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

**Electronic Meeting, 21 February – 03 March 2022**

**Agenda item:** 10.16.10

**Source:** Moderator (Intel Corporation)

**Title:** Email discussion summary for [102-e][327] NR\_exto71GHz\_Demod\_NWM

**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

## Background and scope

This T-doc will be used to guide and summarize the email discussion for the topic of Rel-17 extending current NR operation to 71GHz demodulation and CSI requirements (AI 10.16.10), with the email thread identifier [102-e][327] NR\_exto71GHz\_Demod\_NWM”.

The scope of this email discussion is definition of Rel-17 NR FR2-2 demodulation and CSI performance requirements, and in particular the agenda items:

10.16.10 Demodulation and CSI requirements [NR\_ext\_to\_71GHz-Perf]

10.16.10.1 General [NR\_ext\_to\_71GHz-Perf]

10.16.10.2 UE Demodulation and CSI requirements [NR\_ext\_to\_71GHz-Perf]

10.16.10.3 BS demodulation requirements [NR\_ext\_to\_71GHz-Perf]

RAN4#102-e has 0.5 TU allocated to performance part of NR\_ext\_to\_71GHz-Perf [RP-212990].

Priority topics for discussion are marked directly in the open issues’ summaries.

## Email discussion guidelines

Please follow the “RAN4#102-e E-meeting Arrangements and Guidelines”, available on the reflector, for fundamental guidelines and deadlines.

* Delegates are strongly encouraged to provide comments/concerns asap
  + Silence within a reasonable timeframe means no objection
* It is encouraged to give at least a short reasoning for each expressed view.

# Topic #1: General

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2203530 | Nokia, Nokia Shanghai Bell | Observation 1: Operation in FR2-2 includes support of 120, 480, and 960 kHz SCS.  Observation 2: Channel bandwidths of up to 2000 MHz are supported in FR2-2.  Observation 3: In order to support FR2-2 operation, a UE has to support at least 120 kHz SCS.  Observation 4: Initial access can be supported with SSBs using 120 kHz and 480 kHz SCS.  Observation 5: In order to support one SCS in UL, the UE has to at least support the same SCS in DL.  Observation 6: Support of one SCS in DL does not imply support of the same SCS in UL.  Proposal 1: Specify new demodulation performance requirements for UE and BS for SCS 480 kHz and 960 kHz  Observation 7: Scheduling and link adaptation typically allocates large SCS and MCS in situations with low delay spread.  Observation 8: Distribution of the delay spread in typical scenarios for operation in FR2-2 are mostly concentrated bellow 30 ns, with a large part of the samples experiencing delay spread between 10 and 20 ns.  Observation 9: Existing RAN4 requirements include TDLA30 as the minimum delay spread for fading channels.  Proposal 2: RAN4 to study the use of TDLA10 and TDLA20 for demodulation requirements with large SCS and high MCS.  Observation 10: Doppler shift is directly proportional to the carrier frequency; Hence, it should be higher in FR2-2 compared to FR2-1.  Observation 11: Simulation assumption for FR2 was 30 GHz.  Proposal 3: We propose to double the doppler shifts in FR2-2 than the ones already used for FR2-1. i.e., TDLAxx-150, and TDLAxx-300.  Observation 12: Deployment scenarios agreed in RF and RRM already include FR2-2 only standalone and CA/NR-DC with FR1 anchor.  Proposal 4: RAN4 to consider demodulation requirements including the following scenarios:   * Standalone FR2-2 only * CA and NR-DC with FR1 anchor and FR2-2 |
| R4-2204031 | Ericsson | Proposal 1: Companies deliver two sets of ideal simulation results for requirement discussion. Result set#1 is without phase noise and set#2 is with phase noise. Phase noise model could use model set 1 defined in TR38.808.  Proposal 2: Companies deliver trial simulation results based on channel model TDLA30, TDLA10 and TDLA5. Consider define new channel model TDLA10 or TDLA5 for FR2-2 demodulation requirement if they are feasible.  Proposal 3: Companies deliver trial simulation results based on different maximum Doppler shift 200Hz (UE speed at 3km/h) and 2000Hz (UE at 30km/h) at 70GHz for further discussion.  Proposal 4: Regarding possible outdoor deployment for FR2-2 BS, consider higher UE speed with more DM-RS configuration, such as 30km/h with 1+1 DM-RS, for the requirement if it is feasible.  Proposal 5: Prioritize 120kHz SCS for both BS and UE demodulation requirement discussion. 480kHz and 960kHz SCS could be lower priority.  Proposal 6: Prioritize the minimum and maximum supported bandwidth for each supported SCS for the demodulation discussion.  Observation 1: If LBT is considered, test setup for shared spectrum access is different from NR SA, but there wouldn’t be much performance difference from demodulation perspective.  Observation 2: If LBT is not considered, only TDD patterns for 120kHz SCS are available.  Proposal 7: Define one set of FR2-2 demodulation requirements to cover both NR SA deployment and shared spectrum access deployment if possible.  Proposal 8: Define new TDD patterns for 480kHz and 960kHz SCS. Following patterns can be considered:   * Option 1: Same as FR2-120-1, 3D1S1U, S=10D:2G:2U. * Option 2: Use the same DL/UL duration as 120kHz SCS to keep sufficient processing timeline.   + 480kHz SCS: 12D4S4U, S1=S2=14D:0G:0U, S3=12D:2G:0U, S4=0D:6G:8U   + 960kHz SCS: 24D8S8U, S1=S2=S3=S4=S5=14D:0G:0U, S6=10D:4G:0U, S7=0D:12G:2U, S8=0D:0G:14U   Proposal 9: Follow RF FR2-2 requirement structure, capture FR2-2 demodulation requirement into same section as FR2-1 but with different tables if possible. Adding extra phrase as “for FR2-1” and “for FR2-2” to requirement tables for differentiation. |
| R4-2205916 | Intel Corporation | Proposal 1: RAN4 to discuss and approve the above work plan. |
| R4-2205917 | Intel Corporation | Proposal #1: Reuse existing sections in TS 38.104 and TS 38.141-2 for FR2-2 BS performance requirements definition.  Proposal #2: Reuse existing sections in TS 38.104-1 for FR2-2 UE performance requirements definition. |

## Open issues summary

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

### Sub-topic 1-1: Work plan

*Sub-topic description:*

The latest TU request for NR\_ext\_to\_71GHz can be found in RP-212990, “Status Report to TSG; rapporteur: Qualcomm; Intel Corporation”, WI status report, RAN#94-e]. The target completion date for performance (NR\_ext\_to\_71GHz-Perf) is September 2022. The following amount of TUs are allocated for this work:

* 0.5 TU at RAN4#102-e
* 0.5 TU at RAN4#102-bis-e
* TU at RAN4#103-e

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

**Issue 1-1: Suggested work plan**

* Proposals
  + Proposal 1 (Intel): Suggested workplan
    - RAN4 #102e
      1. Discussion and agreement on work plan.
      2. Discussion on performance requirements scope
      3. Initial discussion on work split
      4. Initial discussion on simulation assumptions
    - RAN4 #102-bis-e
      1. Finish discussions on performance requirements scope per each physical channel
      2. Finish discussions on simulation assumptions per each physical channel
      3. Finish discussions on work split
      4. Initial round of simulation results collection and alignment
      5. Initial draft CRs for TS 38.104 Base Station (BS) radio transmission and reception
      6. Initial draft CRs for TS 38.141-2 Base Station (BS) conformance testing Part 2: Radiated conformance testing
      7. Initial draft CRs for TS 38.101-4 User Equipment (UE) radio transmission and reception; Part 4: Performance requirements
    - RAN4 #103e
      1. Final round of simulation results collection and alignment
      2. CRs for TS 38.104 Base Station (BS) radio transmission and reception
      3. CRs for TS 38.141-2 Base Station (BS) conformance testing Part 2: Radiated conformance testing
      4. CRs for TS 38.101-4 User Equipment (UE) radio transmission and reception; Part 4: Performance requirements
* Recommended WF
  + Collect views in 1st round

### Sub-topic 1-2: General aspects of demodulation requirement definition

*Sub-topic description*

The purpose of this sub-topis is to define the general set of demodulation and CSI reporting requirements. Whether to define completely new set of requirements or reuse existing FR2-1 requirements, and detail scope of requirements are discussed in another issues.

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

**Issue 1-2-1: General scope of BS demodulation performance requirements**

All contributions have discussed introduction of requirements for PUSCH, PUCCH, and PRACH UL physical channel. There are no proposals to deprioritize or skip one these physical channels

* Proposals
  + Option 1 (Huawei, Ericsson, Nokia, Intel): Define PUSCH, PUCCH, and PRACH performance requirements
* Recommended WF
  + Check whether Option 1 is agreeable

**Issue 1-2-2: General scope of UE demodulation and CSI reporting performance requirements**

Based on the contribution review, it seems that all companies propose to define PDSCH, PDCCH, SDR, and CSI reporting requirements. There are different views on requirements introduction for PBCH. One important note that is mentioned in [R4-2205802] that there are no conformance test cases for PBCH due to some testability issues identified.

* Proposals
  + Option 1 (Huawei, Ericsson, Nokia): Define PDSCH, PDCCH, PBCH, and SDR performance requirements.
  + Option 2 (Intel): Define PDSCH, PDCCH, PBCH, and SDR performance requirements. Do not define PBCH performance requirements
  + Option 3 (Huawei): Define PDSCH, PDCCH and PBCH requirements. Don’t define SDR performance requirements
* Recommended WF
  + Check whether it is agreeable to define PDSCH, PDCCH requirements
  + Collect views on whether to define requirements for PBCH and SDR

**Issue 1-2-3: Scenarios to be considered for requirements definition**

* Proposals
  + Proposal 1 (Nokia): RAN4 to consider demodulation requirements including the following scenarios:
    - Standalone FR2-2 only
    - CA and NR-DC with FR1 anchor and FR2-2
  + Proposal 2 (Ericsson): RAN4 defines the UE demodulation and CSI reporting requirements with:
    - Both single carrier (FR2-2) and NR-DC FR1 + FR2-2 scenarios
  + Proposal 3 (Intel): Do not define DL performance requirements for CA in FR2-2 in Rel-17
* Recommended WF
  + Collect views in 1st round for both UL and DL requirements.

**Issue 1-2-4: Shared spectrum access requirements**

* Proposals
  + Proposal 1 (Huawei):
    - Not consider LBT failure for PUSCH, PUCCH and PRACH cases
    - Define two set of PDSCH requirements for license band without LBT mechanism and unlicensed band with LBT mechanism
  + Proposal 2 (Ericsson): Define one set of FR2-2 demodulation requirements to cover both NR SA deployment and shared spectrum access deployment if possible.
  + Proposal 3 (Intel): Define FR2-2 UE demodulation requirements that cover licensed and unlicensed operations
* Recommended WF
  + Collect views in 1st round for both UL and DL requirements.

### Sub-topic 1-3: Channel model for requriements definition

*Sub-topic description*

Several contributions highlighted necessity of channel model revision for FR2-2 compared to the FR2-1 in terms of RMS delay spread and max Doppler frequency.

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

**Issue 1-3-1: Propagation conditions**

* Proposals
  + Proposal 1 (Nokia): Both static propagation condition and Multi-path fading propagation conditions could be considered when defining new requirements and test cases.
* Recommended WF
  + Collect views in 1st round.

**Issue 1-3-2: RMS delay spread**

* Proposals
  + Proposal 1 (Nokia): RAN4 to study the use of TDLA10 and TDLA20 for demodulation requirements with large SCS and high MCS.
  + Proposal 2 (Ericsson): Companies deliver trial simulation results based on channel model TDLA30, TDLA10 and TDLA5. Consider define new channel model TDLA10 or TDLA5 for FR2-2 demodulation requirement if they are feasible
  + Proposal 3 (Intel): Define FR2-2 performance requirements with TDLA 10ns RMS delay spread value and with 200 and 650 Hz max Doppler frequency.
* Recommended WF
  + Collect views on the applicable RMS delay spread in 1st round.

**Issue 1-3-3: Max Doppler frequency**

* Proposals
  + Proposal 1 (Nokia): We propose to double the doppler shifts in FR2-2 than the ones already used for FR2-1. i.e., TDLAxx-150, and TDLAxx-300.
  + Proposal 2 (Ericsson): Companies deliver trial simulation results based on different maximum Doppler shift 200Hz (UE speed at 3km/h) and 2000Hz (UE at 30km/h) at 70GHz for further discussion
  + Proposal 3 (Ericsson): Regarding possible outdoor deployment for FR2-2 BS, consider higher UE speed with more DM-RS configuration, such as 30km/h with 1+1 DM-RS, for the requirement if it is feasible
  + Proposal 4 (Intel): Define FR2-2 performance requirements with TDLA 10ns RMS delay spread value and with 200 and 650 Hz max Doppler frequency.
* Recommended WF
  + Collect views on the applicable max Doppler frequency in 1st round

### Sub-topic 1-4: Phase noise

*Sub-topic description*

Several companies highlighted higher phase noise impact on demodulation performance in FR2-2 compared to FR2-1

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

**Issue 1-4-1: Study on phase noise impact for requirements derivation**

* Proposals
  + Proposal 1 (Ericsson): Companies deliver two sets of ideal simulation results for requirement discussion. Result set#1 is without phase noise and set#2 is with phase noise. Phase noise model could use model set 1 defined in TR38.808.
* Recommended WF
  + Collect views in 1st round regarding the proposed methodology in Proposal 1.

**Issue 1-4-2: Phase noise model**

* Proposals
  + Option 1 (Ericsson): PN model set 1 in TS 38.803.
  + Option 2 (Huawei): PN model example 2 defined in TS 38.803
* Recommended WF
  + Collect views in 1st round

**Issue 1-4-3: TDD pattern**

* Proposals
  + Proposal 1 (Ericsson): Define new TDD patterns for 480kHz and 960kHz SCS. Following patterns can be considered:
    - Option 1: Same as FR2-120-1, 3D1S1U, S=10D:2G:2U.
    - Option 2: Use the same DL/UL duration as 120kHz SCS to keep sufficient processing timeline.
      * 480kHz SCS: 12D4S4U, S1=S2=14D:0G:0U, S3=12D:2G:0U, S4=0D:6G:8U
      * 960kHz SCS: 24D8S8U, S1=S2=S3=S4=S5=14D:0G:0U, S6=10D:4G:0U, S7=0D:12G:2U, S8=0D:0G:14U.
* Recommended WF
  + Collect views in 1st round.

### Sub-topic 1-5: Implementation of FR-2 requirements into specification

*Sub-topic description*

FR2-2 performance requirements should be integrated to the current specifications defined for the original FR2 frequency range:

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| --- |
| From WID:  Note 5: FR2 is extended to cover 24.25GHz to 71GHz with FR2-1 for 24.25-52.6GHz and FR2-2 for 52.6-71GHz.   * + The related UE capabilities and their applicability to the frequency range 52.6 to 71 GHz will have to be analyzed on a case by case basis   + The application of any of the UE feature introduced for 52.6-71 GHz to existing FR1/FR2 should be discussed case by case.   + TSG RAN specifications shall make it very clear (to readers) that frequency bands in the 52.6-71GHz range are only Release-independent from Rel-17 onwards, to ensure that there is clear industry understanding about which FR2 features are applicable for operation in 52.6-71GHz range.   NOTE 5a: Whenever the FR2 is referred, both FR2-1 and FR2-2 frequency sub-ranges shall be considered in this release, unless otherwise stated.  NOTE 5b: The designations FR2-1 and FR2-2 should only be used when needed |

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

**Issue 1-5-1: Implementation of FR-2 requirements into specification**

* Proposals
  + Proposal 1 (Intel): Reuse existing sections in TS 38.104 and TS 38.141-2 for FR2-2 BS performance requirements definition.
  + Proposal 2 (Intel): Reuse existing sections in TS 38.104-1 for FR2-2 UE performance requirements definition.
  + Proposal 3 (Ericsson): Follow RF FR2-2 requirement structure, capture FR2-2 demodulation requirement into same section as FR2-1 but with different tables if possible. Adding extra phrase as “for FR2-1” and “for FR2-2” to requirement tables for differentiation
  + Proposal 4 (Ericsson):

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| Table 1 Specification structure for UE Demodulation performance requirements in FR2-2 (Radiated requirements).   |  |  |  | | --- | --- | --- | | Section number | Section name | Note | | 7.2 | PDSCH demodulation requirements |  | | 7.2.1 | 1RX requirements |  | | 7.2.2 | 2RX requirements |  | | 7.2.2.2 | TDD |  | | 7.2.2.2.[4] | Minimum requirements for UEs in FR2-2 | New section | | 7.3 | PDCCH demodulation requirements |  | | 7.3.1 | 1RX requirements |  | | 7.3.2 | 2RX requirements |  | | 7.3.2.2 | TDD |  | | 7.3.2.2.1 | 1 Tx Antenna performances | Updates on FR2-2 | | 7.3.2.2.2 | 2 Tx Antenna performances | Updates on FR2-2 | | 7.4 | PBCH demodulation requirements |  | | 7.4.1 | 1RX requirements |  | | 7.4.2 | 2RX requirements |  | | 7.4.2.2 | TDD | Updates on FR2-2 UEs |   Table 2 Specification structure for UE CSI reporting requirements in FR2-2 (Radiated requirements).   |  |  |  | | --- | --- | --- | | Section number | Section name | Note | | 8.2 | Reporting of Channel Quality Indicator (CQI) |  | | 8.2.2 | 2RX requirements |  | | 8.2.2.2 | TDD |  | | 8.2.2.2.1 | CQI reporting definition under AWGN | Updates on FR2-2 | | 8.2.2.2.2 | CQI reporting under fading conditions | Updates on FR2-2 | |

* Recommended WF
  + Collect views in 1st round.

## 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: BS performance requirements

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2204032 | Ericsson | Proposal 1: Start with 1/2Tx and 2Rx antenna configuration for FR2-2 BS demodulation requirements  Proposal 2: FR2-2 could take [20dB] SNR limit at current stage. New test cases and method should be defined if it is finally approved that FR2-2 SNR limit is much lower than 20dB.  Proposal 3: Take simulation assumptions in Table 2-1 as the start point for PUSCH demodulation to check the phase noise impact and configuration feasibility. Down selection is needed based on simulation results.  Proposal 4: RAN4 consider define FR2-2 BS demodulation requirements for PUSCH repetition type A.  Proposal 5: Define new requirements for FR2-2 PUCCH performance.  Proposal 6: Take simulation assumptions in Table 2.3-1 and 2.3-2 as the start point for PUCCH demodulation to check the phase noise impact and configuration feasibility. Other PUCCH format could be lower priority.  Proposal 7: Define new requirements for FR2-2 multi-RB PUCCH performance. Take simulation assumptions in Table 2.3-3, 2.3-4 and 2.3-5 as the start point for PUCCH format 0/1/4 to check the phase noise impact and configuration feasibility.  Proposal 8: Define new requirements for FR2-2 PRACH. Take simulation assumptions in Table 2.4-1 as the start point to see the phase noise impact and configuration feasibility |
| R4-2204395 | Intel Corporation | Observation #1: 3 SCSs and up to 4 CBWs for each SCS are specified for FR2-2.  Observation #2: Potentially, quite limited subset of FR2-1 performance requirements from SCS/CBW combination perspective can be reused for FR2-2.  Observation #3: FR2-2 performance requirements should cover licensed and unlicensed operations.  Observation #4: In case of FR2-1 requirements reuse for FR2-2, RAN4 needs to discuss applicability of FR2-1 requirements for unlicensed operation.  Observation #5: PUSCH performance in case of multi-slot PUSCH scheduling by single DCI can be verified by conventional PUSCH test case.  Proposal #1: Define PUSCH performance requirements to verify 32 UL HARQ processes feature.  Proposal #2: Define performance requirements for the enhanced PUCCH formats 0, 1, and 4.  Proposal #3: Define performance requirements for PRACH with 1151 and 571 sequence length with 120 kHz; for PRACH with 571 sequence length with 480 kHz SCS; for PRACH with 139 sequence length with 960 kHz SCS.  Proposal #4: Define FR2-2 performance requirements for 120, 480, and 960 kHz SCS.  Proposal #5: Define FR2-2 performance requirements for at least the following SCS/CBW combinations: 120/100, 120/400, 480/400, 960/400 kHz/MHz.  Proposal #6: Define FR2-2 performance requirements with normal CP only, with up to 2 demodulation branches, and with 1 and 2 Tx antennas.  Observation #6: The PUSCH performance difference between FR2-1 and FR2-2 at 70% of max throughput is up 0.8 dB for 16QAM and up to 1.5 dB for 64QAM.  Observation #7: There is a negligible performance difference between FR2-1 and FR2-2 scenarios for PUCCH formats 2 and 3.  Observation #8: There is a negligible performance difference in terms of PRACH miss detection between FR2-1 and FR2-2.  Proposal #7: Do not reuse FR2-1 performance requirements for FR2-2.  Proposal #8: Define FR2-2 performance requirements with TDLA 10ns RMS delay spread value and with 200 and 650 Hz max Doppler frequency.  Proposal #9: Define FR2-2 performance requirements with transform precoding disabled with 70% and 30% throughput; requirements with transform precoding enabled; requirements with UCI multiplexed on PUSCH.  Proposal #10: Do not define in Rel-17 FR2-2 performance requirements for 2-step RA type, PUSCH performance requirements with repetition type A, and PUSCH performance requirements with mapping type B with non-slot transmission.  Proposal #11: Define FR2-2 PUSCH performance requirements assuming PTRS Tx.  Proposal #12: Define FR2-2 PUSCH performance requirements only with 1+1 DMRS configuration.  Proposal #13: Define FR2-2 PUSCH performance requirements with transform precoding enabled and UCI multiplexed on PUSCH only for the smallest CBWs for each SCS.  Proposal #14: Define FR2-2 PUSCH performance requirements with transform precoding disabled at least for the following SCS/CBW combinations: 120/100, 120/400, 480/400, 960/400 kHz/MHz.  Proposal #15: Define FR2-2 PUSCH performance requirements according to Tables 2-5.  Proposal #16: For FR2-2 define the same set of PUCCH performance requirements as in FR2-1.  Proposal #17: For FR2-2 define the same set of PRACH performance requirements as in FR2-1.  Proposal #18: Define FR2-2 PRACH performance requirements with AWGN channel model and with TDLA10-650 with frequency offset channel models.  Proposal #19: Define FR2-2 PRACH performance requirements for PRACH preambles A1, A2, A3, B4, C0, C2.  Proposal #20: Consider the following PRACH parameters as initial simulation assumptions: Ncs = 69, logical sequence index = 0, v =0.  Proposal #21: As a baseline option consider application of FR2-1 applicability rules for FR2-2 as well. |
| R4-2205803 | Huawei, HiSilicon | Proposal 1: Define the UE requirements for max bandwidth for each SCS. i.e. 400 MHz for 120 kHz SCS, 1600 MHz for 480 kHz and 2000 MHz for 960 kHz.  Proposal 2: Keep the number of transmission RBs open until there are corresponding agreements from RF team.  Proposal 3: Not consider LBT failure for PUSCH, PUCCH and PRACH cases.  Proposal 4: Define PUSCH requirements for 120 kHz, 480 kHz and 960 kHz.  Proposal 5: Define PUSCH performance requirements by using PN model example 2 defined in TS 38.803.  Proposal 6: Define PUSCH performance requirements by using ICI compensation.  Proposal 7: Define the requirements for PRACH operating in FR2-2 with following cases:   * SCS: 120 kHz; Format: A2, B4 and C2; LRA: 1151; Propagation conditions: AWGN and TDLA30-300 * SCS: 480 kHz; Format: A2, B4 and C2, LRA: 571; Propagation conditions: AWGN and TDLA30-300 * SCS: 960 kHz; Format: A2, B4 and C2, LRA: 139; Propagation conditions: AWGN and TDLA30-300   Proposal 8: Reuse test metric of Rel-15 and use assumptions in Table 2 as time error tolerance.  Use following assumptions as start point to discuss for PUCCH requirements definition:   * PF0:   + 120 kHz, NRB=10, 1 OFDM symbol without hopping 1T2R, TDLA30-300 Low   + 120 kHz, NRB=10, 2 OFDM symbol with hopping 1T2R, TDLA30-300 Low   + 480 kHz, NRB=10, 1 OFDM symbol without hopping 1T2R，TDLA30-300 Low   + 480 kHz, NRB=10, 2 OFDM symbol with hopping 1T2R，TDLA30-300 Low   + 960 kHz NRB=10, 1 OFDM symbol without hopping 1T2R，TDLA30-300 Low   + 960 kHz NRB=10, 2 OFDM symbol with hopping 1T2R，TDLA30-300 Low * PF1:   + 120 kHz, NRB=10, 14 OFDM symbol with hopping 1T2R，TDLA30-300 Low   + 480 kHz, NRB=10, 14 OFDM symbol with hopping 1T2R, TDLA30-300 Low   + 960 kHz NRB=10, 14 OFDM symbol with hopping 1T2R, TDLA30-300 Low * PF2:   + 480 kHz, NRB=9, 2 OFDM symbol, 1T2R，TDLA30-300 Low, UCI bits:22bit   + 960 kHz NRB=9, 2 OFDM symbol , 1T2R，TDLA30-300 Low, UCI bits:22bit * PF3   + 480 kHz, NRB=3, 4 OFDM symbol, 1T2R，TDLA30-300 Low, UCI bits:16bit   + 960 kHz NRB=3, 4 OFDM symbol , 1T2R，TDLA30-300 Low, UCI bits:16bit * PF4:   + 120 kHz, NRB=10, 14 OFDM symbol with hopping 1T2R，TDLA30-300 Low, UCI bits: 22 bits with polar coding/ Other UCI bits less than 11 with RM coding, OCC length=2.   + 480 kHz, NRB=10, 14 OFDM symbol with hopping 1T2R，TDLA30-300 Low, UCI bits: 22 bits with polar coding/ Other UCI bits less than 11 with RM coding, OCC length=2   + 960 kHz, NRB=10, 14 OFDM symbol with hopping 1T2R，TDLA30-300 Low, UCI bits: 22 bits with polar coding/ Other UCI bits less than 11 with RM coding, OCC length=2 |
| R4-2204589 | Nokia, Nokia Shanghai Bell | Observation 1: Operation in FR2-2 includes support of 120, 480, and 960 kHz SCS.  Observation 2: No BS demodulation performance requirements is defined for PRACH, PUCCH, and PUSCH for SCS 480 kHz and 960 kHz.  Proposal 1: Specify new BS demodulation performance requirements for PRACH, PUCCH, and PUSCH for SCS 480 kHz and 960 kHz  Observation 3: New channel bandwidths have been introduced in FR2 for 480 kHz and 960 kHz SCS.  Observation 4: CBW 800 MHz, 1600 MHz, and 2000 MHz are new in FR2 and introduced specifically for FR2-2.  Proposal 2: Consider all the new CBWs for the performance with 480 and 940 kHz SCS. i.e., 800 and 1600 MHz for SCS 480 kHz, and 800, 1600 and 2000 MHz for SCS 960 kHz.  Observation 5: The covered deployment scenarios of FR2-2 require performance requirements under static propagation condition and Multi-path fading propagation conditions.  Proposal 3: Both static propagation condition and Multi-path fading propagation conditions could be considered when defining new requirements and test cases.  Observation 6: Scheduling and link adaptation typically allocates large SCS and MCS in situations with low delay spread.  Observation 7: Distribution of the delay spread in typical scenarios for operation in FR2-2 are mostly concentrated bellow 30 ns, with a large part of the samples experiencing delay spread between 10 and 20 ns.  Observation 8: Existing RAN4 requirements include TDLA30 as the minimum delay spread for fading channels.  Proposal 4: RAN4 to study the use of TDLA10 and TDLA20 for demodulation requirements with large SCS and high MCS.  Observation 9: Doppler shift is directly proportional to the carrier frequency; Hence, it should be higher in FR2-2 compared to FR2-1.  Observation 10: Simulation assumption for FR2 was 30 GHz.  Proposal 5: Double the doppler shifts in FR2-2 than the ones already used for FR2-1. i.e., TDLAxx-150, and TDLAxx-300.  Observation 11: New combinations of L\_RA and Δf\_RA is introduced for FR2-2.  Proposal 6: RAN4 to introduce performance requirements for the new combinations of L\_RA and Δf\_RA introduced for FR2-2.  Observation 12: Multi-PUSCH scheduling defined in Rel-16 NR-U is used as a baseline for multi-PUSCH scheduling in Rel-17. and not major modification are spotted with respect to Rel-16.  Proposal 7: RAN4 not to define new BS demodulation requirements for multi-PUSCH scheduling in Rel-17.  Observation 13: For FR2-2, multi-RB PUCCH format 0, 1, and 4 enchantment for 120/480/960 kHz SCS is supported.  Proposal 8: Specify BS demodulation requirements for multi-RB PUCCH format 0, 1, and 4. |

## Open issues summary

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

### Sub-topic 2-1: SCS/CBW combinations

*Sub-topic description:*

*New SCS and CBWs were introduced for FR2-2. RAN4 needs to discuss SCS/CBW combinations for requirements definition. Moderator suggest discussing separately SCS and CBW to converge on the required SCS/CBW combinations.*

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

**Issue 2-1-1: SCS for UL requirements definition**

* Proposals
  + Option 1 (Nokia): 480, 960 kHz.
  + Option 2 (Ericsson): Prioritize 120kHz SCS for both BS and UE demodulation requirement discussion. 480kHz and 960kHz SCS could be lower priority.
  + Option 3 (Huawei, Intel): 120, 480 and 960 kHz.
* Recommended WF
  + Collect views in 1st round on required SCS for UL test cases.

**Issue 2-1-2: CBW for UL requirements definition**

* Proposals
  + SCS 120 kHz
    - Option 1 (Ericsson, Intel): 100 and 400 MHz
    - Option 2 (Huawei): 400 MHz
  + SCS 480 kHz
    - Option 1 (Nokia): 800 and 1600 MHz
    - Option 2 (Ericsson): 400 and 1600 MHz
    - Option 3 (Huawei): 1600 MHz
    - Option 4 (Intel): 400 MHz
  + SCS 960 kHz
    - Option 1 (Nokia): 800, 1600 and 2000 MHz
    - Option 2 (Ericsson): 400 and 2000 MHz
    - Option 3 (Huawei): 2000 MHz
    - Option 4 (Intel): 400 MHz
* Recommended WF
  + Collect views in 1st round on required CBWs for UL test cases.

### Sub-topic 2-2: General issues

*Sub-topic description*

*General aspects regardless of UL Physical channel*

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

**Issue 2-2-1: FR2-1 requirements reuse**

* Proposals
  + Proposal 1 (Intel): Do not reuse FR2-1 performance requirements for FR2-2.
* Recommended WF
  + Collect views in 1st round.

**Issue 2-2-2: General simulation assumptions**

* Proposals
  + Proposal 1 (Ericsson): Start with 1/2Tx and 2Rx antenna configuration for FR2-2 BS demodulation requirements
  + Proposal 2 (Intel): Define FR2-2 performance requirements with normal CP only, with up to 2 demodulation branches, and with 1 and 2 Tx antennas.
* Recommended WF
  + Collect views in 1st round.

**Issue 2-2-3: Test SNR limit**

* Proposals
  + Proposal 1 (Ericsson): FR2-2 could take [20dB] SNR limit at current stage. New test cases and method should be defined if it is finally approved that FR2-2 SNR limit is much lower than 20dB
* Recommended WF
  + Collect views in 1st round.

### Sub-topic 2-3: PUSCH performance requirements

*Sub-topic description*

*Details of PUSCH performance requirements*

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

**Issue 2-3-1: Scope of PUSCH performance requirements**

* Proposals
  + Proposal 1 (Ericsson): RAN4 consider define FR2-2 BS demodulation requirements for PUSCH repetition type A
  + Proposal 2 (Ericsson): The waveform could only consider CP-OFDM. Regarding the potential high PAR caused by worse PA linearization, DFT-s-OFDM could be considered later after the discussion on CP-OFDM
  + Proposal 3 (Intel): Define FR2-2 performance requirements with transform precoding disabled with 70% and 30% throughput; requirements with transform precoding enabled; requirements with UCI multiplexed on PUSCH.
  + Proposal 4 (Intel): Do not define in Rel-17 FR2-2 performance requirements for 2-step RA type, PUSCH performance requirements with repetition type A, and PUSCH performance requirements with mapping type B with non-slot transmission.
  + Proposal 5 (Intel): Define FR2-2 PUSCH performance requirements according to Tables 2-5.

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| Table 2. Transform precoding disabled   |  |  |  |  | | --- | --- | --- | --- | | Number of Tx antennas | Number of demodulation branches | Propagation conditions and correlation matrix | FRC | | 1 | 2 | TDLA10-650 | QPSK, Rank 1 | | TDLA10-650 | 16QAM, Rank 1 | | TDLA10-200 | 64QAM Rank 1 | | 2 | TDLA10-650 | QPSK, Rank 2 | | TDLA10-650 | 16QAM, Rank 2 |   Table 3. Transform precoding enabled   |  |  |  |  | | --- | --- | --- | --- | | Number of Tx antennas | Number of demodulation branches | Propagation conditions and correlation matrix | FRC | | 1 | 2 | TDLA10-650 | QPSK, Rank 1 |   Table 4. UCI multiplexed on PUSCH: CSI part 1 requirements   |  |  |  |  | | --- | --- | --- | --- | | Number of Tx antennas | Number of demodulation branches | Propagation conditions and correlation matrix | UCI bits (CSI part 1, CSI part 2) | | 1 | 2 | TDLA10-650 | 7 (5,2) | | 1 | 2 | TDLA10-650 | 40 (20,20) |   Table 5. UCI multiplexed on PUSCH: CSI part 2 requirements   |  |  |  |  | | --- | --- | --- | --- | | Number of Tx antennas | Number of demodulation branches | Propagation conditions and correlation matrix | UCI bits (CSI part 1, CSI part 2) | | 1 | 2 | TDLA10-650 | 7 (5,2) | | 1 | 2 | TDLA10-650 | 40 (20,20) | |

* Recommended WF
  + Collect views in 1st round.

**Issue 2-3-2: PUSCH performance requirements for multi-PUSCH scheduling**

* Proposals
  + Proposal 1 (Nokia): RAN4 not to define new BS demodulation requirements for multi-PUSCH scheduling in Rel-17
* Recommended WF
  + Collect views in 1st round.

**Issue 2-3-3: PUSCH performance requirements with 32 UL HARQ processes**

* Proposals
  + Proposal 1 (Intel): Define PUSCH performance requirements to verify 32 UL HARQ processes feature
* Recommended WF
  + Collect views in 1st round.

**Issue 2-3-4: General PUSCH test setup**

Moderator suggest discussing different aspects of simulation assumptions in one place since this is the first meeting. Companies, potentially, need more time on detail work on simulation assumptions. Same time it is encouraged to converge on some general aspects.

* Proposals
  + Proposal 1 (Ericsson): Start with MCS4/16/20 to see if it is feasible
  + Proposal 2 (Ericsson): DM-RS/PT-RS configuration could start with Rel-15 assumptions. Further discussion is needed based on simulation results
  + Proposal 3 (Huawei): Keep the number of transmission RBs open until there are corresponding agreements from RF team.
  + Proposal 4 (Intel): Define FR2-2 PUSCH performance requirements assuming PTRS Tx
  + Proposal 5 (Intel): Define FR2-2 PUSCH performance requirements only with 1+1 DMRS configuration
* Recommended WF
  + Collect views in 1st round.

**Issue 2-3-5: Detailed PUSCH test setup**

Several companies have submitted detail set of simulation assumptions. Moderator suggests discussing them in the second round.

* Proposals
  + Proposal 1 (Ericsson): Take simulation assumptions in Table 2-1 as the start point for PUSCH demodulation to check the phase noise impact and configuration feasibility. Down selection is needed based on simulation results

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| Table 2.2-1: Simulation parameters for FR2-2 PUSCH demodulation   |  |  |  | | --- | --- | --- | | Parameter | | Value | | Transform precoding | | Disabled | | Default TDD UL-DL pattern (Note 1) | | 120kHz SCS:  3D1S1U, S=10D:2G:2U | | HARQ | Maximum number of HARQ transmissions | 4 | |  | RV sequence | 0, 2, 3, 1 | | DM-RS | DM-RS configuration type | 1 | |  | DM-RS duration | single-symbol DM-RS | |  | Additional DM-RS symbols | pos0, pos1 | |  | Number of DM-RS CDM group(s) without data | 2 | |  | Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB | |  | DM-RS port(s) | {0}, {0, 1} | |  | DM-RS sequence generation | NID=0, nSCID =0 | | Time domain | PUSCH mapping type | B | | resource | Start symbol index | 0 | |  | Allocation length | 10 | | Frequency domain | RB assignment | Full applicable test bandwidth  (100MHz and 400MHz) | | resource | Frequency hopping | Disabled | | TPMI index for 2Tx two-layer spatial multiplexing transmission | | 0 | | Code block group based PUSCH transmission | | Disabled | | PT-RS | Frequency density (*KPT-RS*) | 2, Disabled | | configuration | Time density (*LPT-RS*) | 1, Disabled | | Test metric | Normalized throughput | 70% | | Antenna | Tx and Rx configuration | 1Tx 2Rx  2Tx 2Rx | | Channel model |  | TDLA30-200/2000  TDLA10-200/2000  TDLA5-200/2000 | | MCS | 64QAM MCS table index | 4/16/20 | | Phase noise | Model sets in TR38.808 | Set 1 (Note) | | Note: Companies are suggested to deliver ideal simulation results with and without phase noise. | | | |

* Recommended WF
  + Collect views in 2nd round

**Issue 2-3-6: Rx processing assumptions**

* Proposals
  + Proposal 1 (Huawei): Define PUSCH performance requirements by using ICI compensation.
* Recommended WF
  + Collect views in 2nd round

**Issue 2-3-7: Other**

This set of proposals directly depends on the other issues or do not require urgent agreement. Can be deprioritized for the second-round discussion

* Proposals
  + Proposal 1 (Intel): Define FR2-2 PUSCH performance requirements with transform precoding enabled and UCI multiplexed on PUSCH only for the smallest CBWs for each SCS.
  + Proposal 2 (Intel): Define FR2-2 PUSCH performance requirements with transform precoding disabled at least for the following SCS/CBW combinations: 120/100, 120/400, 480/400, 960/400 kHz/MHz
  + Proposal 3 (Intel): As a baseline option consider application of FR2-1 applicability rules for FR2-2 as well.
* Recommended WF
  + Collect views in 2nd round

### Sub-topic 2-4: PUCCH performance requirements

*Sub-topic description*

*Details of PUCCH performance requirements*

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

**Issue 2-4-1: Scope of PUCCH performance requirements**

* Proposals
  + Option 1 (Intel, Huawei, Ericsson): Define performance requirements for the enhanced PUCCH formats 0, 1, and 4. Define new requirements for PUCCH formats 2 and 3
  + Option 2 (Nokia): Define performance requirements for the enhanced PUCCH formats 0, 1, and 4
* Recommended WF
  + Collect views in 1st round

**Issue 2-4-3: Detailed PUCCH test setup**

Moderator suggest focusing on at least baseline assumptions like test metrics and SCS. Second level details can be discussed in the second round.

* Proposals
  + Proposal 1 (Ericsson): Take simulation assumptions in Table 2.3-1 and 2.3-2 as the start point for PUCCH demodulation to check the phase noise impact and configuration feasibility. Other PUCCH format could be lower priority.

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| Table 2.3-1: Simulation Parameters for FR2-2 PUCCH format 2   |  |  | | --- | --- | | Parameter | Test | | Number of information bits | 2 | | Number of PRBs | 1 | | Number of symbols | 14 | | First PRB prior to frequency hopping | 0 | | Intra-slot frequency hopping | enabled | | First PRB after frequency hopping | The largest PRB index – (nrofPRBs – 1) | | Group and sequence hopping | neither | | Hopping ID | 0 | | Initial cyclic shift | 0 | | First symbol | 0 | | Index of orthogonal cover code (*timeDomainOCC*) | 0 | | SCS and bandwidth | 120kHz SCS  100MHz/400MHz | | Antenna configuration | 1Tx 2Rx | | Channel model | TDLA30-200/2000  TDLA10-200/2000  TDLA5-200/2000 | | Phase noise model | Set 1 in TR38.808 | | Test metric | SNR@NACK🡪ACK<0.1%  SNR@ACK miss<1% | | Simulation results: Ideal simulation results with/without phase noise. | |   Table 2.3-2: Simulation Parameters for FR2-2 PUCCH format 3   |  |  |  | | --- | --- | --- | | Parameter | Test 1 | Test 2 | | Modulation order | QPSK | | | First PRB prior to frequency hopping | 0 | | | Intra-slot frequency hopping | enabled | | | First PRB after frequency hopping | The largest PRB index – (Number of PRBs - 1) | | | Group and sequence hopping | neither | | | Hopping ID | 0 | | | Number of PRBs | 1 | 3 | | Number of symbols | 14 | 4 | | The number of UCI information bits | 16 | 16 | | First symbol | 0 | 0 | | SCS and bandwidth | 120kHz SCS  100MHz/400MHz | | | Antenna configuration | 1Tx 2Rx | | | Channel model | TDLA30-200/2000  TDLA10-200/2000  TDLA5-200/2000 | | | Phase noise model | Set 1 in TR38.808 | | | Test metric | SNR@BLER<1% | | | Simulation results: Ideal simulation results with/without phase noise. | | | |

* + Proposal 2 (Ericsson): Define new requirements for FR2-2 multi-RB PUCCH performance. Take simulation assumptions in Table 2.3-3, 2.3-4 and 2.3-5 as the start point for PUCCH format 0/1/4 to check the phase noise impact and configuration feasibility

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| Table 2.3-3: Test Parameters for multi-RB PUCCH format 0   |  |  | | --- | --- | | Parameter | Test | | Number of UCI information bits | 1 | | Number of PRBs | 16 | | First PRB prior to frequency hopping | 0 | | Intra-slot frequency hopping | N/A for 1 symbol | | First PRB after frequency hopping | The largest PRB index – (Number of PRBs - 1) | | Group and sequence hopping | neither | | Hopping ID | 0 | | Initial cyclic shift | 0 | | First symbol | 13 for 1 symbol | | SCS and bandwidth | 120kHz SCS  100MHz/400MHz | | Channel model | TDLA30-200/2000  TDLA10-200/2000  TDLA5-200/2000 | | Test metric | SNR@DTX 🡪ACK <1% |   Table 2.3-4: Test Parameters for multi-RB PUCCH format 1   |  |  | | --- | --- | | Parameter | Test | | Number of information bits | 2 | | Number of PRBs | 16 | | Number of symbols | 14 | | First PRB prior to frequency hopping | 0 | | Intra-slot frequency hopping | enabled | | First PRB after frequency hopping | The largest PRB index – (nrofPRBs – 1) | | Group and sequence hopping | neither | | Hopping ID | 0 | | Initial cyclic shift | 0 | | First symbol | 0 | | Index of orthogonal cover code (*timeDomainOCC*) | 0 | | SCS and bandwidth | 120kHz SCS  100MHz/400MHz | | Channel model | TDLA30-200/2000  TDLA10-200/2000  TDLA5-200/2000 | | Test metric | SNR@NACK 🡪ACK <0.1%  SNR@ACK miss <1% | |

* + Proposal 2 (Huawei): Use following assumptions as start point to discuss for PUCCH requirements definition
    - PF0:
      * 120 kHz, NRB=10, 1 OFDM symbol without hopping 1T2R, TDLA30-300 Low
      * 120 kHz, NRB=10, 2 OFDM symbol with hopping 1T2R, TDLA30-300 Low
      * 480 kHz, NRB=10, 1 OFDM symbol without hopping 1T2R，TDLA30-300 Low
      * 480 kHz, NRB=10, 2 OFDM symbol with hopping 1T2R，TDLA30-300 Low
      * 960 kHz NRB=10, 1 OFDM symbol without hopping 1T2R，TDLA30-300 Low
      * 960 kHz NRB=10, 2 OFDM symbol with hopping 1T2R，TDLA30-300 Low
    - PF1:
      * 120 kHz, NRB=10, 14 OFDM symbol with hopping 1T2R，TDLA30-300 Low
      * 480 kHz, NRB=10, 14 OFDM symbol with hopping 1T2R, TDLA30-300 Low
      * 960 kHz NRB=10, 14 OFDM symbol with hopping 1T2R, TDLA30-300 Low
    - PF2:
      * 480 kHz, NRB=9, 2 OFDM symbol, 1T2R，TDLA30-300 Low, UCI bits:22bit
      * 960 kHz NRB=9, 2 OFDM symbol , 1T2R，TDLA30-300 Low, UCI bits:22bit
    - PF3
      * 480 kHz, NRB=3, 4 OFDM symbol, 1T2R，TDLA30-300 Low, UCI bits:16bit
      * 960 kHz NRB=3, 4 OFDM symbol , 1T2R，TDLA30-300 Low, UCI bits:16bit
    - PF4:
      * 120 kHz, NRB=10, 14 OFDM symbol with hopping 1T2R，TDLA30-300 Low, UCI bits: 22 bits with polar coding/ Other UCI bits less than 11 with RM coding, OCC length=2.
      * 480 kHz, NRB=10, 14 OFDM symbol with hopping 1T2R，TDLA30-300 Low, UCI bits: 22 bits with polar coding/ Other UCI bits less than 11 with RM coding, OCC length=2
      * 960 kHz, NRB=10, 14 OFDM symbol with hopping 1T2R，TDLA30-300 Low, UCI bits: 22 bits with polar coding/ Other UCI bits less than 11 with RM coding, OCC length=2
  + Proposal 3 (Intel):
    - DTX to ACK probability requirements
    - Enhanced PUCCH format 0:
      * ACK missed detection requirements
      * 1 and 2 OFDM symbols
    - Enhanced PUCCH format 1
      * NACK to ACK probability requirements
      * ACK missed detection requirements
    - PUCCH format 2:
      * ACK missed detection requirements
      * UCI BLER performance requirements
      * 1 and 2 OFDM symbols
    - PUCCH format 3:
      * UCI BLER performance requirements
      * With and without additional DMRS
      * 4 and 14 OFDM symbols
    - Enhanced PUCCH format 4: With and without additional DMRS
      * UCI BLER performance requirements
* Recommended WF
  + Collect views in 1st round

### Sub-topic 2-5: PRACH performance requirements

*Sub-topic description*

*Details of PRACH performance requirements*

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

**Issue 2-5-1: Scope of PRACH requirements**

* Proposals
  + Proposal 1 (Intel): For FR2-2 define the same set of PRACH performance requirements as in FR2-1:
    - False alarm probability requirements
    - PRACH miss detection requirements
* Recommended WF
  + Collect views in 1st round

**Issue 2-5-2: SCS**

* Proposals
  + Option 1 (Ericsson): Prioritize 120kHz SCS. Lower priority for 480kHz and 960kHz SCS
  + Option 2 (Nokia, Huawei, Intel): 120, 480 and 960 kHz
* Recommended WF
  + Collect views in 1st round

**Issue 2-5-3: Sequence length**

* Proposals
  + Proposal 1 (Ericsson): L= 139, 571, 1151 for 120kHz
  + Proposal 2 (Nokia): RAN4 to introduce performance requirements for the new combinations of L\_RA and Δf\_RA introduced for FR2-2.
  + Proposal 3 (Huawei): Only max supported sequence length for each SCS
  + Proposal 4 (Intel): Define performance requirements for PRACH with 1151 and 571 sequence length with 120 kHz; for PRACH with 571 sequence length with 480 kHz SCS; for PRACH with 139 sequence length with 960 kHz SCS
* Recommended WF
  + Collect views in 1st round

**Issue 2-5-4: PRACH formats**

* Proposals
  + Option 1 (Ericsson, Huawei): A2, B4, C2
  + Option 2 (Intel): A1, A2, A3, B4, C0, C2
* Recommended WF
  + Collect views in 1st round

**Issue 2-5-5: Channel model and Frequency offset**

* Proposals
  + Proposal 1 (Ericsson): Consider AWGN and multi-path fading channels, such as TDLA30-200/2000, TDLA10-200/2000 and TDLA5-200/2000
  + Proposal 2 (Huawei): consider both AWGN and TDLA30-300
  + Proposal 3 (Intel): Define FR2-2 PRACH performance requirements with AWGN channel model and with TDLA10-650 with frequency offset channel models
* Recommended WF
  + Collect views in 1st round

**Issue 2-5-6: Frequency offset**

* Proposals
  + Option 1 (Huawei): 0.1\*71GHz=7100Hz
  + Option 2 (Ericsson): Consider 0.1ppm (7000Hz) for FR2-2.
* Recommended WF
  + Collect views in 1st round

**Issue 2-5-7: Time error tolerance**

* Proposals
  + Proposal 1 (Huawei): Reuse test metric of Rel-15 and use assumptions in Table 2 as time error tolerance.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 2: Time error tolerance for AWGN and TDLA30-300   |  |  |  |  | | --- | --- | --- | --- | | PRACH | PRACH SCS | Time error tolerance | | | preamble | (kHz) | AWGN | TDLA30-300 | | A2, B4, C2 | 120 | 0.07 us | 0.22 us | |  | 480 | 0.02 us | 0.17 us | |  | 960 | 0.01 us | 0.16us | |

* + Proposal 2 (Ericsson): 0.07us for AWGN. For multi-path fading channels, time error could be further discussed based on delay profile and timing error.
* Recommended WF
  + Collect views in 2nd round

**Issue 2-5-8: (Ncs, logical sequence index, v)**

* Proposals
  + Proposal 1 (Intel): Consider the following PRACH parameters as initial simulation assumptions: Ncs = 69, logical sequence index = 0, v =0.
* Recommended WF
  + Collect views in 2nd round

**Issue 2-5-9: Detailed simulation assumptions**

* Proposals
  + Proposal 1 (Huawei): Define the requirements for PRACH operating in FR2-2 with following cases:
    - SCS: 120 kHz; Format: A2, B4 and C2; LRA: 1151; Propagation conditions: AWGN and TDLA30-300
    - SCS: 480 kHz; Format: A2, B4 and C2, LRA: 571; Propagation conditions: AWGN and TDLA30-300
    - SCS: 960 kHz; Format: A2, B4 and C2, LRA: 139; Propagation conditions: AWGN and TDLA30-300.
  + Proposal 2 (Ericsson): Define new requirements for FR2-2 PRACH. Take simulation assumptions in Table 2.4-1 as the start point to see the phase noise impact and configuration feasibility.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 2.4-1: simulation parameters for FR2-2 PRACH   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | PRACH | PRACH SCS | Time error tolerance [us] | | | | Frequency offset | | | preamble | (kHz) | AWGN | TDLA30-200/2000 | TDLA10-200/2000 | TDLA5-200/2000 | AWGN | Multi-path channel | | A2, B4, C2  FFS on other preambles | 120 | 0.07 | FFS | FFS | FFS | 0 | 7000 | |

* Recommended WF
  + Collect views in 2nd round

## Companies views’ collection for 1st round

### Open issues

**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

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

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

## Summary for 1st round

### Open issues

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

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

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Topic #3: UE performance requirements

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2204584 | Ericsson | Proposal 1: RAN4 defines the UE demodulation and CSI reporting requirements with:   * Number of receive antennas: 2Rx * Modulation order: Up to 64QAM * Both single carrier (FR2-2) and NR-DC FR1 + FR2-2 scenarios   Proposal 2: RAN4 defines the UE demodulation requirements with:   * FR2-2 TDD: SCS = 120 kHz with min CBW = 100 MHz and Max CBW = 400 MHz * FR2-2 TDD: SCS = 480 kHz with min CBW = 400 MHz and Max CBW = 1600 MHz   Observation 1: In Rel-17, NR operation in FR2-2 will only support Rel-15 patterns for CP-OFDM  Proposal 3: Consider the parametrized phase noise model in [4] and use Rel-15 PTRS pattern for tests.  Proposal 4: Define PDSCH demodulation requirements for UE with the following test setup.  Proposal 5: Define PDCCH demodulation requirements for UE in FR2-2 with the following test setup.  Proposal 6: Define PBCH demodulation requirements with the following test setup.  Proposal 7: Define SDR test for UE in FR2-2 considering 2Rx UE.  Proposal 8: Define the CQI reporting definition test for 2Rx UE with CQI table 1 (64QAM) by reusing the existing test setup and metrics.  Proposal 9: Define the wideband CQI reporting under fading condition for 2Rx UE with CQI table 1 (64QAM) by reusing the existing test setup and metrics. |
| R4-2204834 | Nokia, Nokia Shanghai Bell | Observation 1: Operation in FR2-2 includes support of 120, 480, and 960 kHz SCS.  Observation 2: Channel bandwidths of up to 2000 MHz are supported in FR2-2.  Observation 3: In order to support FR2-2 operation, a UE has to support at least 120 kHz SCS.  Observation 4: Reduced slot duration and CP length will have an impact on UE demodulation performance.  Observation 5: For FR2-2 the 120kHz SCS is mandatory.  Observation 6: For FR2-2 the 480/960kHz SCS are optional.  Proposal 1: Specify new UE demodulation and CSI reporting performance requirements for SCS 480kHz and 960kHz, including PDSCH, PDCCH and PBCH.  Observation 7: In FR2-2 there is support for operation of 120 kHz SCS with 100 MHz and 400 MHz channel bandwidth.  Observation 8: In order to take advantage of the benefits of the operation above 52.6 GHz, the support of 400 MHz channel bandwidth for 120 kHz SCS might become more important when comparing to operation in FR2-1.  Proposal 2: Specify new UE demodulation and CSI reporting performance requirements for SCS 120 kHz with 400 MHz channel bandwidth for PDSCH, PDCCH and PBCH.  Proposal 3: Study if new UE demodulation and CSI reporting performance requirements for SCS 120 kHz with 100 MHz channel bandwidth are needed for the operation in FR2-2.  Observation 9: Support of 480 kHz SCS includes channel bandwidths from 400 MHz to 1600 MHz.  Observation 10: Support of 960 kHz SCS includes channel bandwidths from 400 MHz to 2000 MHz.  Proposal 4: RAN4 to specify new UE demodulation and CSI reporting requirements for PDSCH, PDCCH and PBCH with the following SCS and channel bandwidth combinations:   * 480 kHz SCS with 400 MHz, 800 MHz, and 1600 MHz channel bandwidth * 960 kHz SCS with 400 MHz, 800 MHz, 1600 MHz, and 2000 MHz channel bandwidth   Observation 11: Currently FDL\_high may not exceeding 48200 MHz as defined in 38.101-4. This value must be increased to cover the FR2-2 frequency range.  Proposal 5: Increase the FLD\_high max frequency to cover FR2-2 frequency bands, i.e. “FDL\_high may not exceed 71000 MHz” and reconsider existing requirements if needed.  Observation 12: Higher frequencies used in FR2-2 will result in increased phase error which needs to be considered when defining the performance requirements for FR2-2 for all SCS defined in FR2-2.  Observation 13: Current configuration for PTRS provides the maximum PTRS REs possible in the standard.  Proposal 6: Rederive performance requirements with the maximally dense PTRS configurations for FR2-2 below:  Observation 14: Scheduling and link adaptation typically allocates large SCS and MCS in situations with low delay spread.  Observation 15: Distribution of the delay spread in typical scenarios for operation in FR2-2 are mostly concentrated below 30 ns, with a large part of the samples experiencing delay spread between 10 and 20 ns.  Observation 16: Existing RAN4 requirements include TDLA30 as the minimum delay spread for fading channels.  Proposal 7: RAN4 to study the use of TDLA10 and TDLA20 for demodulation requirements with large SCS and high MCS.  Observation 17: Doppler shift is directly proportional to the carrier frequency; Hence, it should be higher in FR2-2 compared to FR2-1.  Observation 18: Simulation assumption for FR2 was 30 GHz.  Proposal 8: We propose to double the doppler shifts in FR2-2 than the ones already used for FR2-1. i.e., TDLAxx-150, and TDLAxx-300.  Observation 19: SCS of 120kHz is extended to also be part of FR2-2, hence the current requirements for SCS 120kHz might not be sufficient to cover the full FR2 frequency range.  Observation 20: Based on analysis of impact related to phase noise, channel model doppler and channel bandwidth it can be decided if new requirements for 120kHz SCS in FR2-2 is required or if the existing UE demodulation requirements can be adjusted to cover the full FR2 range (i.e., FR2-1 + FR2-2).  Proposal 9: Analyse the impact of the FR2-2 frequency range on the existing UE demodulation and CSI reporting performance requirements for SCS of 120kHz. If needed, add new performance requirements for PDSCH, PDCCH and PBCH with FR2-2 using 120kHz SCS.  Proposal 10: In case new UE demodulation and CSI reporting requirements are needed for 120kHz SCS in FR2-2, update the existing requirements to be valid for FR2-1 only and create separate requirements for FR2-2.  Observation 21: Multi-PDSCH scheduling by a single DCI has been introduced in Rel.17. However, the scheduled PDSCH resources are independent and as such the same demodulation requirements should apply to each PDSCH instance.  Proposal 11: RAN4 to not include new UE demodulation performance requirements for the feature of Multi-PDSCH scheduled by a single DCI.  Observation 22: The number of HARQ processes has been increase to 32 [4]. There are enough HARQ processes to run the UE demodulation tests without running out of processes and thus starving the transmission pipeline.  Proposal 12: RAN4 to not have explicit new demod requirements for increased number of HARQ processes. However, RAN4 to take care to specify sufficient HARQ processes for other PDSCH requirements.  Observation 23: If the channel model is changed for FR2-2 it should be discussed in RAN4 if changes to the CSI reporting requirements will be needed.  Proposal 13: RAN4 to discuss how changes to the channel models would impact the CSI reporting requirements.  Observation 24: Deployment scenarios agreed in RF and RRM already include FR2-2 only standalone and CA/NR-DC with FR1 anchor.  Proposal 14: RAN4 to consider UE demodulation and CSI reporting requirements including the following scenarios:   * Standalone FR2-2 only * CA and NR-DC with FR1 anchor and FR2-2. |
| R4-2205802 | Huawei, HiSilicon | Proposal 1: Define following performance requirements for UE operating in 71GHz band:   * For 120 kHz SCS: PDSCH * For 480 kHz SCS and 960 kHz SCS (Optional with capability signaling): PBCH, PDCCH and PDSCH   Proposal 2: Use transmission burst model defined in LAA as start point to be discussed and set the gap between two transmission bursts at least to 4/8/16 OFDM symbols for 120/480/960 kHz SCS. Further discuss following test setup:   * COT duration * LBT failure probability * HARQ feedback * Start symbol and end symbol within the slot   Proposal 3: Define the UE requirements for max bandwidth for each SCS. i.e. 400 MHz for 120 kHz SCS, 1600 MHz for 480 kHz and 2000 MHz for 960 kHz.  Proposal 4: Keep the number of transmission RBs open until there are corresponding agreements from RF team.  Proposal 5: Use 2 receiving antennas.  Proposal 5: Define two set of PDSCH requirements for license band without LBT mechanism and unlicensed band with LBT mechanism.  Proposal 6: Define the PDSCH performance requirements for both rank 1 and rank 2:   * Rank 1: DMRS port 1000 is used and configure the RRC signalling indicating UE to assume FDD-OCC is not applied to all the antenna ports for DMRS which is applicable should be configured * Rank 2: DMRS port 1000 and 1002 are used   Proposal 7: Define the PDSCH performance requirements with following assumptions:   * 120 kHz SCS: Single TB scheduling * 480 kHz SCS: 4-TB scheduling * 960 kHz SCS: 8-TB scheduling   Proposal 8: Define the PDSCH performance requirements by using PN model example 2 defined in TS 38.803.  Proposal 9: Define the PDSCH performance requirements by using ICI compensation.  Proposal 10: Use following assumptions for PDCCH performance test.   * SCS: 480 kHz and 960 kHz * Antenna configuration: 1T2R and 1T4R * Aggregation level: 2 and 4 for 1T2R; 8 and 16 for 2T2R * PDCCH transmissions: PDCCH is transmitted in the first slot of every four slots for 480 kHz and in the first slot of every eight slots for 960 kHz   Proposal 11: Use following assumptions for PBCH performance test:   * SCS: 480 kHz and 960 kHz * Antenna configuration: 1T2R * SSB index: Known and set it to index 0 * Propagation conditions: TDLA30-75 * TDD |
| R4-2205918 | Intel Corporation | Observation #1: Existing FR2-1 UE demodulation performance requirements cover all DL physical channels and have quite broad test coverage from functionality/feature perspective.  Observation #2: Using of high SCS is beneficial at high carrier frequency to eliminate negative phase noise impact.  Observation #3: Performance comparison study should be performed to understand whether FR2-1 120 kHz SCS requirements can be reused for FR2-2. New set of requirements should be defined to cover new SCS and CBWs combinations.  Observation #4: FR2-2 performance requirements should cover licensed and unlicensed operations.  Observation #5: In case of FR2-1 requirements reuse for FR2-2, RAN4 needs to discuss applicability of FR2-1 requirements for unlicensed operation.  Proposal #1: Define FR2-2 UE demodulation requirements that cover licensed and unlicensed operations.  Proposal #2: Define PDSCH performance requirements with 480 and 960 kHz SCS with multi-slot scheduling by single DCI.  Proposal #3: Define PDSCH performance requirements for 32 DL HARQ processes with the test metric 30% of maximum throughput.  Proposal #4: Define performance requirements for multi-slot PDCCH monitoring for 480 and 960 kHz SCS.  Proposal #5: Consider 120 kHz SCS with 100 MHz CBW as a baseline scenario for introduction of UE demodulation performance requirements. Define a limited number of test cases for 480 and 960 kHz SCS with 400MHz CBW. Further discuss necessity of requirements introduction for other CBWs considering test setup limitation aspects.  Proposal #6: Define FR2-2 performance requirements with normal CP only, with 2 Rx antennas, and with 1 and 2 Tx antennas that is selected case by case.  Observation #6: Higher than 3 dB performance loss is observed for certain FR2-1 performance requirements when carrier frequency is increased to 71 GHz.  Observation #7: There is a negligible performance difference between PDCCH test cases with 52 and 71 GHz carrier frequencies.  Observation #8: Typical propagation conditions in FR2-2 are different from FR2-1.  Proposal #7: Do not reuse FR2-1 performance requirements for FR2-2.  Proposal #8: Define FR2-2 performance requirements with TDLA 10ns RMS delay spread value and with 200 and 650 Hz max Doppler frequency.  Proposal #9: Define FR2-2 PDSCH performance requirements according to Tables 2-6.  Proposal #10: For FR2-2 120 kHz SCS define the same set of PDCCH performance requirements as in FR2-1 but with the updated channel model.  Proposal #11: Do not define PBCH performance requirements for FR2-2 in Rel-17.  Proposal #12: Define SDR performance requirements for FR2-2.  Proposal #13: Study SNR values applicability in Table 7.5A.1-4: “SNR required to achieve 85% of peak throughput under AWGN conditions” for FR2-2.  Proposal #14: Define CQI reporting requirements only for wideband CQI reporting granularity.  Proposal #15: Study reuse of FR2-1 CQI reporting requirements in Static propagation conditions for FR2-2.  Proposal #16: Define FR2-2 CQI reporting requirements in Fading propagation conditions for FR2-2 with the typical channel model for FR2-2.  Proposal #17: Define FR2-2 PMI reporting requirements with type 1 single panel codebook, rank 1, and wideband PMI reporting granularity.  Proposal #18: Define FR2-2 RI reporting requirements with rank 1 and rank 2, and with low and high antenna correlations.  Proposal #19: Do not define DL performance requirements for CA in FR2-2 in Rel-17. |

## Open issues summary

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

### Sub-topic 3-1: SCS/CBW combinations

*Sub-topic description:*

*New SCS and CBWs were introduced for FR2-2. RAN4 needs to discuss SCS/CBW combinations for requirements definition. Moderator suggest discussing separately SCS and CBW to converge on the required SCS/CBW combinations.*

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

**Issue 3-1-1: SCS for DL requirements definition**

* Proposals
  + Option 1 (Nokia, Huawei, Intel): 120, 480 and 960 kHz
    - Huawei: 120, 480, 960 kHz for PDSCH and 480, 960 kHz for PDCCH/PBCH
  + Option 2 (Ericsson): 120 and 480 kHz
  + Proposal 1 (Nokia): Specify new demodulation performance requirements for UE and BS for SCS 480 kHz and 960 kHz
  + Proposal 2 (Nokia): Specify new UE demodulation and CSI reporting performance requirements for SCS 480kHz and 960kHz, including PDSCH, PDCCH and PBCH.
  + Proposal 3 (Nokia): Specify new UE demodulation and CSI reporting performance requirements for SCS 120 kHz with 400 MHz channel bandwidth for PDSCH, PDCCH and PBCH.
  + Proposal 4 (Ericsson): RAN4 defines the UE demodulation requirements with:
    - FR2-2 TDD: SCS = 120 kHz with min CBW = 100 MHz and Max CBW = 400 MHz
    - FR2-2 TDD: SCS = 480 kHz with min CBW = 400 MHz and Max CBW = 1600 MHz
  + Proposal 5 (Huawei): Define following performance requirements for UE operating in 71GHz band:
    - For 120 kHz SCS: PDSCH
    - For 480 kHz SCS and 960 kHz SCS (Optional with capability signaling): PBCH, PDCCH and PDSCH
  + Proposal 6 (Intel): Define FR2-2 performance requirements for 120, 480, and 960 kHz SCS
  + Proposal 7 (Intel): Consider 120 kHz SCS with 100 MHz CBW as a baseline scenario for introduction of UE demodulation performance requirements. Define a limited number of test cases for 480 and 960 kHz SCS with 400MHz CBW. Further discuss necessity of requirements introduction for other CBWs considering test setup limitation aspects
* Recommended WF
  + Collect views in 1st round on required SCS for DL test cases.
  + Check whether it is agreeable to cover at least 120 and 480 kHz SCS
  + Further discuss whether to cover 960 kHz SCS

**Issue 3-1-2: CBW for DL requirements definition**

Moderator recommends paying intention to the on-going discussion on FR2 enhanced OTA test methods [FR2\_enhTestMethods] in which initial DL SNR assessment during the demod test is discussed for FR2-2.

* Proposals
  + SCS 120 kHz
    - Option 1 (Nokia, Huawei): 400 MHz
    - Option 2 (Ericsson, Intel): 100 MHz and 400 MHz
  + SCS 480 kHz
    - Option 1 (Nokia): 400 MHz, 800 MHz, and 1600 MHz
    - Option 2 (Ericsson): 400 MHz and 1600 MHz
    - Option 3 (Huawei): 1600 MHz
    - Option 4 (Intel): 400 MHz
  + SCS 960 kHz
    - Option 1 (Nokia): 400 MHz, 800 MHz, 1600 MHz, and 2000 MHz
    - Option 2 (Huawei): 2000 MHz
    - Option 3 (Intel): 400 MHz
* Recommended WF
  + Collect views in 1st round on required CBWs for DL test cases.

### Sub-topic 3-2: General issues

*Sub-topic description*

*General aspects regardless of DL Physical channel*

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

**Issue 3-2-1: FR2-1 requirements reuse for 120 kHz SCS**

* Proposals
  + Proposal 1 (Intel): Do not reuse FR2-1 performance requirements for FR2-2.
  + Proposal 2 (Nokia): Study if new UE demodulation and CSI reporting performance requirements for SCS 120 kHz with 100 MHz channel bandwidth are needed for the operation in FR2-2
  + Proposal 3: (Nokia): Analyse the impact of the FR2-2 frequency range on the existing UE demodulation and CSI reporting performance requirements for SCS of 120kHz. If needed, add new performance requirements for PDSCH, PDCCH and PBCH with FR2-2 using 120kHz SCS.
  + Proposal 4: (Nokia): In case new UE demodulation and CSI reporting requirements are needed for 120kHz SCS in FR2-2, update the existing requirements to be valid for FR2-1 only and create separate requirements for FR2-2
* Recommended WF
  + Collect views in 1st round.

**Issue 3-2-2: General simulation assumptions**

* Proposals
  + Proposal 1 (Ericsson): RAN4 defines the UE demodulation and CSI reporting requirements with:
    - Number of receive antennas: 2Rx
    - Modulation order: Up to 64QAM
  + Proposal 2 (Intel): Define FR2-2 performance requirements with normal CP only, with 2 Rx antennas, and with 1 and 2 Tx antennas that is selected case by case.
  + Proposal 3 (Huawei): Use 2 receiving antennas
  + Proposal 4 (Huawei): Keep the number of transmission RBs open until there are corresponding agreements from RF team
* Recommended WF
  + Collect views in 1st round.

**Issue 3-2-3: Other**

* Proposals
  + Proposal 1 (Nokia): Increase the FLD\_high max frequency to cover FR2-2 frequency bands, i.e. “FDL\_high may not exceed 71000 MHz” and reconsider existing requirements if needed:
* Recommended WF
  + Collect views in 1st round.

### Sub-topic 3-3: PDSCH performance requirements

*Sub-topic description*

*Details of PDSCH performance requirements*

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

**Issue 3-3-1: Detailed scope of PDSCH requirements**

Current issue is based on the exact proposed summary tables for PDSCH requirements. Companies may either comment directly to this issue or use issues [3-3-2 – 3-3-8] created in a classical way.

* Proposals
  + Proposal 1 (Ericsson):

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **FR2-2 TDD, SCS 120 KHz**   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | Test number | CBW / SCS | MCS and rank | TDD UL/DL pattern | Propagation condition | Antenna configuration | Metric | Reference from TS38.101-4 7.2.2.2.1 | | 1-1  (Note 1) | 100MHz / 120kHz | QPSK 0.3  Rank 1 | FR2.120-2 | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | Test 2-1 | | 1-2  (Note 1) | 100MHz / 120kHz | 16QAM 0.48  Rank 1 | FR2.120-2 | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | Test 2-3 | | 1-3  Note 1) | 100MHz / 120kHz | 64QAM 0.43  Rank 1 | FR2.120-2 | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | Test 2-6 | | 2-1  (Note 1) | 400MHz / 120kHz | QPSK 0.3  Rank 1 | FR2.120-2 | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | Test 2-1 | | 2-2  (Note 1) | 400MHz / 120kHz | 16QAM 0.48  Rank 1 | FR2.120-2 | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | Test 2-3 | | 2-3  (Note 1) | 400MHz / 120kHz | 64QAM 0.43  Rank 1 | FR2.120-2 | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | Test 2-6 | | 3-1 | TBD / 120kHz | QPSK 0.3  Rank 2 | FR2.120-2 | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | Test 2-1 | | 3-2 | TBD / 120kHz | 16QAM 0.48  Rank 2 | FR2.120-2 | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | Test 2-3 | | Note 1 Tests (1,2)-1, (1,2)-2, and (1,2)-3 will consider Rank 1 instead of Rank 2 as stated in TS 38.101-4 Section 7.2.2.2.1. | | | | | | | |   **FR2-2 TDD, SCS 480 KHz**   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | Test number | CBW / SCS | MCS and rank | TDD UL/DL pattern | Propagation condition | Antenna configuration | Metric | Reference from TS38.101-4 | | 1-1 | 400MHz / 480kHz | QPSK 0.3  Rank 1 | TBD | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | New | | 1-2 | 400MHz / 480kHz | 16QAM 0.48  Rank 1 | TBD | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | New | | 1-3 | 400MHz / 480kHz | 64QAM 0.43  Rank 1 | TBD | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | New | | 2-1 | 1600MHz / 480kHz | QPSK 0.3  Rank 1 | TBD | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | New | | 2-2 | 1600MHz / 480kHz | 16QAM 0.48  Rank 1 | TBD | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | New | | 2-3 | 1600MHz / 480kHz | 64QAM 0.43  Rank 1 | TBD | TDL-A  (5, 10, 30) ns | 2x2 ULA Low | 70% of peak rate | New | |

* + Proposal 2 (Intel): Define FR2-2 PDSCH performance requirements according to Tables 2-6

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Table 2. Requirements for Rank 1 with mapping type A   |  |  |  |  |  | | --- | --- | --- | --- | --- | | CBW (MHz)/SCS (kHz) | Modulation and code rate | Propagation conditions | Correlation matrix and antenna configuration | Fraction of maximum throughput | | 100/120 | QPSK, 0.30 | TDLA10-650 | 2x2 ULA Low | 70 | | 100/120 | 16QAM, 0.48 | TDLA10-650 | 2x2 ULA Low | 30 | | 100/120 | 64QAM, 0.46 | TDLA10-650 | 2x2 XPL Medium | 70 | | 400/480 | QPSK, 0.30 | TDLA10-650 | 2x2 ULA Low | 70 | | 400/960 | QPSK, 0.30 | TDLA10-650 | 2x2 ULA Low | 70 |   Table 3. Requirements for Rank 2 with mapping type A   |  |  |  |  |  | | --- | --- | --- | --- | --- | | CBW (MHz)/SCS (kHz) | Modulation and code rate | Propagation conditions | Correlation matrix and antenna configuration | Fraction of maximum throughput | | 100/120 | QPSK, 0.30 | TDLA10-200 | 2x2 ULA Low | 70 | | 100/120 | 16QAM, 0.48 | TDLA10-650 | 2x2 ULA Low | 70 |   Table 4. Requirements for Rank 2 for enhanced receiver type 1   |  |  |  |  |  | | --- | --- | --- | --- | --- | | CBW (MHz)/SCS (kHz) | Modulation and code rate | Propagation conditions | Correlation matrix and antenna configuration | Fraction of maximum throughput | | 100/120 | 16QAM, 0.48 | TDLA10-200 | 2x2 ULA Medium | 70 |   Table 5. Requirements for Rank 1 with mapping type B   |  |  |  |  |  | | --- | --- | --- | --- | --- | | CBW (MHz)/SCS (kHz) | Modulation and code rate | Propagation conditions | Correlation matrix and antenna configuration | Fraction of maximum throughput | | 100/120 | QPSK, 0.30 | TDLA10-200 | 2x2 ULA Low | 70 |   Table 6. Requirements for 32 DL HARQ processes   |  |  |  |  |  | | --- | --- | --- | --- | --- | | CBW (MHz)/SCS (kHz) | Modulation and code rate | Propagation conditions | Correlation matrix and antenna configuration | Fraction of maximum throughput | | 100/120 | QPSK, 0.30 | TDLA10-200 | 2x2 ULA Low | 30 | |

* Recommended WF
  + Collect views in 1st round.

**Issue 3-3-2: PDSCH performance requirements for multi-PDSCH scheduling**

* Proposals
  + Proposal 1 (Nokia): RAN4 to not include new UE demodulation performance requirements for the feature of Multi-PDSCH scheduled by a single DCI
  + Proposal 2 (Huawei): Define the PDSCH performance requirements with following assumptions:
    - 120 kHz SCS: Single TB scheduling
    - 480 kHz SCS: 4-TB scheduling
    - 960 kHz SCS: 8-TB scheduling
  + Proposal 3 (Intel): Define PDSCH performance requirements with 480 and 960 kHz SCS with multi-slot scheduling by single DCI.
* Recommended WF
  + Collect views in 1st round

**Issue 3-3-3: PDSCH performance requirements with 32 DL HARQ processes**

* Proposals
  + Proposal 1 (Intel): Define PDSCH performance requirements for 32 DL HARQ processes with the test metric 30% of maximum throughput
  + Proposal 2 (Nokia): RAN4 to not have explicit new demod requirements for increased number of HARQ processes. However, RAN4 to take care to specify sufficient HARQ processes for other PDSCH requirements.
* Recommended WF
  + Collect views in 1st round.

**Issue 3-3-4: Mapping type**

* Proposals
  + Proposal 1 (Intel): A and B
* Recommended WF
  + Collect views in 1st round.

**Issue 3-3-5: Requirements with 30% throughput**

* Proposals
  + Proposal 1 (Intel): Define
* Recommended WF
  + Collect views in 1st round.

**Issue 3-3-6: Requirements for enhanced receiver type 1**

* Proposals
  + Proposal 1 (Intel): Define
* Recommended WF
  + Collect views in 1st round.

**Issue 3-3-7: MCS, modulation order for PDSCH requirements**

* Proposals
  + Proposal 1 (Ericsson): QPSK 0.3, 16QAM, 0.48, 64QAM, 0.43
  + Proposal 2 (Intel): QPSK 0.3, 16QAM, 0.48, 64QAM, 0.46
* Recommended WF
  + Collect views in 2nd round.

**Issue 3-3-8: Rank**

* Proposals
  + Proposal 1 (Ericsson): Rank 1 (Rank 2 FFS)
  + Proposal 2 (Huawei): Define the PDSCH performance requirements for both rank 1 and rank 2:
    - Rank 1: DMRS port 1000 is used and configure the RRC signalling indicating UE to assume FDD-OCC is not applied to all the antenna ports for DMRS which is applicable should be configured
    - Rank 2: DMRS port 1000 and 1002 are use
* Recommended WF
  + Collect views in 2nd round.

**Issue 3-3-9: PTRS configuration**

* Proposals
  + Proposal 1 (Ericsson): Use Rel-15 PTRS pattern for tests
  + Proposal 2 (Nokia): Rederive performance requirements with the maximally dense PTRS configurations for FR2-2 below:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  | | --- | --- | --- | --- | | PTRS configuration | Frequency density (*KPT-RS*) |  | 2 | | Time density (*LPT-RS*) |  | 1 | | Resource Element Offset |  | 2 | |

* + Proposal 1 (Intel): Rank 1 and 2
* Recommended WF
  + Collect views in 2nd round.

**Issue 3-3-10: Detailed PDSCH configuration**

* Proposals
  + Proposal 1 (Ericsson): Define PDSCH demodulation requirements for UE with the following test setup:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Assumptions | Value | | --- | --- | | Carrier Frequency [GHz] | 70 GHz | | Subcarrier Spacing [KHz] | 120 KHz, 480 KHz | | Waveform | CP-OFDM | | CP Type | Normal CP | | Channel Model | TDL model as defined in of TR38.901 Clause 7.7.2:  - TDL-A (5ns, 10ns, 30 ns DS) | | Antenna configuration | For TDL model: 2x2 ULA Low | | Velocity | 3 km/h, 30 km/h | | PA Model | None | | gNB TRP PN Model | TR38.803 example 2 BS PN profile and [3] Set 1 | | UE PN Model | TR38.803 example 2 UE PN profile and [3] Set 1 | | Pre-loaded Tx EVM | 0% | | Additive Rx EVM | 0% | | I-Q Imbalance | None | | Frequency Offset | 0 ppm | | Channel Estimation | Realistic channel estimation | | Transmission Rank | Rank 1 (Rank 2 is FFS) | | DMRS Configuration | 2 DMRS symbols at (2,11) symbol index | | PTRS Configuration | For CP-OFDM: (K = 2, L = 1) | | CSI-RS / TRS | CSI-RS/TRS is assumed to be off (for RS overhead) | | MCS/TBS | From MCS Table 1 (TS38.214):  - MCS 7 (QPSK),  - MCS 16 (16QAM),  - [MCS 22] (64QAM).  Note: It is assumed that NohPRB = 0 for MCS calculations. | |

* Recommended WF
  + Collect views in 2nd round pending on above issues progress.

**Issue 3-3-11: Transmission burst model**

* Proposals
  + Proposal 1 (Huawei): Use transmission burst model defined in LAA as start point to be discussed and set the gap between two transmission bursts at least to 4/8/16 OFDM symbols for 120/480/960 kHz SCS. Further discuss following test setup:
    - COT duration
    - LBT failure probability
    - HARQ feedback
    - Start symbol and end symbol within the slot
* Recommended WF
  + Collect views in 2nd round.

### Sub-topic 3-4: PDCCH performance requirements

*Sub-topic description*

*Details of PDCCH performance requirements*

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

**Issue 3-4-1: Performance requirements for multi-slot PDCCH monitoring**

* Proposals
  + Proposal 1 (Intel): Define performance requirements for multi-slot PDCCH monitoring for 480 and 960 kHz SCS:
* Recommended WF
  + Collect views in 1st round.

**Issue 3-4-2: PDCCH simulation assumptions**

* Proposals
  + Proposal 1 (Intel): For FR2-2 120 kHz SCS define the same set of PDCCH performance requirements as in FR2-1 but with the updated channel model.
  + Proposal 2 (Huawei): Use following assumptions for PDCCH performance test.
    - SCS: 480 kHz and 960 kHz
    - Antenna configuration: 1T2R and 1T4R
    - Aggregation level: 2 and 4 for 1T2R; 8 and 16 for 2T2R
    - PDCCH transmissions: PDCCH is transmitted in the first slot of every four slots for 480 kHz and in the first slot of every eight slots for 960 kHz
  + Proposal 3 (Ericsson): Define PDCCH demodulation requirements for UE in FR2-2 with the following test setup.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **FR2-2 TDD, SCS 120 KHz**   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Test number | CBW (MHz) | CORESET RB | CORESET duration | Aggregation level | Propagation condition | Antenna config | Metric (Pm-dsg) | Reference from TS38.101-4 7.3.2.2 | | 1-1 | 100 | 60 | 1 | 2 | TDL-A  (5, 10, 30) ns | 1x2 low | 1% | 1Tx Test 1 | | 1-2 | 100 | 60 | 1 | 4 | TDL-A  (5, 10, 30) ns | 1x2 low | 1% | 1Tx Test 2 | | 1-3 | 100 | 60 | 1 | 8 | TDL-A  (5, 10, 30) ns | 2x2 low | 1% | 2Tx Test 1 | | 1-4 | 100 | 60 | 2 | 16 | TDL-A  (5, 10, 30) ns | 2x2 low | 1% | 2Tx Test 2 | | 2-1 | 400 | TBD | TBD | TBD | TDL-A  (5, 10, 30) ns | 1x2 low | 1% | New | | 2-2 | 400 | TBD | TBD | TBD | TDL-A  (5, 10, 30) ns | 2x2 low | 1% | New |   **FR2-2 TDD, SCS 480 KHz**   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Test number | CBW (MHz) | CORESET RB | CORESET duration | Aggregation level | Propagation condition | Antenna config | Metric (Pm-dsg) | Reference from TS38.101-4 7.3.2.2 | | 1-1 | 400 | TBD | TBD | TBD | TDL-A  (5, 10, 30) ns | 1x2 Low | 1% | New | | 1-2 | 400 | TBD | TBD | TBD | TDL-A  (5, 10, 30) ns | 2x2 Low | 1% | New | | 2-1 | 1600 | TBD | TBD | TBD | TDL-A  (5, 10, 30) ns | 1x2 Low | 1% | New | | 2-2 | 1600 | TBD | TBD | TBD | TDL-A  (5, 10, 30) ns | 2x2 Low | 1% | New | |

* Recommended WF
  + Collect views in 2nd round.

### Sub-topic 3-5: PBCH performance requirements

*Sub-topic description*

*Details of PBCH performance requirements.*

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

**Issue 3-5-1: PBCH simulation assumptions (if introduced pending on outcome of issues Issue 1-2-2)**

* Proposals
  + Proposal 1 (Huawei): Use following assumptions for PBCH performance test:
    - SCS: 480 kHz and 960 kHz
    - Antenna configuration: 1T2R
    - SSB index: Known and set it to index 0
    - Propagation conditions: TDLA30-75
    - TDD:
  + Proposal 2 (Ericsson): Define PBCH demodulation requirements with the following test setup

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Test number | BW / SSB SCS | Propagation condition | Antenna configuration | Metric (Pm-bch) | Reference from TS38.101-4  SS/PBCH block index  A : not known  B : known | | 1-1 | 100 MHz / 120 KHz | TDL-A  (5, 10, 30) ns | 1x2 Low | 1% | A | | 1-2 | 400 MHz / 120 KHz | TDL-A  (5, 10, 30) ns | 1x2 Low | 1% | B | | 2-1  (Note 1) | 400 MHz / 480 KHz | TDL-A  (5, 10, 30) ns | 1x2 Low | 1% | A | | 2-2  (Note 1) | 1600 MHz / 480 KHz | TDL-A  (5, 10, 30) ns | 1x2 Low | 1% | B | | Note 1: SSB SCS 480 KHz is new. | | | | | | |

* Recommended WF
  + Collect views in 2nd round.

### Sub-topic 3-6: SDR performance requirements

*Sub-topic description*

*Details of SDR performance requirements*

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

**Issue 3-6-1: SDR performance requirements**

Introduction of SDR requirements is discussed in Sub-topic 1-2

* Proposals
  + Proposal 1 (Intel): Study SNR values applicability in Table 7.5A.1-4: “SNR required to achieve 85% of peak throughput under AWGN conditions” for FR2-2
* Recommended WF
  + Collect views in 1st round.

### Sub-topic 3-7: CSI repoting requirements

*Sub-topic description*

*Details of CSI reporting requirements*

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

**Issue 3-7-1: Scope of CSI reporting requirements**

* Proposals
  + Proposal 1 (Ericsson): Only CQI
  + Proposal 2 (Intel): CQI, PMI and RI
* Recommended WF
  + Collect views in 1st round

**Issue 3-7-2: Reuse of FR2-1 CQI reporting requirements**

* Proposals
  + Proposal 1 (Intel): Study reuse of FR2-1 CQI reporting requirements in Static propagation conditions for FR2-2
* Recommended WF
  + Collect views in 1st round

**Issue 3-7-3: Channel model for CQI reporting requirements under fading propagation conditions**

* Proposals
  + Proposal 1 (Intel): Define FR2-2 CQI reporting requirements in Fading propagation conditions for FR2-2 with the typical channel model for FR2-2
  + Proposal 2 (Nokia): RAN4 to discuss how changes to the channel models would impact the CSI reporting requirements
* Recommended WF
  + Collect views in 1st round

**Issue 3-7-4: Simulation assumptions for CQI reporting requirements**

* Proposals
  + Proposal 1 (Ericsson): Define the CQI reporting definition test for 2Rx UE with CQI table 1 (64QAM) by reusing the existing test setup and metrics
  + Proposal 2 (Ericsson): Define the wideband CQI reporting under fading condition for 2Rx UE with CQI table 1 (64QAM) by reusing the existing test setup and metrics
  + Proposal 2 (Intel): Define CQI reporting requirements only for wideband CQI reporting granularity
* Recommended WF
  + Collect views in 2nd round

**Issue 3-7-5: Simulation assumptions for PMI reporting requirements**

* Proposals
  + Proposal 1 (Intel): Define FR2-2 PMI reporting requirements with type 1 single panel codebook, rank 1, and wideband PMI reporting granularity
* Recommended WF
  + Collect views in 2nd round

**Issue 3-7-6: Simulation assumptions for RI reporting requirements**

* Proposals
  + Proposal 1 (Intel): Define FR2-2 RI reporting requirements with rank 1 and rank 2, and with low and high antenna correlations
* Recommended WF
  + Collect views in 2nd round

# Recommendations for Tdocs

## 1st round

**New tdocs**

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

**Existing tdocs**

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

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

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-22xxxxx | 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

# Annex

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)