**3GPP TSG-RAN WG4 Meeting # 103-e R4-22XXXXX**

**Electronic Meeting, 09 – 20 May 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.

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
|  |  |  |

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 |

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| [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 |

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| [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 719/1024256QAM: 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  + example1Option 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 frequencyStatic (AWGN) |
| MCS | 64QAM: MCS 23, 24, 26, 28 in TS 38.214 Table 5.1.3.1-1, and other MCSs are not precluded256QAM: MCS 21, 23, 25, 27 in TS 38.214 Table 5.1.3.1-2, and other MCSs are not precludedBaseline: fixed MCSs |
| Symbol type  | CP-OFDM; DFT-S-OFDM |
| HARQ  | 8, None  |
| Antenna configuration | Fading channel: 2x2 for Rank1 and Rank2, Low correlationStatic 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 RXOption 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 . |

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| [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:

|  |  |
| --- | --- |
| **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 frequencyStatic (AWGN) |
| MCS | 64QAM: MCS 23, 24 in TS 38.214 Table 5.1.3.1-1256QAM: MCS 21, 23 in TS 38.214 Table 5.1.3.1-2Baseline: fixed MCSs |
| Symbol type  | CP-OFDM; DFT-S-OFDM |
| HARQ  | 8, None  |
| Antenna configuration | Fading channel: 2x2 for Rank1 and Rank2, Low correlationStatic 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 RXOption 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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | ….Others: |

**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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | ….Others: |

**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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | ….Others: |

**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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | ….Others: |

**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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | ….Others: |

### 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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | ….Others: |

**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** |
| XXX | ….Others: |

**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: |

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

**Issue 1-2: 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** |
| XXX | ….Others: |

## 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** $Δ\_{pol} $**at each measurement grid point:****EIRP = maximum (EIRP(PolMeas=q, PolLink=q), EIRP(PolMeas=f, PolLink=f)) +** $Δ\_{pol}$**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

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

**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

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

**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

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

**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** |
| XXX |  |

**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** |
| XXX |  |

**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** |
| XXX |  |

**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

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

**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** |
| XXX |  |

**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** |
| XXX |  |

### 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 |  |

**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** |
| XXX |  |

**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** |
| XXX |  |

**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** |
| XXX |  |

**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** |
| XXX |  |

**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 |  |

**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** |
| XXX |  |

**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** |
| XXX |  |

### 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** |
| XXX |  |

**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** |
| XXX |  |

### 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** |
| XXX |  |

**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** |
| XXX |  |

### 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** |
| XXX |  |

### 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