine the exact requirement considering this is the first meeting of the WI. One way to go is to take this as a starting point while considering other proposals as well. For example, we also propose to exam the RAR reception to verify the similarity between DL/UL beams. |
| Qualcomm | Option 1 if the intent is to re use min peak EIRP and EIRP at N %ile for MSG1 EIRP and MSG3 EIRP.  We are ok to discuss beam similarity type requirements. Historically (Rel-15), we stopped pursuing this avenue due to test time and method. |
| Verizon | Option 1 |
| Apple | Option 1 as analysed in R4-2211915.  We also open for further discussion. However, we don’t expect to tighten the existing BC requirement for the scenario identified in this WI. |

**Issue 2-2-2: Same beam correspondence requirements are applied for initial access and RRC Inactive**

* Proposals
  + Option 1: Yes (OPPO)
  + Option 2: No
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1 as there is no difference in RSRP measurement and beam management between initial access and RRC inactive. |
| vivo | The RF requirement may be similar for two cases, but does this imply that as long as UE beam correspondence requirement was verified for initial access, the inactive state requirement is met by default? It is possible to maintain UE in idle state during test, but for inactive state, we are not for sure whether it is feasible. |
| Sony | We can take the initial access as a starting point and further check if the requirement for initial access can be re-used for other states in this WI later. |
| Qualcomm | Option 1. We think it is worthwhile to determine common elements across the conditions for the new requirements. See next comment. |
| Verizon | We prefer to have same BC for both initial and RRC\_inactive, however we can take the initial access as a starting point and check if it could be applicable to RRC\_inactive after. |
| Apple | Our understanding is that only SSB based requirement can be the same since only SSB is available in initial access and RRC\_INACTIVE state. It’s recommended to combine the issue 2-2-2 with 2-2-1. |

**Issue 2-2-3: New requirements are needed for**

* Proposals
  + Option 1: MSG1/MSGA (Qualcomm)
  + Option 2: MSG3
  + Option 3: MSG3 when UE already supports *beamCorrespondenceWithoutUL-BeamSweeping* and *beamCorrespondenceSSB-based-r16*
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1 (MSG1 only) but in our view this can be verified by SSB based beam correspondence in connected mode. |
| vivo | Option 1, in our understanding, the beam correspondence for msg1/msgA can reduce the access latency. Generally, UE may use same beam for msg1 and msg3, and UL beam sweeping or further refine the beam pattern is not expected during initial access procedure because all these behaviours are inefficient, so what is the intention to define another requirement for msg3? |
| Sony | Option 1 can be taken as a starting point, e.g., EIRP spherical coverage of Msg1, but we may also need to consider the reception of RAR. |
| Qualcomm | To clarify, our proposal is as follows:  MSG1/MSGA: A new requirement is required to be defined in initial access conditions for all UEs, no matter the support for the two IEs ***beamCorrespondenceWithoutUL-BeamSweeping*** and ***beamCorrespondenceSSB-based-r16***  MSG3: The new requirement does not apply to UEs that support both the IEs due to similarity with PUSCH (because MSG3 benefits from MCS definition, TA definition, TPC, etc)  So our proposal is option 1 + converse condition of option 3. |
| Verizon | Based on the contributions, we are fine with Option 1 |
| Apple | What does “new requirement” exactly mean? Is it totally different value compared to that for the only-SSB based requirement or just reuse it to MSG1/MSGA? Our understanding it should be reuse the SSB-based requirement to MSG1/MSGA for initial access and Type 1 PUSCH for CG-SDT. |

**Issue 2-2-4: Power Class applicability of Rel-18 Beam Correspondence Requirements**

* Proposals
  + Option 1: Prioritize PC3 requirements, then extend to other power classes (Nokia)
  + Option 2: Other
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1 is ok. |
| vivo | Ok with option1 |
| Sony | Option 1 |
| Qualcomm | We would like to get clarity on what is saved by this choice of action. We do not foresee the need for power class specific simulation activity. All power classes can be agreed together based on the same principles |
| Verizon | We also prefer to all power classes. |
| Apple | Option 1. |

**Issue 2-2-5: beam correspondence for non-SDT, RA-SDT in initial access and CG-SDT in RRC\_inactive should be verified based on radiated preamble power pattern**

* Proposals
  + Option 1: Yes (Xiaomi)
  + Option 2: Other
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1 if it means MSG1 OTA power. |
| Sony | In generally, we are fine with the proposal, but we feel it is a bit premature to agree on such a detail information since this depends on how we would set the requirement for beam correspondence for initial access. If we need to consider different beam pattern and aim to verify the similarity between DL/UL beams that could be used for initial access, some additional information, e.g., RAR reception might need also be checked. |
| Qualcomm | Option 1 |
| Verizon | As STD is main motivation of this work, we support Option 1 |
| Apple | 2 questions for clarifications,   1. What does it mean by “RA-SDT in initial access”? Our understanding is that RA-SDT is in RRC connected state. 2. What does it mean “radiated preamble power pattern”?   It seems this issue can be merged to Issue 2-2-3. |

**Issue 2-2-6: Only defining spherical coverage requirements**

* Proposals
  + Option 1: Yes (Nokia)
  + Option 2: RACH minimum peak EIRP and spherical coverage requirement (OPPO)
  + Option 2: Other
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 2 is preferred to keep alignment with connected mode beam correspondence. |
| vivo | We are open for this issue and it depends on how we define spherical coverage. On the one hand, the min peak EIRP is to ensure the minimum system level performance, and if it is not defined and we define the spherical coverage as in connected state, it may imply we does not expect the UE performance can be much better than the 50%-tile EIRP. On the other hand, if we only define the spherical coverage, it can provide more freedom for UE design. |
| Sony | We can further discuss this once we agree on the general test metric. |
| Qualcomm | Option 2, because it seems aligned with legacy requirements. |
| Apple | The current BC requirement is based on option 2. But we are also open for option 1. |

**Issue 2-2-7: Requirements for spherical coverage in initial access (Vivo)**

* Proposals
  + Option 1: Define a specific EIRP value at N% of the distribution of radiated power
  + Option 2: Define the gain drop difference between Rx and corresponding Tx beam at N% of the distribution of radiated power
  + Define the N% of all test point can finish access procedure successfully with corresponding Tx beam
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1. This is aligned with connected mode beam correspondence requirement definition. |
| vivo | Our concern here is that currently it is common understanding UE may use “rough beam” during initial access, but there are no rules to indicate how UE to perform a “rough beam”, and the solution may be various across different vendor. The 3 options we provided above just an example, and the intention is to invite experts to discuss how to define a requirement to avoid the unnecessary restriction on UE beam choice during initial access.  From our perspective, the option 1 is most likely to impact the beam choice because the specific EIRP must discussed depend on a reference beam pattern. The option 3 have least impact but it needs to face more challenge in test. |
| Qualcomm | Option 1 with qualification. We support option1 as it applies to DFT-s-QPSK PUSCH. We do not want to open a new discussion on N% and EIRP |
| Verizon | Option 1 |
| Apple | We still prefer to taking the existing BC requirements as the baseline. However, this is based on the assumption that the same codebook will be used for RRC\_CONNECTED, RRC\_INACTIVE and initial access. If different codebooks are used, we are open to revisit how to relax the existing BC requirements in this WI. |

**Issue 2-2-8: MSG1 EIRP (peak and spherical) requirements are the same as those for single CC DFT-s-QPSK**

* Proposals
  + Option 1: Yes (Qualcomm)
  + Option 2: Other
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1 considering in the test UE will be scheduled (indirect schedule) to max power and fine beam will be used. |
| Apple | The proposal is not very clear for us. Does it mean the existing waveform and modulation order used to define the existing BC requirements will be reused for MSG1. |

**Issue 2-2-9: new tolerance requirement for UE at initial access with smaller tolerance limit between the best-matched beam and automatically chosen beam**

* Proposals
  + Option 1: Yes (CMCC)
  + Option 2: No
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | If understand correctly this relates to the partial beam correspondence capable UE where tolerance between best beam and automatically chosen beam is defined. If this is also defined for initial access, we are fine to further discuss whether define smaller tolerance. |
| vivo | It makes sense in connected state because UE can get the best-match beam by UL beam sweeping procedure, but for initial access, the beam sweeping is not expected and we don’t know whether it is still meaningful. |
| Sony | There is no uplink beam sweeping for initial access, it is unclear to us how we can test the tolerance or beam correspondence for initial access. |
| Qualcomm | Option 2  The tolerance requirement is on the power change before and after UL beam sweeping. The latter is only possible in connected mode, so conceptually the proposal does not seem to work.  In our view all UEs would have to meet the same requirement. |
| Verizon | Option 2 |
| Apple | Option 2.  Regarding option 1, we would like to understand why there is a room to have tightened requirement given the condition for beam correspondence requirement becomes challenging in initial access than in RRC\_CONECTED state. |

### Sub-topic 2-3: Rel-18 Beam Correspondence Test

*In this sub-topic companies are invited to bring issues to the attention of the group, which have not been captured in the previous sub-topics.*

**Issue 2-3-1: Need to further study whether Tx beam changes**

* Proposals
  + Option 1: Yes (Vivo)
  + Option 2: No
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| vivo | Our concern here is the BEAM\_LOCK mode can only be used in connected mode and during the test for initial access, UE may change its Tx beam, e.g., if we prohibit TE response RAR to keep UE transmit msg1, UE may try another beam. Then we cannot get a stable performance result and the beam change should be avoided. |
| Qualcomm | Option 2: No  We think the expected UE behavior is much like connected mode. The UE should not change its beam unless it finds a better SSB from some other direction. So we think Option 2. |
| Apple | We agree this issue can be further discussed. We also think it depends how the requirement and test are designed. Prefer FFS. |

**Issue 2-3-2: verify UE’s beam correspondence requirements based on EIRP CDF requirements without UL sweeping in RRC\_IDLE and RRC\_INACTIVE mode**

* Proposals
  + Option 1: Yes (Huawei)
  + Option 2: No
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Ok with Option 1. |
| vivo | “without UL sweeping” is ok, but “based on EIRP CDF” depends on how we define the requirement. |
| Sony | Similar to other issues, general fine to take EIRP spherical coverage of Msg 1 as starting point but don’t want to preclude other possible metric, e.g., RAR receptions, at this stage. Additional test might be useful if we considering different UE beam pattern and implementations, and also if we really want to verify the similarity between Tx and Rx beams. |
| Qualcomm | Option 1 but with qualification: We support option1 as it applies to DFT-s-QPSK PUSCH. We do not want to open a new discussion EIRP requirements |
| Apple | Technically this makes sense. We prefer to discuss together with UE capability. |

**Issue 2-3-3: Test for Random Access SDT and Configured Grant SDT in RRC\_INACTIVE**

* Proposals
  + Option 1: Only test to RA
  + Option 2: Test both RA-SDT and CG-SDT
  + Option 3: BC test for initial access for verification of the correspondence between the TX and RX beams during the RACH procedure (Ericsson)
  + Option 4: FFS the intention and value of RAR measurement (OPPO)
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1 is ok, and if companies are also interesting with RAR testing then Option 4 is also ok to us. |
| vivo | Before we discuss SDT, one question here is can we maintain UE in inactive state during the test? |
| Sony | We suggest starting the work with random access and check if additional test would be needed for other cases later. |
| Qualcomm | Option 2  UE needs RRC release to go into inactive mode. The bigger problem is how to trigger an SDT – R4 has sent an LS to R5 seeking this info, per our understanding. From a test perspective it is therefore better to look at msg1 and msg3 as independent components to test, no matter SDT or RACH. |
| Apple | We think UE only need to be tested for in one of the three scenarios including initial access, RA-SDT and CG-SDT. |

**Issue 2-3-4: Output power of UE in test**

* Proposals
  + Option 1: Maximum output power in the beam correspondence of initial access and RRC\_INACTIVE
  + Option 2: other
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1. This can give consistent test results. |
| vivo | OK with option 1 |
| Sony | Option 1 |
| Qualcomm | Option 1, if it means EIRP requirement shall be same as for DFT-s-QPSK PUSCH |
| Apple | Option 1 |

**Issue 2-3-5: Achieve maximum power of UE during test**

* Proposals
  + Option 1: Multiple times test along with decreasing DL RS power level.
  + Option 2: Hold RAR message to enable power ramp until maximum output power.
  + Option 3: Adopt a test mode to force UE transmit with maximum output power.
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 2 is ok. |
| Vivo | Prefer option 2 for now. option 1 seems inefficient and test mode in option 3 will bring additional software design cost. |
| Sony | Option 2 seems the most promising solution and we can take it as starting point. |
| Qualcomm | Option 2 |
| Apple | FFS |

**Issue 2-3-6: Compensation approach to address the testability limitation**

* Proposals
  + Option 1: EIRP = maximum (EIRP(PolMeas=q, PolLink=q), EIRP(PolMeas=f, PolLink=f)) + Δpol
  + Option 2: Other
  + Option 3: Not needed
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| vivo | The issue is also caused by lack of beam lock function and generally ok with option 1, but this issue can be further discussed after we confirm how to define the spherical coverage during initial access. |
| Sony | We would like to understand better how to set the compensation values in option 1. |
| Qualcomm | Option 2 or 3.  For option 2, we would like to ask why this would not be usable instead:  EIRP = maximum (EIRP(PolLink=), EIRP(PolLink=)) |
| Apple | FFS |

**Issue 2-3-7: min peak EIRP for initial access requirement**

* Proposals
  + Option 1: relax requirement by 7 dB (vivo)
  + Option 2: Other
  + Option 3: no relaxation
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Depends on whether max power is tested, if it is then no relaxation is needed, otherwise Option1. |
| vivo | Option 1 if we confirm the min peak EIRP need to be specified. 7 dB gain difference between “rough beam” and “fine beam” for PC3 comes from RRM. |
| Qualcomm | Option 3: The EIRP requirement shall be same as for DFT-s-QPSK PUSCH, with appropriate test conditions to enable that operation. |
| Apple | This issue can be merged with 2-2-7. |

**Issue 2-3-8: Test time**

* Proposals
  + Option 1: full sphere
  + Option 2: 50%-tile of the direction obtained from connected mode
  + Option 3: study harmonizing beam correspondence for initial access and connected to reduce test time (OPPO)
  + Option 4: Other
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 2, and 3 are ok to further study. |
| vivo | Option 2 and option 3 can be further discussed. |
| Qualcomm | While this is not a core consideration, option 2 and 3 seem reasonable. For option 2, some fallback is necessary if UEs cannot meet the requirement in the top 50% points. |
| Apple | FFS |

### Sub-topic 2-4: DRX implications in Rel-18 Inactive Beam Correspondence

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

**Issue 2-4-1: Define DRX operation for UE beam correspondence requirements for RRC\_INACTIVE and initial access in IDLE mode**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 2, no. The testing time would be long if DRX operation is used and it will further add much more testing costs to FR2 and today the testing burden already very high. |
| vivo | For RF requirement, we don’t see the difference between DRX-on and DRX-off. |
| Qualcomm | No strong view, but we agree that it only impacts the dynamics of beam refinement, not the final refinement state |
| Apple | Can proponent please clarify what "DRX operation...for initial access in IDLE mode" means |

**Issue 2-4-2: Include DRX operation in Rel-18 Inactive Beam Correspondence requirements**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 2. In our view, if initial access is tested, there is no need to further test inactive beam correspondence, we see no difference between them. |
| vivo | Similar comment as issue 2-4-1 |
| Apple | Not clear what is the proposal about. |

### Sub-topic 1-5: UE capability

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

**Issue 2-5-1: UE need indicate support beam correspondence without UL beam sweeping for RRC\_inactive and initial access**

* Proposals
  + Option 1: Yes (Xiaomi)
  + Option 2: No
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1. |
| vivo | option 1 |
| Sony | There is no uplink beam sweep can be used for initial access, and all UE must support beam correspondence without uplink beam sweeping in this case. In addition, the UE capabilities are usually transmitted afterwards, and we are not sure how it can help to indicate that a UE can support BC for initial access once it has been already in the connected mode. Therefore, we are not sure if UE need to indicate anything here. |
| Qualcomm | Option 2: No.  The RACH EIRP requirement shall apply uniformly to all UEs – it should not depend on its capability. We are in Rel-18 and we are still trying to protect a carve out for early UE implementation (bit 0 UE)  Does option 1 mean RACH EIRP requirements do not apply to a bit0 UE? |
| Verizon | Option 2 as without uplink beam sweeping is a mandatory. |
| Apple | Merge with Issue 2-5-2. |

**Issue 2-5-2: Send LS to RAN1 and RAN2 to ask them consider how to indicate the capability of supporting beam correspondence without UL beam sweeping for RRC\_inactive and initial access**

* Proposals
  + Option 1: Yes (Xiaomi)
  + Option 2: No
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Probably Option 2, the initial access and inactive beam correspondence are pure UE centric behaviour and doesn’t need NW help. In our view, if we define capability for this feature, it is more like for requirement definition/testing purpose especially in initial access since the capability will only be reported after it is in connected mode. |
| vivo | Maybe we should figure out the relationship between these capabilities before sending this LS. |
| Sony | We are not sure if we need any new capability here since all UEs should support beam correspondence without UL beam sweeping for initial access and RRC\_inactive mode. In addition, as we mentioned earlier, we don’t see the benefit to indicate the UE can support BC for initial access once it has been in the connected mode. |
| Qualcomm | In our view, we do not need to define a new (in)capability. The RACH EIRP requirement shall apply uniformly to all UEs and there is no justification for relaxation for bit0 UEs |
| Apple | This issue can be discussed when we have a clear picture of the requirement. It’s not urgent to send this LS to other WG. |

### Sub-topic 2-6: UE beam type

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

**Issue 2-6-1: Consider ‘rough beam’ or ‘fine beam’ for EIRP CDF requirements in RRC\_IDLE and RRC\_INACTIVE (Huawei)**

* Proposals
  + Option 1: Fine beam
  + Option 2: Rough beam
  + Option 3: both
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1, if tested under max power. |
| vivo | Option 3. Rough beam is generally used in idle state and inactive state, but if we considering the requirement, fine beam may be a worst case as reference because there is no clear rule for what “rough beam” is. |
| Sony | Fine to consider both for now. |
| Qualcomm | Option 1 with clarification that there is no definition of these beams for RF requirements. The test conditions should be enough to stimulate beam refinement, just as would happen in the field.  We are ok to test ‘low EIRP’ requirements in addition to ‘high EIRP’ if there is justification. |
| Verizon | Option 1 |
| Apple | We assume the same assumption as that in RRC connected mode. But we are open for the discussion. |

### 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 | Title, Source |
| Company A |
| Company B |
|  |
| YYY | Title, Source |
| 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*

*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)

## 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”* |
|  |  |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |  |
| --- | --- | --- | --- |
| **New Tdoc number** | **Title** | **Source** | **Comments** |
|  | WF on … | YYY |  |
|  | LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |  |

**Existing tdocs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

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** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-22xxxxx |  | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-22xxxxx |  | 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