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

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

**Agenda item:** 11.12.5

**Source:** Moderator (CMCC)

**Title:** Email discussion summary for [104-e][236] NR\_ATG\_RRM

**Document for:** Information

# Introduction

This email discussion focuses on RRM core requirements for Rel-18 NR ATG, including agenda 11.12.4. It is the first meeting to discuss RRM core requirement in this WI, the latest revised WID is in RP-221369.

The targets of email discussion for 1st round and 2nd round are:

• 1st round:

* Identify the RRM core requirements which are need to be defined for ATG
* Identify the impacted RRM core requirements by ATG feature.
* Further discuss the ATG solutions for impacted requirements as much as possible

• 2nd round: Strive to conclude the RRM core requirements scope for ATG. Approve the WF.

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

Contact information

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| --- | --- | --- |
| **Company** | **Name** | **Email address** |
| CMCC | Shiyuan Wang | wangshiyuan@chinamobile.com |
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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)

# Topic #1: General RAN4 RRM ATG related aspects

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2211918 | Apple | Observation: ATG UE is a special UE in terms of operating scenarios and potential different UE behaviours.  Proposal 1: It is proposed to define a basic RRM requirement for single CC operation in Rel-18. E.g. CA/DC/enhanced features like MDT are not considered. |
| R4-2212302 | CMCC | Proposal 1: For RRM core requirements, the FR2 related requirements, CA/DC related requirements and inter-RAT measurement related requirements are not applicable to R18 ATG.  Proposal 2: Both inter-frequency and intra-frequency measurement for ATG scenario should be considered. |
| R4-2212384 | LG Electronics UK | Proposal 1: RAN4 needs to study impact on TDD band operation due to longer propagation delay between ground gNB and ATG UE.  Proposal 2: RAN4 needs to study ATG UE assistance information such as altitude, location, propagation delay difference. |
| R4-2212696 | Ericsson | Proposal 1 General section on bands and terminologies are updated with A2G bands and terminologies. |
| R4-2212974 | Huawei, HiSilicon | Proposal 1: Prioritize single carrier operation for RRM requirements. |
| R4-2213868 | ZTE Corporation | Proposal 2: Not need to consider inter-RAT measurement for cell re-selection due to no commerical demand. |

## 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: ATG Use cases and scenarios

*Sub-topic description:*

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

**Issue 1-1-1: Scenarios to be considered for ATG RRM**

* Proposals
  + Option 1: It is proposed to define a basic RRM requirement for single CC operation in Rel-18. E.g. CA/DC/enhanced features like MDT are not considered. (Apple)
  + Option 2: For RRM core requirements, the FR2 related requirements, CA/DC related requirements and inter-RAT measurement related requirements are not applicable to R18 ATG. (CMCC)
  + Option 3: Prioritize single carrier operation for RRM requirements. (HW)
  + Option 4: Not need to consider inter-RAT measurement for cell re-selection due to no commercial demand. (ZTE)
  + Option 5: Both intra-frequency and inter-frequency measurement requirements need to be defined. (CMCC)
* Recommended WF
  + FR2 related requirements, CA/DC related requirements and inter-RAT measurement related requirements are not applicable to R18 ATG.
    - FFS whether MDT and other enhanced features need to be considered in other related Issues
  + Both intra-frequency and inter-frequency measurement requirements need to be defined.

### Sub-topic 1-2：Others general impactions due to ATG feature

*Sub-topic description*

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

**Issue 1-2-1: Impaction on TS38.133 Section 3: Definitions, symbols and abbreviations**

* Proposals
  + Option 1: General section on bands and terminologies are updated with A2G bands and terminologies. (Ericsson)
  + Option 2: Depending on potential different REFSENS requirement for ATG UE, new grouping might be needed. (Apple)
  + Option 3: New definitions, symbols and abbreviations will be introduced for ATG (CMCC)
* Recommended WF
  + ATG terminologies need to be introduced. FFS on ATG bands table.

**Issue 1-2-2: TDD impaction**

* Proposals
  + Option 1: RAN4 needs to study impact on TDD band operation due to longer propagation delay between ground gNB and ATG UE. (LGE)
* Recommended WF
  + Discuss Option 1.

**Issue 1-2-3: UE assistance information**

* Proposals
  + Option 1: RAN4 needs to study ATG UE assistance information such as altitude, location, propagation delay difference. (LGE)
* Recommended WF
  + Discuss Option 1.

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1: ATG Use cases and scenarios

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| **Company** | **Comments** |
| Huawei | **Issue 1-1-1: Scenarios to be considered for ATG RRM**  We are generally fine with recommended WF.  Regarding how to facilitate the discussion and identify RRM spec impact, we thought it is an insufficient approach to pick each requirements to check whether it is needed or not and create dedicated sections for ATG. It will make the spec very huge and unsustainable.  We suggest to follow the HST approach that only updating the spec where specific updating for ATG is needs (current requirements cannot be reused directly). Then there is no need to combine ATG with each requirements.  Thus, we propose to add following principles to facilitate the discussion.  **Identify RRM impact where specific updating for ATG is needed similar as HST.** |
| Ericsson | **Issue 1-1-1: Scenarios to be considered for ATG RRM**  We are fine with the recommended WF.  At this stage of the WI, it is too early to decide whether we can follow approach from HST. We are fine to use those as examples, but we prefer to avoid the note stated in HW’s comment. |
| Apple | **Issue 5-1-1: General measurement requirement**  Option 1-1: GAP design related capability/signalling needs to be reconsidered.  **Issue 5-1-2: NR intra-frequency measurements**  Prefer option 1-1. More thinking is needed on the details.  **Issue 5-1-3: NR inter-frequency measurements**  Prefer Option 1-1. More thinking is needed on the details.  **Issue 5-1-4: L1-RSRP and L1-SINR measurements for Reporting**  Ok with the recommendation from moderator.  **Issue 5-1-5: Cross Link Interference measurements**  Option 2. CLI feature is not necessary for ATG.  **Issue 5-1-6: CSI-RS based L3 measurements**  Keep open for further discussion  **Issue 5-1-7: L1-RSRP measurements for a cell with different PCI from serving cell**  Keep open for further discussion.  **Issue 5-1-8: NR measurements with autonomous gaps**  Keep open for further discussion.  **Issue 5-1-9: Other measurement related requirements**  Option1. |

Sub topic 1-2: Others general impactions due to ATG feature

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| **Company** | **Comments** |
| Huawei | **Issue 1-2-1: Impaction on TS38.133 Section 3: Definitions, symbols and abbreviations**  Support recommended WF. Input from RF is needed.  **Issue 1-2-2: TDD impaction**  We are open to discuss the issue. More specific impact on RRM requirements shall be identified.  **Issue 1-2-3: UE assistance information**  We are open to discuss the issue. We have similar proposal for timing/mobility requirements that whether to utilize assistant information as NTN. |
| Ericsson | **Issue 1-2-1: Impaction on TS38.133 Section 3: Definitions, symbols and abbreviations**  We are fine with the recommended WF.  **Issue 1-2-2: TDD impaction**  We support option 1. We also agree it is a new scenario and its impact needs to be studied.  **Issue 1-2-3: UE assistance information**  In general we fine, but we would like to revise the option as follows:  *RAN4 needs to study ATG UE assistance information such as altitude, location, propagation delay difference, flight path etc., or change in any of these parameters.* |
| Apple | **Issue 1-2-1: Impaction on TS38.133 Section 3: Definitions, symbols and abbreviations**  Agree with the recommended WF by moderator.  **Issue 1-2-2: TDD impaction**  We are open for further study for option 1.  **Issue 1-2-3: UE assistance information**  Open for further discussion for option1. But our understanding is that ATG UE should assume GNSS capable. |

## Summary for 1st round

### Open issues

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

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

## Discussion on 2nd round (if applicable)

# Topic #2: Mobility

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2211643 | CATT | Observation 1: The proposed RRM requirements need to be defined and postponed for ATG UE are listed in Table 1. |
| R4-2211918 | Apple | Proposal 1: It is proposed to define a basic RRM requirement for single CC operation in Rel-18. E.g. CA/DC/enhanced features like MDT are not considered. |
| R4-2212302 | CMCC | Proposal 1: For RRM core requirements, the FR2 related requirements, CA/DC related requirements and inter-RAT measurement related requirements are not applicable to R18 ATG.  Proposal 2: Both inter-frequency and intra-frequency measurement for ATG scenario should be considered.  Observation 2: Considering of the max UE speed 1200km/h, if the ISD is smaller than 118km/h, the current cell re-selection requirement cannot be directly reused. |
| R4-2212696 | Ericsson | Proposal 2 RAN4 to assess if existing IDLE/INACTIVE requirements on serving cell evaluation from HST can be reused for A2G.  Proposal 3 The A2G UE is allowed to not measure on the neighbour cells based on the coverage information of the serving cell e.g. if serving cell RSRP is above threshold.  Proposal 4 For cell reselection and handover, the A2G UE should resume the neighbor cell measurement in normal manner without any relaxation if there is any unpredictable change in flight path or sudden drop in aircraft height due to any critical or emergency situation.  Proposal 5 For cell reselection and handover, UE can determine the sudden change in the flight path autonomously (e.g. internally from flight data) or based on assistance information from the ground base station. Details are FFS.  Proposal 6 The measurement capability requirements of A2G is FFS.  Proposal 7 The current IDLE/INACTIVE paging reception requirements, excluding inter-RAT, are reused for A2G.  Proposal 8 SDT requirements are defined for A2G. Details are FSS.  Proposal 9 The principle from the legacy RRC re-establishment requirements can be reused as baseline for A2G, and any further impact is FFS.  Proposal 10 The principle from the random access requirements can be reused as baseline for A2G, and any further impact is FFS.  Proposal 11 RAN4 to discuss whether to define requirements for 2-step RA for A2G.  Proposal 12 The principle from the RRC connection release with redirection for A2G, and any further impact is FFS. |
| R4-2212974 | Huawei, HiSilicon | Observation 1: The existing requirements should be used if possible.  Proposal 1: Prioritize single carrier operation for RRM requirements.  Proposal 2: RAN4 to discuss whether to consider CHO (timer-based and location-based) introduced in Rel-17 NTN.  Proposal 5: Whether to define requirements for CSI-RS based measurement and positioning measurement for ATG. |
| R4-2213868 | ZTE Corporation | Proposal 1: Reusing legacy R15 requirements of intra-frequency and inter-frequency measurements in cell re-selection is fine.  Proposal 2: Not need to consider inter-RAT measurement for cell re-selection due to no commerical demand.  Proposal 3: Re-using legacy MDT if necessary for ATG UE is fine.  Proposal 4: Considering the requirements for known case handover, re-using legacy legacy requirement for ATG UE is fine.  Proposal 5: Not need to consider handover to unknown cell for ATG scenario.  Proposal 6: Re-using the legacy RRC re-establishment requirements for ATG UE. |

## 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: Mobility in RRC\_IDLE/INACTIVE

*Sub-topic description:*

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

**Issue 2-1-1: Cell selection requirements**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, CMCC, Ericsson)
    - Option 1-1: No impact observed (Apple, CMCC, Ericsson)
* Recommended WF
  + Cell selection requirements will be defined for ATG, reuse the legacy requirments.

**Issue 2-1-2: Cell re-selection requirements**

**Issue 2-1-2-1: Cell re-selection measurement capability**

* Proposals
  + Option 1: The measurement capability requirements of A2G is FFS. (Ericsson)
  + Option 2: Reuse current UE capability for NR intra-frequency measurement and NR inter-frequency measurement. (CMCC)
* Recommended WF
  + Discuss above Options

**Issue 2-1-2-2: Cell re-selection measurement requirements**

* Proposals
* Option 1: Reusing legacy R15 requirements of intra-frequency and inter-frequency measurements in cell re-selection is fine. (ZTE)
* Option 2: Take the current HST requirement as the starting point and check what need to be further enhanced. (Apple)
* Option 3: FFS based on minimum ISD and largest UE movement speed. (CMCC)
* Option 4: (Ericsson)
  + RAN4 should assess if the principle of current serving cell evaluation requirements defined HST can be reused.
  + The A2G UE is allowed to not measure on the neighbour cells based on the coverage information of the serving cell e.g. if serving cell RSRP is above threshold.
    - For cell reselection and handover, the A2G UE should resume the neighbor cell measurement in normal manner without any relaxation if there is any unpredictable change in flight path or sudden drop in aircraft height due to any critical or emergency situation.
    - For cell reselection and handover, UE can determine the sudden change in the flight path autonomously (e.g. internally from flight data) or based on assistance information from the ground base station. Details are FFS
* Recommended WF
  + Define serving cell evaluation requirements, details are FFS. FFS for neighbour cell evaluation requirements.

**Issue 2-1-2-3: Neighbour cell measurements**

* Proposals
* Option 1: (Ericsson)
  + The A2G UE is allowed to not measure on the neighbour cells based on the coverage information of the serving cell e.g. if serving cell RSRP is above threshold.
* Recommended WF
  + Discuss the option.

**Issue 2-1-2-4: Conditions for performing neighbour cell measurements**

* Proposals
* Option 1: (Ericsson)
  + - For cell reselection and handover, the A2G UE should resume the neighbor cell measurement in normal manner without any relaxation if there is any unpredictable change in flight path or sudden drop in aircraft height due to any critical or emergency situation.
    - For cell reselection and handover, UE can determine the sudden change in the flight path autonomously (e.g. internally from flight data) or based on assistance information from the ground base station. Details are FFS
* Recommended WF
  + Discuss the option.

**Issue 2-1-2-5: Paging reception requirements**

* Proposals
  + Option 1: The current IDLE/INACTIVE paging reception requirements, excluding inter-RAT, are reused for A2G. (Ericsson, CMCC, ZTE)
* Recommended WF
  + Check whether Option 1 can be agreeable.

**Issue 2-1-3: Minimization of Drive tests (MDT)**

* Proposals
  + Option 1: Not applicable in this release. (CATT, Apple)
  + Option 2: Re-using legacy MDT if necessary for ATG UE (ZTE, CMCC)
* Recommended WF
  + First discuss the necessity of MDT in RRC\_IDLE and RRC\_INACTIVE

**Issue 2-1-4: IDLE Mode CA/DC requirements**

* Proposals
  + Option 1: Not applicable in this release. (CATT, Apple, CMCC)
* Recommended WF
  + Check whether Option 1 can be agreeable.

**Issue 2-1-5: Small Data Transmissions (SDT)**

* Proposals
  + Option 1: Not applicable in this release. (CATT, Apple)
  + Option 2: SDT requirements are defined for A2G. Details are FSS (Ericsson)
* Recommended WF
  + Discuss above Options

**Issue 2-1-6: Positioning measurements**

* Proposals
  + Option 1: Not applicable in this release. (CATT, Apple)
  + Option 2: Further check whether to define requirements for positioning measurement for ATG (HW)
* Recommended WF
  + Based on moderator’s understanding on HW’s proposal Option 2, HW think there is no significant benefits to support positioning measurement in ATG. Therefore, please check whether Option 1 is agreeable.

### Sub-topic 2-2: Mobility in RRC\_CONNECTED

*Sub-topic description*

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

**Issue 2-2-1: Handover**

**Issue 2-2-1-1: NR Handover**

* Proposals
* Option 1: Only intra-frequency HO and [inter-frequency HO] need to be defined. (Apple)
* Option 2: Both intra-frequency HO and inter-frequency HO need to be defined. (CMCC)
  + Option 2-1: Reuse legacy handover requirements for ATG UE (CMCC, ZTE)
* Option 3: The A2G UE is allowed to not measure on the neighbour cells based on the coverage information of the serving cell e.g. if serving cell RSRP is above threshold. (Ericsson)
  + For cell reselection and handover, the A2G UE should resume the neighbor cell measurement in normal manner without any relaxation if there is any unpredictable change in flight path or sudden drop in aircraft height due to any critical or emergency situation.
  + For cell reselection and handover, UE can determine the sudden change in the flight path autonomously (e.g. internally from flight data) or based on assistance information from the ground base station. Details are FFS
* Recommended WF
  + Discuss above Options

**Issue 2-2-1-2: NR Handover to Other RATs**

* Proposals
  + Option 1: Not applicable in this release. (CATT, Apple, CMCC)
* Recommended WF
  + Check whether Option 1 can be agreeable.

**Issue 2-2-1-3: NR DAPS Handover**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT,)
  + Option 2: FFS whether to include DAPS handover in this release. (Apple, CMCC)
* Recommended WF
  + Companies provide views about whether to include DAPS handover

**Issue 2-2-1-4: NR Conditional Handover**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT,)
  + Option 2: FFS whether to include NR conditional handover in this release. (Apple, CMCC)
    - Option 2-1: RAN4 to discuss whether to consider CHO (timer-based and location-based) introduced in Rel-17 NTN. (HW)
* Recommended WF
  + Companies provide views about whether to include legacy CHO and R17 NTN enhanced CHO

**Issue 2-2-1-5: NR Handover with PSCell**

* Proposals
  + Option 1: Not applicable in this release. (CATT, Apple, CMCC)
* Recommended WF
  + Check whether Option 1 can be agreeable.

**Issue 2-2-2: RRC Connection Mobility Control**

**Issue 2-2-2-1: SA: RRC Re-establishment**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, Ericsson, CMCC, ZTE)
    - Option 1-1: RRC Re-establishment delay need to be considered (Apple)
    - Option 1-2: Re-using the legacy RRC re-establishment requirements for ATG UE. (Ericsson, CMCC, ZTE)
* Recommended WF
  + RRC Re-establishment requirements will be defined for ATG, FFS the delay requirements value

**Issue 2-2-2-2: Random access**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, Ericsson, CMCC)
    - Option 1-1: The principle from the random access requirements can be reused as baseline for A2G, and any further impact is FFS. (Ericsson, CMCC)
    - Option 1-2: RAN4 to discuss whether to define requirements for 2-step RA for A2G. (Ericsson)
* Recommended WF
  + Random access requirements will be defined for ATG. Discuss 2-step RA for ATG, FFS the further impact due to ATG feature.

**Issue 2-2-2-3: SA: RRC Connection Release with Redirection**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, Ericsson, CMCC)
    - Option 1-1: The principle from the legacy RRC re-establishment requirements can be reused. (Ericsson, CMCC)
* Recommended WF
  + RRC Connection Release with Redirection will be defined for ATG. Re-using the principle from the legacy RRC re-establishment requirements.

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1: Mobility in RRC\_IDLE/INACTIVE

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| **Company** | **Comments** |
| Huawei | **Issue 2-1-1: Cell selection requirements**  Support recommended WF. Existing requirements can apply  **Issue 2-1-2: Cell re-selection requirements**  **Issue 2-1-2-1: Cell re-selection measurement capability**  **Issue 2-1-2-2: Cell re-selection measurement requirements**  We support taking Rel-15 cell re-selection requirements as starting point.  **Issue 2-1-2-3: Neighbour cell measurements**  We are open to discuss the issue.  **Issue 2-1-2-4: Conditions for performing neighbour cell measurements**  We are open to discuss the issue.  **Issue 2-1-2-5: Paging reception requirements**  Support option 1  **Issue 2-1-3: Minimization of Drive tests (MDT)**  We are fine to not considering the requirements. But it is a bit ambiguous to say it is not applicable as it is up to UE’s capability indication. It only means RAN4 is not going to define ATG specific requirements.  **Issue 2-1-4: IDLE Mode CA/DC requirements**  Same as issue 2-1-3  **Issue 2-1-5: Small Data Transmissions (SDT)**  Same as issue 2-1-3**Issue 2-1-6: Positioning measurements**  Same as issue 2-1-3 |
| Ericsson | **Issue 2-1-1: Cell selection requirements**  We don’t agree to the recommend WF. We support option 1 which is that RAN4 needs to define RRM requirements for ATG UE for the serving cell selection and evaluation requirements. What those requirements are and how to define those needs to be discussed. As an example, RAN4 to asses whether the framework used for defining the HST requirements can be reused for defining the ATG requirements. This is an issue that needs to be kept open for discussions.  **Issue 2-1-2-1: Cell re-selection measurement capability**  The operating scenario is not entirely clear at the moment. In one example, the serving cell can have much wider coverage and ISD than the corresponding legacy assumptions. In another example, there can be scenarios with many aircraft in same areas in which case multiple cells may be needed to provide service. Therefore, the number carriers to identify and monitor needs more discussions and can be kept as FFS until the scenario is more clear in the RF group.  **Issue 2-1-2-2: Cell re-selection measurement requirements**  Multiple options can be agreed as they are not contradicting. Thus we propose following options to be agreed and captured for further evaluations:   * + RAN4 should assess if the principle of current serving cell evaluation requirements defined HST can be reused.   + The A2G UE is allowed to not measure on the neighbour cells based on the coverage information of the serving cell e.g. if serving cell RSRP is above threshold.     - For cell reselection and handover, the A2G UE should resume the neighbor cell measurement in normal manner without any relaxation if there is any unpredictable change in flight path or sudden drop in aircraft height due to any critical or emergency situation.     - For cell reselection and handover, UE can determine the sudden change in the flight path autonomously (e.g. internally from flight data) or based on assistance information from the ground base station. Details are FFS   + FFS based on minimum ISD and largest UE movement speed.   **Issue 2-1-2-3: Neighbour cell measurements**  We support option 1. Unlike in operation with handled devices in classical TN network, the UE is not expected to do frequent cell changes due to the large cell size, ISD and deterministic flight path. Therefore we believe the UE can be allowed to skip the neighbour cell measurements under some conditions as explained in our paper [R4-2212696]. The detailed conditions need more discussions and thus FFS.  **Issue 2-1-2-4: Conditions for performing neighbour cell measurements**  We support option 1, see our previous comments. The detailed conditions need more discussions and thus FFS.  **Issue 2-1-2-5: Paging reception requirements**  We are fine with option 1.  **Issue 2-1-3: Minimization of Drive tests (MDT)**  We don’t think it is realistic to define MDT requirements within the Rel-18 time frame. Our preference is to focus on developing the core requirements as highest priority and MDT can have lower priority.    **Issue 2-1-4: IDLE Mode CA/DC requirements**  Option 1 should be clarified that RAN4 shall focus on developing RRM requirements assuming single carrier operation in Rel-18, with such clarification we are fine.  **Issue 2-1-5: Small Data Transmissions (SDT)**  We think SDT can be useful feature to support since it can be used to provide NW with critical or periodical updates without switching to CONNECTED mode. In addition, we think most of the existing requirements can be reused with minor effort. We are also open to continue the discussions.  **Issue 2-1-6: Positioning measurements**  Positioning measurement requirements should be down prioritized for ATG. ATG UE will have GNSS and the GNSS coverage is good as it is in the air. Positioning measurements for A2G will also require significant additional work. Therefore we do not see any good motivation for positioning measurement requirements for ATG in R18. |
| Apple. | **Issue 2-1-1: Cell selection requirements**  Agree with the recommended WF by moderator.  **Issue 2-1-2: Cell re-selection requirements**  **Issue 2-1-2-1: Cell re-selection measurement capability**  Option 2 can be a starting point.  **Issue 2-1-2-2: Cell re-selection measurement requirements**  Keep all options open  **Issue 2-1-2-3: Neighbour cell measurements**  Keep all options open  **Issue 2-1-2-4: Conditions for performing neighbour cell measurements**  Keep all options open.  **Issue 2-1-2-5: Paging reception requirements**  The recommended WF seems reasonable.  **Issue 2-1-3: Minimization of Drive tests (MDT)**  We don’t see the motivation to support small data transmission for ATG UE. Since the purpose of ATG UE is to provide high speed data service for in-flight passengers.  So, Option 1.  **Issue 2-1-4: IDLE Mode CA/DC requirements**  Option 1  **Issue 2-1-5: Small Data Transmissions (SDT)**  Option 1  **Issue 2-1-6: Positioning measurements**  Option 1 |
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Sub topic 2-2: Mobility in RRC\_CONNECTED

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| **Company** | **Comments** |
| Huawei | **Issue 2-2-1: Handover**  **Issue 2-2-1-1: NR Handover**  Support option 2, and the details can be FFS.  **Issue 2-2-1-2: NR Handover to Other RATs**  Same as issue 2-1-3  **Issue 2-2-1-3: NR DAPS Handover**  Same as issue 2-1-3  **Issue 2-2-1-4: NR Conditional Handover**  We think CHO is an important feature to be considered. Whether to consider location based CHO depends on whether to reply on assistant information as Rel-17 NTN.  **Issue 2-2-1-5: NR Handover with PSCell**  Same as issue 2-1-3  **Issue 2-2-2: RRC Connection Mobility Control**  **Issue 2-2-2-1: SA: RRC Re-establishment**  Fine with option 1-2  **Issue 2-2-2-2: Random access**  Support option 1-1  **Issue 2-2-2-3: SA: RRC Connection Release with Redirection**  Support option 1-1. |
| Ericsson | **Issue 2-2-1: Handover**  **Issue 2-2-1-1: NR Handover**  We agree that RAN4 shall define both intra-frequency and inter-frequency requirements for A2G in Rel-17. However, the details should be FFS.  We are fine to keep the discussions related to option 3 in one place under IDLE mode IDLE mode cell re-selection issue (issue 2-1-2-2) since the rationale is the same.  **Issue 2-2-1-2: NR Handover to Other RATs**  Option 1 is agreeable.  **Issue 2-2-1-3: NR DAPS Handover**  We support option 2. At this stage of the WI, we think option 2 is more reasonable as it give companies more time to check and analyse the benefits.  **Issue 2-2-1-4: NR Conditional Handover**  We support option 1. We also think conditional CHO by utilizing the assistant information can be useful for A2G and to avoid unnecessary measurements and cell changes.  **Issue 2-2-1-5: NR Handover with PSCell**  Assuming single carrier operation is considered in this release, no need to consider HO with PSCell.  **Issue 2-2-2: RRC Connection Mobility Control**  **Issue 2-2-2-1: SA: RRC Re-establishment**  Given that this is the first meeting for the WI, we suggest to agree that RAN4 shall define RRC re-establishment requirements for A2G, but the details are FFS.  **Issue 2-2-2-2: Random access**  Given that this is the first meeting for the WI, we suggest to agree that RAN4 shall define RA requirements for A2G, but the details are FFS.  **Issue 2-2-2-3: SA: RRC Connection Release with Redirection**  Given that this is the first meeting for the WI, we suggest to agree that RAN4 shall define requirements for RC connection release with redirection for A2G, but the details are FFS. |
| Apple | **Issue 2-2-1: Handover**  **Issue 2-2-1-1: NR Handover**  Either Option 1 or option 2 is ok.  **Issue 2-2-1-2: NR Handover to Other RATs**  Option 1  **Issue 2-2-1-3: NR DAPS Handover**  Option2. DAPS can be left for future release.  **Issue 2-2-1-4: NR Conditional Handover**  OK with recommended WF  **Issue 2-2-1-5: NR Handover with PSCell**  Option 1  **Issue 2-2-2: RRC Connection Mobility Control**  **Issue 2-2-2-1: SA: RRC Re-establishment**  Ok with the recommended WF.  **Issue 2-2-2-2: Random access**  Ok with the recommended WF  **Issue 2-2-2-3: SA: RRC Connection Release with Redirection**  Ok with the recommended WF |
|  |  |

## 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:* |

## 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: Timing and frequency adjustment

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2211643 | CATT | Observation 3: The ATG UE should measure its position and moving velocity.  Observation 4: The ATG UE should do the compensation of transmit frequency and timing based on relative moving velocity and distance between UE and gNB.  Observation 5: The mechanism of Koffset and Kmac for NTN system should be used for ATG network. |
| R4-2211918 | Apple | Proposal 4: It is proposed that ATG UE in R18 is GNSS capable. |
| R4-2212302 | CMCC | Observation 1: If the speed of ATG UE is larger than 594km/h, the existing gradual timing adjustment requirement cannot be reused for ATG UE.  Observation 5: The timing advance caused by large ISD and high UE speed can be addressed by current timing adjustment procedure.  Proposal 4: Use the current timing adjustment procedure as the baseline.  Observation 6: ATG UE is feasible to perform UL timing pre-compensation and frequency pre-compensation by using PV ephemeris format and its GNSS.  Proposal 5: Further study whether to introduce the UE based UL timing pre-compensation and frequency pre-compensation based on necessity and performance gain. |
| R4-2212696 | Ericsson | Observation 3: Air-to-ground network (ATG) for NR WI is a RAN4 only WI. This means that we have to rely on the existing procedures up to and including rel-17, that is TN and NTN procedures up to and including release-17, for random access and Timing Advance.  Observation 4: The maximum Doppler frequency for ATG UE is at least 5.6 kHz to cover example bands.  Observation 5: The maximum Doppler frequency for ATG BS is at least 11.6 kHz to cover example bands whilst assuming existing terrestrial 5G access procedures.  Observation 6: There is a fundamental tradeoff between cell range and ability to suppress Doppler frequency in a TN network.  Observation 7: A long sequence is closer to meet the ATG requirement of up to 300 km cell range but can only reach around 100 km and handle ordinary Doppler corresponding to UE speed of up to 300 km/h or 500 km/h with Restricted Sets. A short sequence can handle the Doppler of ATG but not the range.  Observation 8: An ATG system needs a full slot or even several slots of GP, however the large ISD and beamforming might mitigate any issues with regards to GP for TDD.  Observation 9: An NTN network can handle the 300 km cell range of an ATG system.  Observation 10: An NTN network can handle the Doppler of an ATG system.  Observation 11: For ATG, the scenario differs in that the UE is in the air and the BS is on the ground. The equivalent of ephemeris information would be a knowledge of BS positions.  Proposal 25: Clarify maximum Doppler frequency for ATG UE and BS requirements.  Proposal 26: Clarify maximum range in ATG given the capabilities of existing releases up to and including release 17.  Proposal 27: Clarify the need for and size of GP for ATG TDD. |
| R4-2212974 | Huawei, HiSilicon | Observation 1: The legacy close-loop TA adjustment is sufficient to support ATG network.  Proposal 3: RAN4 to discuss whether to consider UE specific TA estimation in ATG network.  Proposal 4: Tp and Tq shall be updated for ATG UE. |
| R4-2213868 | ZTE Corporation | Observation 1: For some combination of frequency and SCS, SSB+TRS is feasible implementation for frequency offset tracking to support 1200km/h for ATG deployment.  Observation 2: The solution of frequency offset tracking in NTN system can be considered as reference for ATG system when SSB+TRS is not sufficient for some combination of frequency and SCS.  Proposal 9: For gradual timing adjustment, since the extremely high speed of ATG, the gradual timing adjustment Tp/Tq need to be magnified. When identifying the exact value, the total time drift of 242 ns should be considered.  Proposal 10: For initial transmit timing, the assumptions for GNSS in NTN can be a baseline. |

## 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: General issues

*Sub-topic description:*

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

**Issue 3-1-1: Whether ATG UE should be capable of GNSS measurement**

* Proposals
  + Option 1: ATG UE should be capable of GNSS measurement (CATT, Apple, ZTE)
  + Option 2: FFS ATG UE should be capable of GNSS measurement or not (CMCC, HW)
* Recommended WF
  + This issue is highly related with Issue 3-2-1, moderator suggest to discuss Issue 3-2-1 first

**Issue 3-1-2: The mechanism of *Koffset* and *Kmac***

* Proposals
  + Option 1: The mechanism of Koffset and Kmac for NTN system should be used for ATG network. (CATT)
* Recommended WF
  + Discuss Option 1

**Issue 3-1-3: Frequency offset tracking**

* Proposals
  + Option 1: The solution of frequency offset tracking in NTN system can be considered as reference for ATG system when SSB+TRS is not sufficient for some combination of frequency and SCS. (ZTE)
* Recommended WF
  + Discuss Option 1

**Issue 3-1-4: Maximal cell range and Doppler**

* Proposals
  + Option 1: (Ericsson)
    - Clarify maximum Doppler frequency for ATG UE and BS requirements
      * The maximum Doppler frequency for ATG BS is at least 11.6 kHz to cover example bands whilst assuming existing terrestrial 5G access procedures
    - Clarify maximum range in ATG given the capabilities of existing releases up to and including release 17.
      * A long sequence is closer to meet the ATG requirement of up to 300 km cell range but can only reach around 100 km and handle ordinary Doppler corresponding to UE speed of up to 300 km/h or 500 km/h with Restricted Sets. A short sequence can handle the Doppler of ATG but not the range.
    - Clarify the need for and size of GP for ATG TDD.
      * An ATG system needs a full slot or even several slots of GP, however the large ISD and beamforming might mitigate any issues with regards to GP for TDD
* Recommended WF
  + Please provide your comments.

### Sub-topic 3-2：Timing and frequency pre-compensation by UE

*Sub-topic description*

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

**Issue 3-2-1: Whether to introduce UE based Timing pre-compensation**

* Proposals
  + Option 1: The ATG UE should do the compensation of transmit frequency based on relative moving velocity and distance between UE and gNB. (CATT, ZTE, Ericsson)
  + Option 2: Further study whether to introduce the UE based UL timing pre-compensation based on necessity and performance gain. (CMCC, Apple, HW)
    - Option 2-1: Use the current timing adjustment procedure as the baseline. (CMCC, HW)
* Recommended WF
  + Discuss the necessity of introducing UE based Timing pre-compensation

**Issue 3-2-2: Whether to introduce UE based Frequency pre-compensation**

* Proposals
  + Option 1: The ATG UE should do the compensation of timing based on relative moving velocity and distance between UE and gNB. (CATT)
  + Option 2: Further study whether to introduce the UE based UL frequency pre-compensation based on necessity and performance gain. (CMCC)
* Recommended WF
  + Discuss the above options

### Sub-topic 3-3：Timing requirements

*Sub-topic description*

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

**Issue 3-3-1: UE transmit timing**

**Issue 3-3-1-1: Initial transmit timing requirements Te**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE. (CATT, ZTE, Apple, CMCC, HW)
    - FFS if UE specific TA shall be considered in the Te requirement design, like in NTN (Apple, CMCC, HW)
    - Introduce UE specific TA in the Te requirement design. (CATT, ZTE)
* Recommended WF
  + This issue is highly related with Issue 3-2-1, moderator suggest to discuss Issue 3-2-1 first

**Issue 3-3-1-2: Gradual timing adjustment**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE. (CATT, ZTE, Apple, CMCC, HW)
    - Option 1-1: Tp and Tq shall be updated for ATG UE (HW, CMCC, Apple, ZTE)
    - Option 1-2: When identifying the exact value, the total time drift of 242 ns should be considered. (ZTE)
* Recommended WF
  + Check whether Option 1-1 can be agreed, companies are encouraged to provide specific values for ATG.

**Issue 3-3-2: UE timer accuracy**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE. (CATT, Apple, CMCC, Ericsson)
    - Option 1-1: The current requirements can be reused. (CMCC, Apple, CATT)
* Recommended WF
  + Check whether Option 1-1 can be agreed

**Issue 3-3-3: Timing advance**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE. (CATT, Apple, CMCC, Ericsson)
    - Option 1-1: FFS on the necessity of considering the open loop TA (UE specific TA if needed) and close loop (TAC based adjustment) for the TA adjustment requirement, like in NTN. (CMCC, Apple)
* Recommended WF
  + This issue is highly related with Issue 3-2-1, moderator suggest to discuss Issue 3-2-1 first

**Issue 3-3-4: Cell phase synchronization accuracy**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE. (CATT, Apple, CMCC)
    - Option 1-1: The legacy TN requirement can be reused or tightened (Apple)
    - Option 1-2: The legacy TN requirement can be reused (CMCC, CATT)
* Recommended WF
  + Cell phase synchronization accuracy will be defined for ATG, the legacy TN requirement can be the baseline, FFS whether to tighten the requirements or not

**Issue 3-3-5: deriveSSB-IndexFromCell tolerance**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE. (Apple, CMCC)
    - Option 1-1: The time misalignment tolerance for ‘deriveSSB-IndexFromCell= true’ shall be revisited due to the extreme large radius of ATG cell. (Apple)
    - Option 1-2: The legacy TN requirement can be reused (CMCC)
  + Option 2: Not applicable for R18 ATG (CATT)
* Recommended WF
  + Discuss the Options above.

**Issue 3-3-6: deriveSSB-IndexFromCell-inter tolerance**

* Proposals
  + Option 1: This section was introduced in MG enhancement WI which is not needed for ATG UE (Apple, CATT)
* Recommended WF
  + Further discuss

**Issue 3-3-7: Other timing requirements**

* Proposals
  + Option 1: For Maximum Transmission Timing Difference and Maximum Receive Timing Difference and the requirements are not applicable for R18 ATG (CATT, Apple, CMCC)
* Recommended WF
  + Check whether Option 1 is agreeable or not.

## 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.*

Sub topic 3-1: General issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | **Issue 3-1-1: Whether ATG UE should be capable of GNSS measurement**  Support recommended WF  **Issue 3-1-2: The mechanism of *Koffset* and *Kmac***  We think the RTT in ATG is not that serve as NTN. It is not well justified whether TN framework can handle the case without introducing Koffset and Kmac.  **Issue 3-1-3: Frequency offset tracking**  **Issue 3-1-4: Maximal cell range and Doppler**  We would like to know what the impact on RRM spec of option 1. For instance, the configuration of GP is determined by gNB, and it will not be reflected in RRM spec. |
| Ericsson | **Issue 3-1-1: Whether ATG UE should be capable of GNSS measurement**  Option 1: ATG UE should be capable of GNSS measurement. We base this on analysis of cell range and Doppler for ATG compared to what a TN and NTN system can achieve. Airborne ATG will also have good GNSS coverage.  **Issue 3-1-2: The mechanism of *Koffset* and *Kmac***  The mechanism of Koffset and Kmac van be used if we decide to have NTN as base for ATG.  **Issue 3-1-3: Frequency offset tracking**  Option 1 is fine for us: The solution of frequency offset tracking in NTN system can be considered as reference for ATG system when SSB+TRS is not sufficient for some combination of frequency and SCS.  **Issue 3-1-4: Maximal cell range and Doppler**  Our analysis show range and Doppler of regular TN and NTN system. A regular TN PRACH preamble has either long range (100 km) but poor Doppler performance and vice versa. |
| Apple | **Issue 3-1-1: Whether ATG UE should be capable of GNSS measurement**  **Option 1.**  **Issue 3-1-2: The mechanism of *Koffset* and *Kmac***  Needs more discussion  **Issue 3-1-3: Frequency offset tracking**  FFS  **Issue 3-1-4: Maximal cell range and Doppler** |
|  |  |

Sub topic 3-2: Timing and frequency pre-compensation by UE

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | **Issue 3-2-1: Whether to introduce UE based Timing pre-compensation**  We think the current TN TA framework can handle ATG scenarios. Can companies clarify the necessity of having UE pre-compensation?  **Issue 3-2-2: Whether to introduce UE based Frequency pre-compensation**  Similar as Issue 3-2-1. |
| Ericsson | **Issue 3-2-1: Whether to introduce UE based Timing pre-compensation**  We are fine with both options 1 and 2. We can further study topic.  **Issue 3-2-2: Whether to introduce UE based Frequency pre-compensation**  We are fine with both options 1 and 2. We can further study topic. |
| Apple | **Issue 3-2-1: Whether to introduce UE based Timing pre-compensation**  Option 2  **Issue 3-2-2: Whether to introduce UE based Frequency pre-compensation**  Option 2 |
|  |  |

Sub topic 3-3: Timing requirements

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | **Issue 3-3-1: UE transmit timing**  **Issue 3-3-1-1: Initial transmit timing requirements**  Depends on issue 3-2-1  **Issue 3-3-1-2: Gradual timing adjustment**  Support option 1-1  **Issue 3-3-2: UE timer accuracy**  Support 3-3-2  **Issue 3-3-3: Timing advance**  Depends on issue 3-2-1  **Issue 3-3-4: Cell phase synchronization accuracy**  Support option 1-2.  **Issue 3-3-5: deriveSSB-IndexFromCell tolerance**  The propagation delay different may impact the tolerance. Suggest FFS.  **Issue 3-3-6: deriveSSB-IndexFromCell-inter tolerance**  Not sure what is the ATG specific impact on this.  **Issue 3-3-7: Other timing requirements**  Fine with option 1. |
| Ericsson | **Issue 3-3-1: UE transmit timing**  **Issue 3-3-1-1: Initial transmit timing requirements**  Option 1 is fine: Introduce UE specific TA in the Te requirement design. FFS if UE specific TA shall be considered in the Te requirement design, like in NTN .  **Issue 3-3-1-2: Gradual timing adjustment**  We are fine with to update Tp and Tq if needed as stated in option 1-1. We think this depends on if TN or NTN rel-17 is used as baseline.  **Issue 3-3-2: UE timer accuracy**  Option 1-1 is fine.  **Issue 3-3-3: Timing advance**  Option 1 and 1-1 is fine: FFS on the necessity of considering the open loop TA (UE specific TA if needed) and close loop (TAC based adjustment) for the TA adjustment requirement, like in NTN.  **Issue 3-3-4: Cell phase synchronization accuracy**  Recommended WF is fine.  **Issue 3-3-5: deriveSSB-IndexFromCell tolerance**  We support option 1 and agree that the details can be revisited based on the A2G scenario assumptions.  **Issue 3-3-6: deriveSSB-IndexFromCell-inter tolerance**  We disagree to option 1. Our view is that the MG enhancements introduced in Rel-17 should also be considered for A2G. The motivation is that NCSG(deriveSSB-IndexFromCell-inter) has benefit for A2G system since the throughput is an important KPI for ATG.  **Issue 3-3-7: Other timing requirements**  This depends on feature set of ATG, sinve MRTD/MTTD is set per feature (CA, DC, MIMO, etc). |
| Huawei | **Issue 3-3-1: UE transmit timing**  **Issue 3-3-1-1: Initial transmit timing requirements**  Option 1  **Issue 3-3-1-2: Gradual timing adjustment**  Option 1-1  **Issue 3-3-2: UE timer accuracy**  Option 1  **Issue 3-3-3: Timing advance**  Option 1  **Issue 3-3-4: Cell phase synchronization accuracy**  Option 1-1  **Issue 3-3-5: deriveSSB-IndexFromCell tolerance**  Option 1-1  **Issue 3-3-6: deriveSSB-IndexFromCell-inter tolerance**  Option 1  **Issue 3-3-7: Other timing requirements**  Option 1 |

## 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:* |

## Discussion on 2nd round (if applicable)

# Topic #4: Signalling characteristics

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2212696 | Ericsson | Proposal 1 General section on bands and terminologies are updated with A2G bands and terminologies.  Proposal 13 Interruption requirements defined in section 8.2 are not applicable assuming that single carrier is considered for A2G in this release.  Proposal 14 The existing link recovery requirements defined for FR1 are used as baseline for A2G.  Proposal 15 The existing active BWP switch delay requirements defined for FR1 are used as baseline for A2G.  Proposal 16 The existing active TCI state switch delay requirements defined for FR1 are used as baseline for A2G.  Proposal 17 The existing active spatial relation switch delay requirements defined for FR1 are used as baseline for A2G.  Proposal 18 The existing UE specific CBW change requirements defined for FR1 are used as baseline for A2G.  Proposal 19 No need to consider pathloss reference signal switch delay requirements for A2G in Rel-18.  Proposal 20 The existing requirements on SCell activation and deactivation are used as baseline for A2G provided that CA/multiple carriers are supported for A2G. |
| R4-2213868 | ZTE Corporation | Proposal 11: Reusing legacy requirements of RLM, BFD, LRP and BWP switching is fine. |

## 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 4-1: Signalling characteristics related requriments

*Sub-topic description:*

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

**Issue 4-1-1: Radio Link Monitoring**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, CMCC, Ericsson)
    - Option 1-1: FFS if the existing RLM evaluation and L1 interval is applicable to ATG UE. (Apple)
    - Option 1-2: Reuse legacy R15 requirements (CMCC, Ericsson, ZTE)
* Recommended WF
  + Radio Link Monitoring requirements will be defined for ATG, please check whether Option 1-2 is agreeable or not based on majority views.

**Issue 4-1-2: Link Recovery Procedure**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, CMCC, Ericsson)
    - Option 1-1: FFS: if the existing BFD/CBD evaluation and BFD L1 interval is applicable to ATG UE. (Apple)
    - Option 1-2: Reuse legacy R15 SA requirements (CMCC, Ericsson, ZTE)
* Recommended WF
  + Link Recovery Procedure requirements will be defined for ATG, please check whether Option 1-2 is agreeable or not based on majority views.

**Issue 4-1-3: Active BWP switching delay**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, CMCC, Ericsson)
    - Option 1-1: The current requirement can be reused. (Apple, CMCC, Ericsson)
* Recommended WF
  + Active BWP switching delay requirements will be defined for ATG, please check whether Option 1-1 is agreeable or not

**Issue 4-1-4: Active TCI state switching delay**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, Ericsson)
    - Option 1-1: FFS: if the existing TCI switching requirement is applicable to ATG UE. (Apple)
    - Option 1-2: The principle from the legacy active TCI state switch delay can be reused. (Ericsson)
* Recommended WF
  + Active TCI state switching delay requirements will be defined for ATG. Further discuss Option 1-1 and Option 1-2

**Issue 4-1-5: Active spatial relation switch delay**

* Proposals
  + Option 1: The principle from the legacy active spatial relation switch delay requirements can be reused. (Ericsson)
  + Option 2: Not applicable to R18 ATG (CATT, Apple, CMCC)
* Recommended WF
  + Further check if Option 2 is agreeable based on majority view.

**Issue 4-1-6: UE-specific CBW change**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, Ericsson, CMCC)
    - Option 1-1: The principle from the legacy UE specific CBW change requirements can be reused. (Apple, CMCC,)
* Recommended WF
  + UE-specific CBW change requirements will be defined for ATG. Further check if Option 1-1 is agreeable

**Issue 4-1-7: Pathloss reference signal switching delay**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, CMCC)
    - Option 1-1: FFS: if the existing PL-RS switching requirement is applicable to ATG UE. (Apple)
    - Option 1-2: Reuse legacy requirement (CMCC)
  + Option 2: This feature is related to eMIMO and thus no need to consider for A2G. ()
* Recommended WF
  + Discuss the Options above

**Issue 4-1-8: Active downlink TCI state switching delay for unified TCI**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple)
    - Option 1-1: The current requirement could be reused. (Apple)
  + Option 2: No need to consider this feature for A2G. (CMCC,)
* Recommended WF
  + Discuss the Options above

**Issue 4-1-9: Active uplink TCI state switching delay for unified TCI**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT)
  + Option 2: This is from R16 eMIMO, no need to consider this feature for A2G. (Apple, CMCC,)
* Recommended WF
  + Discuss the Options above

**Issue 4-1-10: TRP specific Link Recovery Procedures**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT)
  + Option 2: This is from R16 eMIMO, no need to consider this feature for A2G. (Apple, CMCC,)
* Recommended WF
  + Discuss the Options above

**Issue 4-1-11: Pre-configured measurement gap activation/deactivation delay**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT)
  + Option 2: GAP enhancement contents are not considered for ATG UE in Rel-18. (Apple, CMCC,)
* Recommended WF
  + Discuss the Options above

**Issue 4-1-12: Other CA related signalling characteristics requirements**

* Proposals
  + Option 1: For Interruption requirement, SCell activation and deactivation delay requirement, due to single CC operation in this release, they are not applicable for R18 ATG (CATT, Apple, CMCC)
  + Option 2: Depends on the scope of WI. If CA/multicarriers are supported then the existing requirements can be used as baseline. (Ericsson)
* Recommended WF
  + This issue is related to Issue 1-1-1, can be discussed after Issue 1-1-1 is concluded.

**Issue 4-1-13: Other signalling characteristics requirements**

* Proposals
  + Option 1: For UE UL carrier RRC reconfiguration delay requirement, NE-DC: E-UTRAN PSCell Addition and Release Delay requirement, NR-DC: PSCell Addition and Release Delay requirement, PSCell Change requirement and SCG Activation and Deactivation Delay requirement, they are not applicable for R18 ATG. (CATT, Apple, CMCC,)
* Recommended WF
  + Check if Option 1 can be agreed.

## Companies views’ collection for 1st round

### Open issues

Sub topic 4-1

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| --- | --- |
| **Company** | **Comments** |
| Huawei | **Issue 4-1-1: Radio Link Monitoring**  Support option 1-2  **Issue 4-1-2: Link Recovery Procedure**  Support option 1-2  **Issue 4-1-3: Active BWP switching delay**  Support option 1-1  **Issue 4-1-4: Active TCI state switching delay**  Support option 1-2  **Issue 4-1-5: Active spatial relation switch delay**  No need to consider  **Issue 4-1-6: UE-specific CBW change**  Current requirements can apply  **Issue 4-1-7: Pathloss reference signal switching delay**  Current requirements can apply  **Issue 4-1-8: Active downlink TCI state switching delay for unified TCI**  We are fine not to consider requirements and focus on identified spec impact.  **Issue 4-1-9: Active uplink TCI state switching delay for unified TCI**  We are fine not to consider requirements and focus on identified spec impact.  **Issue 4-1-10: TRP specific Link Recovery Procedures**  We are fine not to consider requirements and focus on identified spec impact.  **Issue 4-1-11: Pre-configured measurement gap activation/deactivation delay**  We are fine not to consider requirements and focus on identified spec impact.  **Issue 4-1-12: Other CA related signalling characteristics requirements**  Support recommended WF  **Issue 4-1-13: Other signalling characteristics requirements**  For requirements related to CA/DC operation, we are fine to not considering the updating if any. For UL carrier reconfiguration delay, it is basic requirements introduced in R15 apply to single Cell, which is referred to RAN2 spec about RRC procedure delay. No spec impact is identified. |
| Ericsson | **Issue 4-1-1: Radio Link Monitoring**  We prefer a high-level agreement as stated in option 1, but the details can be FFS. It is too early to conclude whether the evaluation period or other details are identical to legacy requirements.  **Issue 4-1-2: Link Recovery Procedure**  We prefer a high-level agreement as stated in option 1/option 1-1, but the details can be FFS. It is too early to conclude whether the CBD/BFD evaluation period or other details are identical to legacy requirements.  **Issue 4-1-3: Active BWP switching delay**  Similar comment, prefer a high-level agreement that RAN4 shall define requirements for active BWP switching for A2G, but the details are FFS.  **Issue 4-1-4: Active TCI state switching delay**  For similar reason, both option 1-1 and 1-2 can be reused.  **Issue 4-1-5: Active spatial relation switch delay**  Assuming that FR2 is not considered in this WI, option 2 is agreeable.  **Issue 4-1-6: UE-specific CBW change**  Option 1-1 is agreeable, FFS on the details.  **Issue 4-1-7: Pathloss reference signal switching delay**  It depends on whether eMIMO is considered in the WI. Since it is not explicitly excluded, we prefer option 1-1.  **Issue 4-1-8: Active downlink TCI state switching delay for unified TCI**  We suggest an alternative proposal:  *“RAN4 to define active downlink TCI state switching requirements for A2G, but it is FFS whether legacy requirements can be reused. “*  **Issue 4-1-9: Active uplink TCI state switching delay for unified TCI**  We suggest an alternative proposal:  *“RAN4 to define active uplink TCI state switching requirements for A2G, but it is FFS whether legacy requirements can be reused. “*  **Issue 4-1-10: TRP specific Link Recovery Procedures**  More discussions are needed whether link recovery procures using multi-TRP transmission is relevant for A2G UEs. We are not confident that this feature is very useful for the A2G, thus we are fine with option 2.  TRP-specific link recovery is the feature UE maintains TCI per TRP. This means gNB provide multi-TRP transmission. In ATG, UE is on the plane, and cell ISD=200km. So I don't think ATG gNB provide multi-TRP transmission for ATG UEs.  **Issue 4-1-11: Pre-configured measurement gap activation/deactivation delay**  We support option 1. Please note that Ericsson’s position has be wrongly captured.  **Issue 4-1-12: Other CA related signalling characteristics requirements**  Assuming single carrier operation only for A2G in this release, option 1 is agreeable.  **Issue 4-1-13: Other signalling characteristics requirements**  Assuming single carrier operation only for A2G in this release, option 1 is agreeable. |
| Apple | **Issue 4-1-1: Radio Link Monitoring**  Option 1-1. Would like to further check though option 1-2 might be ok.  **Issue 4-1-2: Link Recovery Procedure**  Option 1-1. Would like to further check though option 1-2 might be ok.  **Issue 4-1-3: Active BWP switching delay**  Option 1-1  **Issue 4-1-4: Active TCI state switching delay**  Option 1-1. Would like to further check though option 1-2 might be ok.  **Issue 4-1-5: Active spatial relation switch delay**  Option 5  **Issue 4-1-6: UE-specific CBW change**  Option 1-1  **Issue 4-1-7: Pathloss reference signal switching delay**  Would like to keep this open for the time being.  **Issue 4-1-8: Active downlink TCI state switching delay for unified TCI**  **Issue 4-1-9: Active uplink TCI state switching delay for unified TCI**  Option 2  **Issue 4-1-10: TRP specific Link Recovery Procedures**  Option 2  **Issue 4-1-11: Pre-configured measurement gap activation/deactivation delay**  Option 2  **Issue 4-1-12: Other CA related signalling characteristics requirements**  Option 1  **Issue 4-1-13: Other signalling characteristics requirements**  Option 1 |
|  |  |

## 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:* |

## Discussion on 2nd round (if applicable)

# Topic #5: Measurement

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2212302 | CMCC | Observation 3: Considering of the max UE speed 1200km/h, as long as ISD is larger than 3.2km, the current intra-frequency measurement requirement can be reused.  Observation 4: Considering of the max UE speed 1200km/h, as long as ISD is larger than 12.16km, the current inter-frequency requirement can be reused.  Proposal 3: For R18 ATG intra-frequency measurement and inter-frequency measurement, reuse the current requirements. |
| R4-2212696 | Ericsson | Proposal 21 Only FR1 MG is considered in ATG network.  Proposal 22 CSSF needs update if single carrier is supported, such as no deactivated SCell measurement, no SCCs, PSCell measurement. RedCap single carrier measurement requirement can be a reference.  Proposal 23 RAN4 can further study the trade-off between Inter-frequency measurement within MG and the throughput due to large cell coverage.  Proposal 24 UE doesn’t need to support any inter-RAT measurement in ATG system.  Proposal 25 RAN4 to further discuss whether UE supports CGI reading in ATG system. |
| R4-2212974 | Huawei, HiSilicon | Proposal 5: Whether to define requirements for CSI-RS based measurement and positioning measurement for ATG. |
| R4-2213868 | ZTE Corporation | Proposal 7: It is not necessary to specify the upper bound of DRS cycle for ATG system.  Proposal 8: Reusing legacy requirements of L1 measurement is fine. |

## 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 5-1: Measurement procedure and requirements

*Sub-topic description:*

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

**Issue 5-1-1: General measurement requirement**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, CMCC, Ericsson)
    - Option 1-1: GAP design and related capability/scaling needs to be reconsidered. (Apple)
    - Option 1-2: Reuse legacy R15 requirements (CMCC)
    - Option 1-3: Only FR1 MG is considered in ATG network. (Ericsson)
* Recommended WF
  + General measurement requirement will be defined for ATG, further discuss the GAP design and related capability/scaling.

**Issue 5-1-2: NR intra-frequency measurements**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, CMCC, Ericsson, ZTE, HW)
    - Option 1-1: FFS on the details. (Apple)
    - Option 1-2: Reuse legacy R15 requirements, it is not necessary to specify the upper bound of DRS cycle for ATG system. (CMCC, ZTE)
    - Option 1-3: CSSF needs update if single carrier is supported, such as no deactivated SCell measurement, no SCCs, PSCell measurement. RedCap single carrier measurement requirement can be a reference. (Ericsson)
* Recommended WF
  + NR intra-frequency measurements will be defined for ATG, further discuss the details

**Issue 5-1-3: NR inter-frequency measurements**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, CMCC, Ericsson, ZTE, HW)
    - Option 1-1: FFS on the details. (Apple)
    - Option 1-2: Reuse legacy R15 requirements, it is not necessary to specify the upper bound of DRS cycle for ATG system. (CMCC, ZTE)
    - Option 1-3: RAN4 can further study the trade-off between Inter-frequency measurement within MG and the throughput due to large cell coverage. (Ericsson)
* Recommended WF
  + NR inter-frequency measurements will be defined for ATG, further discuss the details

**Issue 5-1-4: L1-RSRP and L1-SINR measurements for Reporting**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, Apple, CMCC, ZTE)
    - Option 1-1: Reusing legacy requirements of L1 measurement. (CMCC, ZTE, Apple)
* Recommended WF
  + L1-RSRP and L1-SINR measurements for Reporting will be defined for ATG, further check if Option 1-1 can be agreed.

**Issue 5-1-5: Cross Link Interference measurements**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT)
  + Option 2: This requirement is not necessary for ATG UE (Apple, CMCC)
* Recommended WF
  + Discuss the above Options.

**Issue 5-1-6: CSI-RS based L3 measurements**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, CMCC)
  + Option 2: FFS Whether to define requirements for CSI-RS based measurement and positioning measurement for ATG. (HW)
* Recommended WF
  + Discuss the above Options.

**Issue 5-1-7: L1-RSRP measurements for a cell with different PCI from serving cell**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, CMCC)
* Recommended WF
  + Discuss the above Options.

**Issue 5-1-8: NR measurements with autonomous gaps**

* Proposals
  + Option 1: Need defined RRM requirements for ATG UE (CATT, CMCC)
    - Option 1-1: Reusing legacy requirements. (CMCC)
    - Option 1-2: RAN4 to further discuss whether UE supports CGI reading in ATG system. (Ericsson)
* Recommended WF
  + Discuss the above Options.

**Issue 5-1-9: Other measurement related requirements**

* Proposals
  + Option 1: For Inter-RAT measurements, NE-DC: Measurements, NR measurements for positioning, Measurement for Propagation Delay Compensation, they are not applicable for R18 ATG UE (CATT, Apple, CMCC, HW)
* Recommended WF
  + Please check if Option 1 is agreeable.

### Sub-topic 5-2: Measurement performance

*Sub-topic description:*

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

**Issue 5-2-1: Measurement performance requirement**

* Proposals
  + Option 1: The following measurement performance are needed. (Apple)
    - Intra-frequency RSRP accuracy requirement for FR1
    - Inter-frequency RSRP accuracy requirement for FR1
    - Intra-frequency RSRQ accuracy requirement for FR1
    - Inter-frequency RSRQ accuracy requirement for FR1
    - Intra-frequency SINR accuracy requirement for FR1
    - Inter-frequency SINR accuracy requirement for FR1
    - Power headroom
    - Pcmax,c,c
    - L1-RSRP accuracy requirements for FR1
    - SFTD accuracy requirements
    - CLI measurement accuracy requirement??
  + Option 2: Measurements for E-UTRAN and UTRAN FDD are not needed. (Apple)
* Recommended WF
  + Suggest to focus on measurement core requirements first, then come back to this issue.

## 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.*

Sub topic 5-1: Measurement procedure and requirements

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | **Issue 5-1-1: General measurement requirement**  Support recommended WF.  **Issue 5-1-2: NR intra-frequency measurements**  Support recommended WF.  **Issue 5-1-3: NR inter-frequency measurements**  Support recommended WF.  **Issue 5-1-4: L1-RSRP and L1-SINR measurements for Reporting**  Support recommended WF.  **Issue 5-1-5: Cross Link Interference measurements**  We think CLI are an important feature for ATG as ATG is deployed in non-disjoint frequency manner. It is suggested to FFS the RRM impact of CLI  **Issue 5-1-6: CSI-RS based L3 measurements**  We are open to discuss the RRM impact of CSI-RS L3 measurement  **Issue 5-1-7: L1-RSRP measurements for a cell with different PCI from serving cell**  We are open to discuss.  **Issue 5-1-8: NR measurements with autonomous gaps**  Support option 1-1  **Issue 5-1-9: Other measurement related requirements**  Generally fine. Suggest to focus on ATG specific impact. |
| Ericsson | **Issue 5-1-1: General measurement requirement**  Support recommended WF.  We also want to further check the understanding in the group whether we will only define the FR1 MG for ATG network.  **Issue 5-1-2: NR intra-frequency measurements**  Support recommended WF.  **Issue 5-1-3: NR inter-frequency measurements**  Support recommended WF.  **Issue 5-1-4: L1-RSRP and L1-SINR measurements for Reporting**  Support recommended WF.  **Issue 5-1-5: Cross Link Interference measurements**  Assuming that only single carrier is considered A2G, we are fine with option 2.  **Issue 5-1-6: CSI-RS based L3 measurements**  Option 2. We think CSI-RS measurement is an enhanced method for L3 measurement. Now we’re just defining the baseline solution for ATG.  **Issue 5-1-7: L1-RSRP measurements for a cell with different PCI from serving cell**  We want to further check the reason why UE needs to measurement a cell different with serving cell for L1-RSRP.  **Issue 5-1-8: NR measurements with autonomous gaps**  Support option 1-1  **Issue 5-1-9: Other measurement related requirements**  Support option 1 |
| Apple | **Issue 5-1-1: General measurement requirement**  Option 1-1: GAP design related capability/signalling needs to be reconsidered.  **Issue 5-1-2: NR intra-frequency measurements**  Prefer option 1-1. More thinking is needed on the details.  **Issue 5-1-3: NR inter-frequency measurements**  Prefer Option 1-1. More thinking is needed on the details.  **Issue 5-1-4: L1-RSRP and L1-SINR measurements for Reporting**  Ok with the recommendation from moderator.  **Issue 5-1-5: Cross Link Interference measurements**  Option 2. CLI feature is not necessary for ATG.  **Issue 5-1-6: CSI-RS based L3 measurements**  Keep open for further discussion  **Issue 5-1-7: L1-RSRP measurements for a cell with different PCI from serving cell**  Keep open for further discussion.  **Issue 5-1-8: NR measurements with autonomous gaps**  Keep open for further discussion.  **Issue 5-1-9: Other measurement related requirements**  Option1. |

Sub topic 5-2: Measurement performance

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | **Issue 5-2-1: Measurement performance requirement**  Support recommended WF. |
| Ericsson | Support recommended WF. |
| Apple | Option 1 and Option 2.  Our understanding is that the performance definition and mapping for each measurement can be delayed to performance part. However, the requirement structure should be discussed together with core part. E.g. which requirement is in the structure and which is not. |

## 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:* |

## Discussion on 2nd round (if applicable)

# Topic #6: Specifiction documentaion

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2211643 | CATT | Observation 2: The RRM requirements for ATG UE can be defined in new sections of section number with suffix D in specification. |
| R4-2211918 | Apple | Proposal 2: It is proposed to define RRM requirement for ATG UE in separate subclause |
| R4-2212302 | CMCC | Proposal 6: Add ATG related requirements in the current corresponding section, similar as HST |

## 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 6-1: Specifiction documentaion

*Sub-topic description:*

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

**Issue 6-1-1: How to involve ATG RRM core requirements in TS38.133**

* Proposals
  + Option 1: The RRM requirements for ATG UE can be defined in new sections of section number with suffix D in specification. (CATT, Apple)
  + Option 2: Add ATG related requirements in the current corresponding section, similar as HST. (CMCC)
* Recommended WF
  + Discuss this issue in later meetings, after identify the RRM impact of ATG features.

## Companies views’ collection for 1st round

### Open issues

Sub topic 6-1: Specifiction documentaion

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | **Issue 6-1-1: How to involve ATG RRM core requirements in TS38.133**  We support option 2. Spec updating can be made when the requirements needs to be changed for ATG just like HST. We prefer not to create dedicated sections for ATG, which will make the spec more and more complicated and unsustainable. |
| Ericsson | We support option 1 which a much cleaner approach. But we are also fine to keep this open until the full RRM impact is identified. |
| Apple | Option 1 is preferred. |
|  |  |

## 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:* |

## Discussion on 2nd round (if applicable)

# 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