**3GPP TSG-RAN4 Meeting #98bis-eR4-210xxxx**

**Online, 12 – 20 April, 2021**

**Agenda item:** 8.4

**Source:** Moderator (Apple)

**Title:** Email discussion summary for [98-bis-e][216] NR\_RRM\_enh2\_1

**Document for:** Information

# Introduction

This email discussion summary includes SRS antenna port switching (8.4.2.1), and HO with PSCell (8.4.2.2).

Candidate target of email discussion for 1st round and 2nd round

* 1st round:
  + Stage 0: Session chairs announce the set of email threads (no later than Monday 8am UTC, Apr. 12)
  + Stage 1: Moderators kick off email discussion (Monday Apr. 12)
  + Stage 2: Companies provide comments for the 1st round (Apr. 12 – Wednesday 8am UTC Apr. 14)
  + Stage 3: Moderators summarize the status and possible proposals, recommending what decisions can be made for 1st round. A formal t-doc will be used (Wednesday 11pm UTC, Apr. 14)
  + Stage 4: After receiving the summary from moderators, session chair may approve documents, make agreements or assign new CRs, WFs, LSs, etc. (no later than Friday 3pm UTC, Apr. 16)
* 2nd round:
  + Stage 5: Companies provide comments for 2nd round starting from Thursday 8am UTC Apr. 15.
    - Draft WF/LS and revised CRs/TPs shall be shared by Friday 11pm UTC, Apr. 16.
    - Commenting shall stop by Monday 11pm UTC, Apr. 19.
    - Formal tdocs of WF/LS/CRs/TPs shall be uploaded to the Inbox (except Cat A CRs) by Tuesday 1am UTC, Apr. 20.
  + Stage 6: Moderators provide 2nd round summary with a formal tdoc by Tuesday 9am UTC, Apr. 20.
  + Stage 7: Session chairs announce close of sessions (no later than 5pm UTC, Apr. 20). Final decisions will be captured in Chairman meeting report (to be shared after the meeting is closed)

# Topic #1: SRS antenna port switching (8.4.2.1)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2104565**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104565.zip) | MediaTek inc. | Proposal 1: Only define the interruption requirements at SRS antenna switching in FR1, unless the transient period in FR2 gets clarification in RF session.  Proposal 2: No need to define the delay requirement for SRS antenna port switching.  Observation 1: SRS antenna switching in one band will possibly influence other bands’ DL/UL.  Proposal 3: The interruption requirement should be defined based on the band combination capability reported by UE, i.e., *txSwitchImpactToRx* or *txSwitchWithAnotherBand*.  Proposal 4: Interruption requirement of SRS antenna port switching will not depend on for per-UE or per-FR gap capability.  Proposal 5: Define the interruption requirement for SRS antenna port switching based on slot level.  Observation 2: The max number of symbols for SRS in one slot is 6, including SRS resource(s) and guard period for switching among SRS ports.  Proposal 6: The SRS antenna switching time is 15us.  Proposal 7: The SRS antenna switching interruption time should be   1. SRS Transmission time (up to 6 symbols). 2. 2 \* 15us   Proposal 8: The SRS antenna switching interruption requirement should be defined based on SCSs of aggressor cell and victim cells in NR.  Proposal 9: One single requirement to cover the synchronous and asynchronous scenarios with or without UL TA.  Proposal 10: The SRS antenna switching interruption requirement should be specified as follows.  Table 2. Interruption length (slots) due to SRS antenna switch   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Victim cell SCS(KHz) | Aggressor Cell SCS (KHz) | | | | | 15 | 30 | 60 | 120 | | 15 | 2 | 2 | 2 | 2 | | 30 | 2 | 2 | 2 | 2 | | 60 | 3 | 2 | 2 | 2 | | 120 | 5 | 3 | 3 | 2 | |
| [**R4-2104694**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104694.zip) | Xiaomi | Proposal 1: RAN4 to prioritize the requirement for SRS antenna port switching in FR1.  Proposal 2: The guard period defined in TS 38.214 is considered as the antenna switching time when defining the interruption requirement.  Proposal 3: It is proposed to define the interruption requirement based on the UE capability signaling with txSwitchImpactToRx or txSwitchWithAnotherBand respectively.  Proposal 4: If the signalling of txSwitchWithAnotherBand is reported, the interruption requirement at SRS antenna switching should be the guard period defined in TS 38.214 for the aggressor CCs in the band combination.  Proposal 5: If the signalling of txSwitchImpactToRx is reported, the interruption requirement should include the guard period defined in TS 38.214 and SRS transmission time for the aggressor CCs in the band combination.  Proposal 6: RAN4 to define the interruption requirement for SRS antenna switching based on slot level.  Proposal 7: The SRS antenna switching interruption requirement for FR1 is shown as follow.  Table 1. Interruption length (slots) due to SRS antenna switching for DC   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Victim cell SCS(KHz) | Aggressor Cell SCS (KHz) | | | | | | | signalling txSwitchWithAnotherBand | | | signalling txSwitchImpactToRx | | | | 15 | 30 | 60 | 15 | 30 | 60 | | 15 | 1 | 1 | 1 | 1 | 1 | 1 | | 30 | 2 | 1 | 1 | 2 | 1 | 1 | | 60 | 3 | 2 | 1 | 4 | 2 | 1 |   Table 2. Interruption length (slots) due to SRS antenna switching for CA   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Victim cell SCS(KHz) | Aggressor Cell SCS (KHz) | | | | | | | signalling txSwitchWithAnotherBand | | | signalling txSwitchImpactToRx | | | | 15 | 30 | 60 | 15 | 30 | 60 | | 15 | 1 | 1 | 1 | 1 | 1 | 1 | | 30 | 1 | 1 | 1 | 1 | 1 | 1 | | 60 | 1 | 1 | 1 | 2 | 1 | 1 | |
| [**R4-2104758**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104758.zip) | CATT | Proposal 1: Do not define SRS antenna port switching delay requirement in RRM.  Proposal 2: No RRM requirement would be impacted by SRS antenna port switching.  Proposal 3: It may be appropriate to define the requirement only for SRS antenna port switching in FR1.  Proposal 4: The interruption requirement should base on the band combination capability (indicated by *txSwitchImpactToRx* or *txSwitchWithAnotherBand*) reporting by UE.  Proposal 5: Use same interruption set of requirements for different SRS antenna switch patterns supported by UE capability indicated in *supportedSRS-TxPortSwitch*.  Proposal 6: The interruption requirement will be defined based on slot level.  Proposal 7: The interruption time of SRS antenna port switching in FR1 includes all guard symbols, all SRS symbols transmitted on other antenna port, and only one switching time.  Proposal 8: Interruption requirement is based on the aggressor CC SCS and victim CC SCS.  Proposal 9: The interruption requirement can differentiate between sync and async cases.  Proposal 10: No need to define the UE (not) capable of per-FR gaps requirement for SRS antenna port switching in RAN4.  Proposal 11: The interruption requirements should base on sync/async case, Aggressor Cell SCS, Victim cell SCS, number of guard symbol, and number SRS symbol transmitted on other antenna port and 15us transient period for FR1. |
| [**R4-2104831**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104831.zip) | Apple | Proposal 1: Do not define SRS antenna port switching delay requirement in RRM.  Proposal 2: Regarding the impact of SRS antenna port switching to other RRM requirements, RAN4 would clarify the relaxation or applicability in those RRM requirements whose wanted DL RS or UL RS could be interrupted by SRS antenna port switching, e.g., the delay requirement could be extended if SRS antenna port switching happens during the UE procedure, or the requirement only applies when SRS antenna port switching is not colliding with the reference signal.  Proposal 3: RAN4 defines the RRM requirements for SRS antenna port switching for FR1.  Proposal 4: The interruption requirement of SRS antenna port switching should base on the band combination capability (indicated by txSwitchImpactToRx or txSwitchWithAnotherBand) reporting by UE.  Proposal 5: RAN4 uses same interruption requirement applies to different SRS antenna port switching patterns.  Proposal 6: Interruption requirement of SRS antenna port switching shall be defined based on slot level for NR victim CC and based on subframe level for LTE victim CC respectively.  Proposal 7: The components within interruption time of SRS antenna port switching in FR1 include:   * SRS antenna port switching time (transient time) * SRS transmission time * Transient time before and after SRS transmission occasion   Proposal 8: total interruption time due to SRS antenna port switching in one UL slot could be 6 symbols + 20us.  Proposal 9: Interruption requirement is based on the aggressor CC and victim CC SCS.  Proposal 10: Interruption requirement is based on the async case for the minimum requirement.  Proposal 11: No need to differentiate the requirement for the UE with or without capability of per-FR gap for SRS antenna port switching in RAN4. But in the interruption requirement applicability condition, RAN4 shall clarify that the indication of txSwitchImpactToRx or txSwitchWithAnotherBand is not allowed to indicate any band combination cross FR1 and FR2 if UE is capable of per-FR MG.  Proposal 12: the interruption requirement of SRS antenna port switching is summarized as:   |  |  |  |  | | --- | --- | --- | --- | | Victim CC SCS(kHz) | Aggressor CC SCS (kHz) | | | | 15 | 30 | 60 | | 15 (NR or LTE) | 2 | 2 | 2 | | 30 | 2 | 2 | 2 | | 60 | 3 | 2 | 2 |   Unit of interruption requirement is slot for NR and subframe for LTE. |
| [**R4-2104909**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104909.zip) | Qualcomm, Inc. | Proposal 1: Do not specify RRM requirement for FR2 SRS antenna switching. Do not specify SRS antenna switching delay requirement in RRM.  Proposal 2: The carriers being interrupted are the union of the carrier groups specified in *txSwitchImpactToRx* and in *txSwitchWithAnotherBand* that contains the SRS antenna switching carrier.  Proposal 3: No impact to NR measurement requirements relevant to measurements based on SSB/CSI-RS due to NR SRS antenna switching, as NR measurements are always prioritized.  Proposal 4: In EN-DC and NE-DC operation,   * NR SRS antenna switching colliding with E-UTRA measurement   + Interruptions on E-UTRA measurement in the interrupted carrier group are allowed due to NR SRS antenna switching, but NOT allowed due to NR SRS antenna switching for the carriers not in the interrupted carrier group.   + Additional delay can be expected on E-UTRA measurement in the interrupted carrier group when UE is configured to perform NR SRS antenna switching.   + NR SRS antenna switching is allowed to be dropped when colliding with E-UTRA measurement in the interrupted carrier group. * E-UTRA SRS antenna switching colliding with NR measurement   + Interruptions on NR measurement in the interrupted carrier group are allowed due to LTE SRS antenna switching, but NOT allowed due to E-UTRA SRS antenna switching for the carriers not in the interrupted carrier group.   + Additional delay can be expected on NR measurement in the interrupted carrier group when UE is configured to perform E-UTRA SRS antenna switching.   + E-UTRA SRS antenna switching is allowed to be dropped when colliding with NR measurement in the interrupted carrier group.   Proposal 5: Interruption time is specified in the unit of slot.  Proposal 6: Interruption time is specified based on 2 transient period and 6 symbol time.  Proposal 7: SRS antenna switch interruption is specified as the following table for NR SA. In EN-DC, interruption on LTE carrier is the same as victim SCS = 15kHz case in NR SA.   |  |  |  |  | | --- | --- | --- | --- | |  | Interruption Length (slots) | | | | Victim SCS (kHz) | 15 | 30 | 60 | | 15 | 2 | 2 | 2 | | 30 | 2 | 2 | 2 | | 60 | 3 | 2 | 2 | |
| [**R4-2104945**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104945.zip) | CMCC | Proposal 1: considering RF has defined the transient period due to SRS antenna switching, which in our understanding is the SRS switching delay, it is not necessary to define SRS antenna port switching delay requirement in RRM  Proposal 2: since UE stay connection with the serving CCs, the interruption time for SRS antenna port switching delay includes transient periods before and after SRS transmission, and it is not necessary to consider SRS transmission time.  Proposal 3: if the interruption time only includes transient periods before and after SRS transmission, and considering that the transient period specified in FR session is 15us, it is suggested to specify the interruption requirements based on slot level. |
| [**R4-2104979**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104979.zip) | NEC | Proposal 1: RAN4 to define the SRS antenna port switching delay as RF retuning time and the SRS antenna port switching delay to be contained within the (or overlapped with) transient period.  Proposal 2: If victim CC and SRS transmission on aggressor CC are transmitted on the same antenna, interruption requirement shall include SRS antenna switching in delay/TP, SRS transmission, GP, SRS antenna switching back delay/TP.  Proposal 3: If victim CC and SRS transmission on aggressor CC are transmitted on the different antenna, interruption requirement shall include SRS antenna switching in delay/TP, SRS antenna switching back delay/TP only.  Proposal 4: RAN4 to define interruption due to SRS antenna port switching in terms of symbols.  Proposal 5: For impact on other RRM requirements due to SRS antenna port switching, RAN4 shall consider SRS carrier switching as the baseline.  Proposal 6: RAN4 should first discuss and agree on timing misalignment value before discussion of SRS antenna port switch impact on gNB measurements. |
| [**R4-2104991**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104991.zip) | LG Electronics Inc. | * Observation 1: The interruption could be different according to ‘resourceType’;   + The interruption occurs per SRS-ResourceSet for ‘aperiodic’   + The interruption occurs per SRS resource for ‘periodic’ or ‘semi-persistent’ * Observation 2: The interruption requirement depends on whether Tx antenna is required to switch back after SRS transmission. * Observation 3: The interruption requirement could depend on UL-DL or UL-DL slot configuration. * Observation 4: The interruption occurs in the uplink symbols in case of flexible symbols within a slot. * Proposal 1: Do not define SRS antenna port switching delay requirement in RRM as option 1. * Proposal 2: The interruption requirement can be defined based on slot level for full uplink symbols within a slot and based on symbol level for flexible symbols with in slot. * Proposal 3: The components within interruption time is   + Time to antenna switching before SRS transmission and SRS transmission time for ‘aperiodic’ SRS-ResourceSet   + Time to antenna switching before SRS transmission for ‘periodic’ or ‘semi-persistent’ SRS-ResourceSet   + Additionally, the time to switch back after SRS transmission depending on UE behavior * Proposal 4: Interruption requirements for SRS antenna port switching are shown in Table 1 and Table 2.   Table 1 Proposed interruption requirements per *SRS-ResourceSet* ('aperiodic')   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Victim cell SCS [kHz] | Interruption length [slot] | | | | | | | Aggressor cell SCS [kHz] | | | | | | | 15 | | 30 | | 60 | | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | | 15 | 2 | 1 | 2 | 1 | 2 | 1 | | 30 | 2 | 1 | 2 | 1 | 2 | 1 | | 60 | 3 | 2 | 2 | 1 | 2 | 1 | | Case 1: UL-UL slot configuration for synchronous case, and UL-UL or UL-DL slot configuration for asynchronous case  Case 2: UL-DL slot configuration for synchronous case  Note 1: If SRS resource is configured in flexible symbols within a slot in synchronous case, the interruption requirements apply to uplink symbols. | | | | | | |   Table 2 Proposed interruption requirements per SRS resource (‘periodic’ or ‘semi-persistent’)   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Victim cell SCS [kHz] | Interruption length [slot] | | | | | | | Aggressor cell SCS [kHz] | | | | | | | 15 | | 30 | | 60 | | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | | 15 | 2 | 1 | 2 | 1 | 2 | 1 | | 30 | 2 | 1 | 2 | 1 | 2 | 1 | | 60 | 2 | 1 | 2 | 1 | 2 | 1 | | Case 1: UL-UL slot configuration for synchronous and asynchronous cases  Case 2: UL-DL slot configuration for and asynchronous cases  Note 1: If SRS resource is configured in flexible symbols within a slot in synchronous case, the interruption requirements apply to uplink symbols. | | | | | | | |
| [**R4-2106409**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106409.zip) | Nokia, Nokia Shanghai Bell | Observation1: The guard period defined in RAN1 is supposed to cause interruption on the carrier within which the UE is restricted from at least uplink transmission.  Proposal1: The interruption at SRS antenna switching shall be defined at least within the guard period in Table 6.2.1.2-1 of [2].  Proposal2: The interruption requirement shall be defined when the SRS resources of a set in a slot are configured on the symbols which separated by exactly the minimum guard period.  Proposal3: RAN4 shall discuss if the interruption requirements are defined when the SRS resources of a set in a slot are separated by a length larger than a minimum guard period.  Proposal4: Add one note indicating the DL may be affected due to SRS antenna switching if *txSwitchImpactToRx* is configured.  Proposal5: It is proposed to define the interruption requirements at SRS antenna switching only for FR1 unless the transient period in FR2 gets clarified in RF session. |
| [**R4-2106462**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106462.zip) | Intel Corporation | Proposal 1: Clarify that Current SRS antenna switching time of 15us is applied for FR2 case where SRS antenna switch in the same panel.  Proposal 2: For the case that SRS antenna switching happens between different panels for FR2, it needs further discussion whether extra ramp up timing for other panels are needed.  Proposal 3: For FR1, the interruption time will include antenna switching time, SRS transmission time after switching.  Proposal 4: The interruption requirement don’t need to differentiate between sync and async cases. |
| [**R4-2106532**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106532.zip) | OPPO | Observation 1: Define the interruption requirements of SRS antenna port switching for FR1 firstly, and further study the feasibility of FR2 cases.  Observation 2: Different impact should be considered for UE capable of per UE gap or per FR gap if FR1+FR2 SRS antenna port switching was to be specified.  Proposal 1: Do not define SRS antenna port switching delay requirement in RRM.  Proposal 2: For MR-DC, the interruption requirements should be defined for E-UTRA and NR DL carriers respectively, based on band combination capability reporting by UE.  Proposal 3: Suggest one same set of requirements for different SRS antenna switch patterns.  Proposal 4: RAN4 considers antenna switching time, SRS transmission time together with transient periods for interruption time of SRS antenna port switching.   * SRS Transmission time (up to 7 symbols). * SRS antenna switching time (15us \*2) * transient period (10us\*2)   Proposal 5: For NR SRS antenna port switching impacting LTE CC, the interruption is 2 subframes.  Proposal 6: For NR SRS antenna port switching impacting NR CC, the interruption should be specified as the following table based on the SCS of the victim CC.   |  |  |  |  | | --- | --- | --- | --- | |  | Interruption Length (slots) | | | | Victim SCS (kHz) | 15 | 30 | 60 | | 15 | 2 | 2 | 2 | | 30 | 3 | 2 | 2 | | 60 | 4 | 3 | 2 | |
| [**R4-2106881**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106881.zip) | Ericsson | Proposal 1: Define SRS antenna port switching delay requirement. FFS for the value. At least RF retuning time shall be included.  Proposal 2: Further look into performance impact on timing-based measurements from SRS antenna port switching, and if needed, identify how to mitigate performance degradation (e.g. by avoiding switching during timing-based measurements).  Proposal 3: Focus on requirements for SRS antenna port switching in FR1 firstly.  Proposal 4: Interruption requirement applicability to be further discussed.  Proposal 5: Interruption requirements for SRS antenna port switching shall be defined in OFDM symbol granularity.  Proposal 6: The interruption time for SRS antenna port switching comprises at least antenna switching time and SRS transmission time.  Proposal 7: The interruption requirements depend at least on SCS for victim cell.  Proposal 8: Different interruption requirements apply for synchronous and asynchronous cases.  Proposal 9: Potential impact of UE capability for per-FR gap on interruption requirements can be further studied once the other aspects influencing the interruption time have been settled. |
| [**R4-2106986**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106986.zip) | Huawei, HiSilicon | Proposal 1: Do not define SRS antenna port switching delay requirements in RRM.  Proposal 2: Define RRM requirements for SRS antenna switching in FR1.  Proposal 3: Define the SRS antenna switching interruption requirements in symbol level.  Proposal 4: The interruption requirement should base on the band combination capability (indicated by txSwitchImpactToRx or txSwitchWithAnotherBand) reporting by UE.  Proposal 5: Discuss the impact of SRS antenna switching on positioning related measurement in Rel-17 position session. |
| [**R4-2107079**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107079.zip) | vivo | Observation 1 So far the SRS antenna port switching feature only has impact on FR1 requirements.  Observation 2 RAN1 spec has only specified gaps between SRSs, while the transient period in RAN4 RF spec covers the case of potential separation between SRS and PUSCH/PUCCH.  Observation 3 Similar to what was discussed for transient periods in RF session in R16, 15us for SRS antenna switching delay can be a loose requirement for some higher capability UE.  Proposal 1 Specify SRS antenna port switching delay requirements in R17 for FR1.  Proposal 2 For SRS antenna port switching delay, RAN4 should consider to specify UE capability to differentiate the needed minimal separation between SRSs and/or between SRS-PUSCH/PUCCH, similar to the transient period capability defined in R16.  Proposal 3 Do not consider impact to timing measurements in R17 SRS antenna port switching.  Proposal 4 Do not specify any requirements for FR2 in R17 SRS antenna port switching, unless if some clarification to the use cases can be made.  Proposal 5 Send LS to RAN1 to check the prioritization rule for SRS antenna switching, especially for the case in CA/DC operation.  Proposal 6 The interruption requirements should be based on the band combination capability (indicated by txSwitchImpactToRx or txSwitchWithAnotherBand) reporting by UE.  Proposal 7 If UE indicates that in the corresponding band the Rx or Tx is impacted by antenna port switching, then only the corresponding band is allowed to be interrupted when UE is configured to switch SRS antenna port.  Proposal 8 Do not refer antenna switching patterns in the spec when defining SRS antenna switching interruption requirements.  Proposal 9 The interruption requirement is preferred to be defined based on slot level.  Proposal 10 The interruption requirement is preferred to be defined without differentiating sync and async case, at least in R17.  Proposal 11 For interruption requirements, the interruption time is preferred to include antenna switching time and SRS transmission time.  Proposal 12 For interruption requirements, the interruption time is preferred to be based on the aggressor CC and victim CC SCS.  Proposal 13 RAN4 should firstly study whether and how network can obtain the interrupted symbol information, when SRS antenna port switching is performed in another band. |

## 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: Scope of SRS antenna switching requirement

*Sub-topic description:*

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

**Issue 1-1-1: whether delay requirement would be defined in RRM for SRS antenna port switching**

* Proposals
  + Option 1 (MTK, CATT, Apple, QC, CMCC, LGE, OPPO, HW, Xiaomi): Do not define SRS antenna port switching delay requirement in RRM.
  + Option 1a (Nokia): Do not define SRS antenna port switching delay requirement in RRM if only RF returning time is considered.
  + Option 2 (NEC, Ericsson, vivo): Define SRS antenna port switching delay requirement in RRM
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| --- | --- |
| **Company** | **Comments** |
| Apple | The transient time has already been defined in RF spec and no need to capture that in RRM spec. |
| LG | Support option 1 for FR1. Further discussion might be needed for FR2. |
| OPPO | No. The antenna port switching time has been defined in RF. |

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| Huawei | Support option 1. |

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| --- | --- |
| Xiaomi | Support Option 1. |
| QC | Support option 1. Switching delay, if specified, will be the same as on-off mask in RF, no need to repeat specification. |
| vivo | Support option 2.  We see differences between RF transient period and the potential SRS antenna switching delay.  1. RF transient period is specified as a window where EVM can be relaxed. However, delay requirement normally refers to a window that scheduling and configurations needs to skip.  2. As discussed in RF session, transient period specified in RF session does not necessarily means scheduling on that period needs to avoided. It can be up to network implementation. However, for the SRS antenna switching, UE may not transmit any signal during the switching period, and therefore gap is needed. Such gap is already specified in RAN1 spec for the case of between SRSs, but it is not clear for the case of between SRS and PUSCH/PUCCH.  3. For RF transient period, there is no difference on the definition between the case of same port transient period and different port transient period. Only the length is different. That may cause confusion, especially for the interruption requirements are going to be defined. Of course we are not going to define interruption for all the cases of transient period.  Regarding the test method to test such symbol-level delay requirement, in our view RAN4 can work on new testing methodology for this. It is fine to reuse the test methodology for EVM testing in RF session. It is also possible if no test case is defined for such delay requirement since it is only a background information for the potential interruption. |
| CATT | Support option 1. |
| Nokia | We are basically fine with Option 1 but would like to add some condition:   * Option 1a: Do not define SRS antenna port switching delay requirement in RRM if only RF returning time is considered.   In our views, if only RF retuning time is considered, it is captured in transient period defined in RF. There is no need to define SRS antenna switching delay requirement in RRM. But we are open to discuss if other elements are identified further extending the switching delay. |
| MediaTek | Support option 1. The transient time has already been defined in RF session. |
| NEC | Support option 2. In RF specification, it is specified as transition period. Our understanding is it is not specified as transient period=SRS antenna switching delay. For better clarification we prefer specifying it in RRM spec. |

**Issue 1-1-2: RAN4 defines the requirement only for SRS antenna port switching in FR1 or in both FR1 and FR2**

* Proposals
  + Option 1 (MTK, Xiaomi, CATT, Apple, QC, Nokia, OPPO, Ericsson, HW, vivo): define the RRM requirements of SRS antenna switching in FR1.
  + Option 2 (Intel): SRS antenna port switching in FR1 and FR2 are considered
* Recommended WF
  + Agreement: Define the RRM requirements at SRS antenna switching only for FR1 unless the transient period in FR2 gets clarified in RF session (the scope of “RRM requirements” here depends on the conclusions from issue 1-1-1)
* 1st round Comment collection:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Support Option 1 and can also agree with the recommended WF. |
| LG | Support recommended WF |
| OPPO | Agree with the recommended WF. Define the requirements of SRS antenna port switching for FR1 firstly, and further study the feasibility of FR2 cases. |
| Huawei | Support Option 1 and can also agree with the recommended WF. |
| Xiaomi | Support the recommended WF. |
| QC | Support the recommended WF. |
| vivo | Support the recommended WF. |
| CMCC | OK with the recommended WF |
| Ericsson | Support the recommended WF. |
| CATT | Support the recommended WF. |
| Intel | We are fine with the recommended WF. |
| Nokia | We support the recommended WF. |
| MediaTek | Support moderator’s suggestion |
| NEC | We are OK with recommended WF |

**Issue 1-1-3: Impact of SRS antenna port switching to other RRM requirements**

* Proposals
  + Option 1 (CATT): No RRM requirement would be impacted by SRS antenna port switching.
  + Option 2 (Apple, OPPO, Ericsson): Regarding the impact of SRS antenna port switching to other RRM requirements, RAN4 would clarify the relaxation or applicability in those RRM requirements whose wanted DL RS or UL RS could be interrupted by SRS antenna port switching, e.g., the delay requirement could be extended if SRS antenna port switching happens during the UE procedure, or the requirement only applies when SRS antenna port switching is not colliding with the reference signal.
  + Option 3 (QC, Apple, vivo, Xiaomi):
    - No impact to NR measurement requirements relevant to measurements based on SSB/CSI-RS due to NR SRS antenna switching, as NR measurements are always prioritized.
    - In EN-DC and NE-DC operation,
      * NR SRS antenna switching colliding with E-UTRA measurement
        + Interruptions on E-UTRA measurement in the interrupted carrier group are allowed due to NR SRS antenna switching, but NOT allowed due to NR SRS antenna switching for the carriers not in the interrupted carrier group.
        + Additional delay can be expected on E-UTRA measurement in the interrupted carrier group when UE is configured to perform NR SRS antenna switching.
        + NR SRS antenna switching is allowed to be dropped when colliding with E-UTRA measurement in the interrupted carrier group.
      * E-UTRA SRS antenna switching colliding with NR measurement: FFS
  + Option 4 (NEC): For impact on other RRM requirements due to SRS antenna port switching, RAN4 shall consider SRS carrier switching as the baseline. RAN4 should first discuss and agree on timing misalignment value before discussion of SRS antenna port switch impact on gNB measurements.
  + Option 5(Nokia): Add one note indicating the DL may be affected due to SRS antenna switching if *txSwitchImpactToRx* is configured.
  + Option 6 (Ericsson): Further look into performance impact on timing-based measurements from SRS antenna port switching, and if needed, identify how to mitigate performance degradation (e.g. by avoiding switching during timing-based measurements).
  + Option 7 (vivo, Huawei, CATT): Do not consider impact to timing measurements in R17 SRS antenna port switching.
  + Option 8 (Nokia, NEC) : TBD after the interruption of SRS antenna port switching is clarified
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| --- | --- |
| **Company** | **Comments** |
| Apple | Support option 2. But we can agree with part of option3: NR measurement could be prioritized, like what we agreed in SRS carrier based switching requirement, and NR SRS antenna port switching could cause interruption to LTE indicated by *txSwitchImpactToRx* or *txSwitchWithAnotherBand* in case of EN-DC or NE-DC mode; but we need to further check the interruption from LTE antenna port switching to NR measurement since LTE SRS antenna port switching is not the motivation of this WID. |
| OPPO | Agree with option 2 in principle. The requirements for collision can be similar to those for SRS carrier-based switching requirements. For SA mode, NR measurements could be prioritized. For EN-DC/NE-DC, FFS whether and how to define the requirements, including the priorities of NR SRS antenna switching vs. E-UTRA measurement, E-UTRA SRS antenna switching vs. NR measurement. |
| Huawei | For option 2, it seems the transmission of SRS is prioritized. However, if we take SRS carrier switching as the baseline, thing are not always like that. E.g. for NR measurement, the SRS transmission is dropped. For impact on timing requirements, we can agree with option 7. |
| Xiaomi | Option 3 is fine to us. We should follow the same principle in the SRS carrier switching requirements. |
| QC | To Apple: we can leave the LTE antenna port switching part as FFS. |
| vivo | Generally we support option 3, except that we think LTE antenna port switching is NOT within the scope. Option 7 is related to issue 1-1-4.  We are not sure whether the issue discussed here needs to consider some of the issues discussed in 1-4-2.  We agree with most companies that NR SRS antenna switching should not be prioritized over NR measurements, as what RAN4 has done for SRS carrier switching.  Additionally, it seems R15 SRS antenna switching only considers the single CC scenario, and the cases under CA and DC are not considered. Therefore, when discussing interruption requirements, we also think the issues for other channel/signal needs to be discussed:  • PUSCH/PUCCH transmission with priority index 1 or DL pre-emption transmission  • PUSCH/PUCCH transmission carrying HARQ-ACK/positive SR/RI/CRI/SSBRI and/or PRACH  • PUSCH transmission carrying aperiodic CSI (if periodic/semi-persistent SRS resources are configured)  For these channels/signals, the principle for R16 SRS carrier switching can be baseline. |
| Ericsson | We support option 2 and option 6. The basic principle is that SRS antenna port switching will impact RRM requirements including those requirements which uses SRS signals (e.g. positioning measurement requirements). RAN4 need further analysis on detailed impact.  If companies want to avoid any impact on RRM measurement requirements then we need to define UE behavior for SRS antenna switching e.g. SRS antenna switching is delayed to avoid performance degradation or interruption on RS used for measurements (SSB, CSI-RS, PRS etc). |
| CATT | We think the SRS antenna port switching should have no impact on the UL timing measurement.  Firstly, Tx timing may be different between different antenna ports. But this timing difference should be less than 1ns and can be ignored. Secondly, the UL timing should be measured on UL signal or SRS on normal antenna port rather than the switched antenna port and UE should switch to the normal antenna port. So the timing measurement and corresponding requirements should not be impacted by SRS antenna port switching.  For other RRM requirements, if the SRS antenna switching is colliding with SSB, it may have impact and depend on the issue 1-2-1. |
| Nokia | We think the impact to other RRM requirements shall be discussed after the interruption are clarified. Only after we understand on which carrier and where the interruption would happen, it is able to identify if the RRM measurements on the carrier are impacted. |
| NEC | We share similar view as Nokia. We need to agree on SRS antenna switching delay and interruption length. |

**Issue 1-1-4: Impact of SRS antenna port switching to positioning related requirements**

* Proposals
  + Option 1 (Huawei, Apple, OPPO, Xiaomi, QC, vivo, CATT): Discuss the impact of SRS antenna switching on positioning related measurement in Rel-17 position session.
  + Option 2 (Nokia): Discuss the impact of SRS antenna switching on positioning related measurement in this Rel-17 FeRRM.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | We are fine to not discuss this impact to positioning measurement in FeRRM WI. |
| OPPO | Option 1 is fine. |
| Huawei | Support option 1. |
| Xiaomi | Support Option 1. |
| QC | Support option 1. |
| vivo | We share same view as option 1. |
| Ericsson | The impact of SRS antenna switching on positioning related measurement need to be analysed. If companies want to discuss it under Rel-17 position WI is also fine. But there should be clear agreement that this will be addressed in positioning WI. |
| CATT | Fine with option 1. |
| Nokia | This also relates to the impact on other RRM measurements due to SRS antenna switching. We think this shall be discussed after the basic interruption are clarified. |

### Sub-topic 1-2: Interruption requirement applicability

*Sub-topic description*

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

**Issue 1-2-1: Interruption requirement applicability**

* Proposals
  + Option 1 (MTK, Xiaomi, CATT, Apple, QC, OPPO, HW, vivo, LGE, CMCC, Ericsson, Intel, Nokia, MTK, NEC): The interruption requirement should be defined based on the band combination capability reported by UE, i.e., *txSwitchImpactToRx* or *txSwitchWithAnotherBand*.
    - Option 1a (vivo, Apple, OPPO, Nokia):
      * The interruption requirement should be defined based on the band combination capability reported by UE, i.e., *txSwitchImpactToRx* or *txSwitchWithAnotherBand*.
      * If UE indicates that in the corresponding band the Rx or Tx is impacted by antenna port switching, then only the corresponding band is allowed to be interrupted when UE is configured to switch SRS antenna port
    - Option 1b (QC): SRS antenna switching interruptions on both DL and UL applies to the band combinations signaled in *txSwitchImpactToRx* or *txSwitchWithAnotherBand*.
  + Option 2 (Ericsson): Interruption requirement applicability to be further discussed.
* Recommended WF
  + Continue discussion on option 1 and option 1b, and agreements would be captured in the WF.
* 1st round Comment collection:

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| --- | --- |
| **Company** | **Comments** |
| Apple | Both option 1 and option 1a are fine to us. |
| LG | Support option 1. |
| OPPO | OK with option 1 and 1a. |
| Huawei | Support option 1. |
| Xiaomi | Support Option 1. |
| QC | We support option 1, but our proposal is that the interrupted carriers are the union of the ones specified in *txSwitchImpactToRx* and *txSwitchWithAnotherBand* |
| vivo | Support Option 1 and 1a. |
| CMCC | We are OK with option 1 and 1a. |
| Ericsson | We are fine with Option 1. |
| CATT | Support option 1. |
| Intel | Support option 1. |
| Nokia | We are fine with Option1 and also Option1a.  We assume this does not preclude other factors e.g. guard period which need also be taken into account when defining the interruption requirements. |
| MediaTek | Support option 1 |
| NEC | We are OK with Option 1. |

**Issue 1-2-2: whether same interruption requirement applies to different SRS antenna port switching patterns**

* Proposals
  + Option 1 (CATT, Apple, OPPO, vivo, Huawei, Xiaomi, QC, Intel, MTK): use same set of requirements for different SRS antenna switch patterns
  + Option 2 (LGE): The interruption could be different according to ‘resourceType’.
* Recommended WF
  + TBA
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Support option 1. In our understanding, we could use the same philosophy from SRS carrier switching requirement, i.e., define a generic minimum requirement regardless of the switching pattern. Differentiating SRS switching patterns in the requirement may not result in different interruption requirement in terms of slot (ACK/NACK) loss. |
| LG | The same interruption requirement could be used for different SRS antenna port switching patterns such as 1T2R, 2T4R, and 1T4R. However, depending on ‘resourceType’ for SRS resource set such as aperiodic, periodic, or semi-persistence, interruption requirement could be different since SRS resource(s) for antenna switching could be configured within or different slot. |
| OPPO | Support option 1. We consider the minimum requirement regardless of the switching pattern. |
| Huawei | Support option 1. It is suggested to define the interruption per resource. |
| Xiaomi | Support option 1. As RAN4 always consider the worst case, it is reasonable to use same set of requirements for different SRS antenna switch patterns. |
| QC | Support option 1 |
| vivo | Support option 1. This is related to issue 1-3-1. It is better if we can agree on issue 1-3-1 first. |
| Ericsson | Before concluding, RAN4 should study this more carefully the difference between interruptions due to different patterns. |
| CATT | Support option 1. |
| Intel | Support option 1. One requirement is applied for different patterns. |
| Nokia | We would like to clarify what “switch patterns” means. Does it refer to 1T2R, 1T4R as indicated by *srs-TxSwitch*, or some other configuration/parameters?  If it refers to srs-TxSwitch, it seems no need to define separate interruption requirements. But we see some difference dependent on how SRS resources are configured within one slot. |
| MediaTek | Support option1. To be simple, one requirement could be considered. |
| NEC | Looking at LG comments, we think further clarification/discussion is required on the issue. |

**Issue 1-2-3: Would the interruption requirement based on different SCS?**

* Proposals
  + Option 1 (MTK, Xiaomi, CATT, QC, LGE, OPPO, vivo, Apple, CMCC, Ericsson, Intel, Nokia, NEC): Interruption requirement is based on the aggressor CC and victim CC SCS.
  + Option 2 (Ericsson): The interruption requirements depend at least on SCS for victim cell.
* Recommended WF
  + Agreement: Interruption requirement is based on the aggressor CC and victim CC SCS.
* 1st round Comment collection:

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| --- | --- |
| **Company** | **Comments** |
| Apple | Support option 1. |
| LG | Support option 1 |
| OPPO | Support option 1 |
| Xiaomi | Support option 1 |
| QC | Support option 1 |
| vivo | Support option 1 |
| CMCC | OK with option 1. |
| Ericsson | We are fine with Option 1. |
| CATT | Support option 1. |
| Intel | Support option 1 |
| Nokia | We support Option 1.  In our view, the interruption should at least consider the guard period where the length is defined based on the SCS of aggressor cell. And then the interruption on victim cells are translated into number of slots based on SCS of victim cell. |
| MediaTek | Support option 1 |
| NEC | OK with option 1. |

**Issue 1-2-4: Would the interruption requirement differentiate between sync and async cases?**

* Proposals
  + Option 1 (MTK, Apple, Intel, vivo, OPPO, Xiaomi, QC): No; one single requirement to cover the synchronous and asynchronous scenarios with or without UL TA.
    - Option 1a (Apple, Xiaomi, QC): No, interruption requirement is based on the async case for the minimum requirement.
  + Option 2 (CATT, Ericsson, LG, Nokia, NEC): Yes, the interruption requirement can differentiate between sync and async cases.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| --- | --- |
| **Company** | **Comments** |
| Apple | Support option 1 and option 1a. We still believe the same assumption from SRS carrier-based switching could be used in this case since the TA between UL and DL and the MTTD needs to be considered. |
| LG | Support option 2. Interruption length would be different according to MTTD for sync and async. |
| OPPO | Support option 1 |
| Huawei | Companies should first consider whether there is significant difference between synchronous and asynchronous cases. For existing interruption requirements, one additional slot is allowed for async case as the interruption time may partially overlaps with the slots of victim CCs. But for SRS AS, the switching time is located before and after the SRS resources, which means even in sync cases, the interruption time is also misaligned with the slots of victim CCs. |
| Xiaomi | Option 1 and Option 1a are both fine to us. |
| QC | Support option 1 and 1a, also agree with Huawei’s comment. The transient time is needed “after” SRS transmission, which can interrupt the next slot even if carriers are aligned and no TA is added. |
| vivo | Option 1. This is related to issue 1-3-1. It is better if we can agree on issue 1-3-1 first. |
| Ericsson | Support Option 2. Then if we find out later that it would not matter, we can merge. But up until then we would like to look into two sets of requirements, one for sync and one for async. |
| CATT | Support option 2. The number of interrupted slots will be different for sync and async cases. |
| Intel | Support option 1. |
| Nokia | We support Option 2.  At least we should firstly conclude on the interruption length in async and sync cases respectively, and check the difference in-between before we could merge them. |
| MediaTek | Support option 1. One additional slot would be consider for TA. Thus, no need to differentiate between sync and async cases. |
| NEC | Support option 2 at least till RAN4 agrees interruption granularity. |

**Issue 1-2-5: Interruption requirement for UE with or without per-FR MG capability**

* Proposals
  + Option 1 (MTK, CATT, HW, vivo, Ericsson, Intel): Interruption requirement of SRS antenna port switching will not depend on for per-UE or per-FR gap capability.
  + Option 2 (Apple, OPPO, Xiaomi): No need to differentiate the requirement for the UE with or without capability of per-FR gap for SRS antenna port switching in RAN4. But in the interruption requirement applicability condition, RAN4 shall clarify that the indication of *txSwitchImpactToRx* or *txSwitchWithAnotherBand* is not allowed to indicate any band combination cross FR1 and FR2 if UE is capable of per-FR MG.
  + Option 3 (OPPO): Different impact should be considered for UE capable of per UE gap or per FR gap if FR1+FR2 SRS antenna port switching was to be specified.
  + Option 4 (Ericsson, Nokia, NEC): Potential impact of UE capability for per-FR gap on interruption requirements can be further studied once the other aspects influencing the interruption time have been settled.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Option 2. We think RAN4 still needs to clarify that the indication of *txSwitchImpactToRx* or *txSwitchWithAnotherBand* is not allowed to indicate any band combination cross FR1 and FR2 if UE is capable of per-FR MG; otherwise, it could have confliction between per-FR MG capability and this SRS interruption capability, e.g., UE supports per-FR MG but still indicates interruption between FR1 CC and FR2 CC in *txSwitchImpactToRx* or *txSwitchWithAnotherBand*. |
| OPPO | Support option 2 and 3. The applicability of interruption for UE capable of per UE or per FR gap should be clarified for FR1+FR2 band combination.  For example, if UE is capable of per FR gap, no interruption of SRS antenna port switching is allowed; Otherwise, the interruption requirements can apply. |
| Huawei | Option 1. We should carefully consider the relation between the per-FR gap and the other RRM requirements since the overloading issue has been discussed since Rel-16. |
| Xiaomi | Support Option 2. We think there is no need to differentiate the requirement for the UE with or without per-FR gap capability for SRS antenna port switching. It is good to have clear clarification. |
| QC | Support option 1. The interrupted carriers are signaled in the two IEs as mentioned in option 2, no need to consider per-FR/per-UE. For option 2, putting limitation on RAN2 defined signaling requires more study. |
| vivo | Option 1. Do not see the necessity to define any restriction. This can be left to UE implementation. Current spec is fine. |
| Ericsson | We are fine with Option 1. |
| CATT | Support option 1. Share the same view as QC. |
| Intel | Prefer option 1. the two IEs has already specify impacted carriers. |
| Nokia | We support Option 4. |
| MediaTek | Support option 1. But we can further study for option 2. |
| NEC | We support option 4 at this stage. |

### Sub-topic 1-3: Interruption requirement design

*Sub-topic description*

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

**Issue 1-3-1: The interruption requirement is defined based on slot level or symbol level**

* Proposals
  + Option 1 (MTK, Xiaomi, CATT, Apple, QC, vivo, OPPO, Huawei, Intel): based on slot level
  + Option 2 (CMCC): if the interruption time only includes transient periods before and after SRS transmission, and considering that the transient period specified in FR session is 15us, it is suggested to specify the interruption requirements based on symbol level.
  + Option 3 (LGE, Huawei, Ericsson): The interruption requirement can be defined based on slot level for full uplink symbols within a slot and based on symbol level for flexible symbols with in slot.
  + Option 4 (NEC, Ericsson, HW, CMCC, Nokia): based on symbol level
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| --- | --- |
| **Company** | **Comments** |
| Apple | Support option 1, considering the uncertain TA and MTTD. Furthermore, the legacy interruption requirement would be verified by the ACK/NACK loss which is also a slot level loss, and we prefer to reuse the same philosophy from SRS carrier based switching. |
| LG | Support option 3. At least synchronous case, when SRS antenna switching is performed in the slot composed of flexible symbols (DL / UL symbols), it would have no impact on DL symbols in the slot. So symbol level interruption could be considered. |
| OPPO | Option 1, slot level is preferred. |
| Huawei | Considering the switching time which is even shorter than 1 OFDM symbol, the slot level interruption means resource some slot is wasted even most of symbols are not affected. But we also agree that is hard to verify the performance in the test if the symbol level interruption is defined. Prefer option 3 but could compromise to option 1. |
| Xiaomi | Support Option 1. |
| QC | We understand the concern raised by Huawei for resource utilization. Ideally if gNB can dynamically filling out resource in symbol level according to SRS antenna switching scheduling, symbol level interruption specification will be helpful. But based on our understanding, the implementation complexity is pretty high to achieve such dynamic scheduling.  If in practice gNB mostly manages the resource during SRS antenna switching in slot level, we believe option 1 is more reasonable. |
| vivo | Prefer option 1. It is difficult to make any synchronization assumption for both the sync case and async case, and therefore it is more realistic to define slot-level based interruption.  Regarding option 3, maybe clarification is needed. Whether ‘full symbols’ or ‘flexible symbols’ refers to the aggressor CC or the victim CC or both. |
| CMCC | We support option 4. We made a typo in the proposal of our contribution, sorry for the inconvenience. |
| Ericsson | Our preference is Option 3 or 4. |
| CATT | Support option 1. We think the data block coding is defined generally with some PRB in full slot. The HARQ feedback of UE receiving data is also based on data block decoding. The interruption requirements are tested generally using UE ACK/NACK feedback in the test case. So the requirement is better to be defined in slot level. If it is defined based on symbol level, the test cases should be redesigned and more complexity will be introduced. |
| Intel | Fine with option 1, if the requirement is applied when UE is allowed to cause interruption to other active serving cells. |
| Nokia | We support Option 4.  Considering guard period is only 1 symbol length in FR1, the network performance will be degraded if the whole slot is restricted from any scheduling. And we already defined interruption in unit of symbols for Tx switching in Rel16. We can apply the same to SRS antenna switching. |
| MediaTek | Support option 1. The symbol level interruption is introduced due to the frequent switching within a slot for Tx switching. However, we do not see the reason to define SRS antenna switching based on symbol level. |
| NEC | We support option 4. RAN1 defined guard period already in OFDM symbol level. Since interruption is of same granularity, we support defining in terms of OFDM symbols. |

**Issue 1-3-2: The components within interruption time of SRS antenna port switching in FR1**

* Proposals
  + Option 1 (MTK, Intel, vivo, Apple, Huawei, Ericsson): includes antenna switching time and SRS transmission time
    - Option 1a(Ericsson): The interruption time for SRS antenna port switching comprises at least antenna switching time and SRS transmission time.
  + Option 2 (Xiaomi): The guard period defined in TS 38.214 is considered as the antenna switching time when defining the interruption requirement.
    - If the signalling of *txSwitchWithAnotherBand* is reported, the interruption requirement at SRS antenna switching should be the guard period defined in TS 38.214 for the aggressor CCs in the band combination.
    - If the signalling of *txSwitchImpactToRx* is reported, the interruption requirement should include the guard period defined in TS 38.214 and SRS transmission time for the aggressor CCs in the band combination.
  + Option 3 (CATT): The interruption time of SRS antenna port switching in FR1 includes all guard symbols, all SRS symbols transmitted on other antenna port, and only one switching time.
  + Option 4 (Apple, OPPO, QC, vivo, Intel, MTK): The components within interruption time of SRS antenna port switching in FR1 include:
    - SRS antenna port switching time (transient time)
    - SRS transmission time
    - Transient time before and after SRS transmission occasion
  + Option 5 (CMCC):
    - Since UE stay connection with the serving CCs, the interruption time for SRS antenna port switching delay includes transient periods before and after SRS transmission, and it is not necessary to consider SRS transmission time.
  + Option 6 (NEC):
    - If victim CC and SRS transmission on aggressor CC are transmitted on the same antenna, interruption requirement shall include SRS antenna switching in delay/TP, SRS transmission, GP, SRS antenna switching back delay/TP.
    - If victim CC and SRS transmission on aggressor CC are transmitted on the different antenna, interruption requirement shall include SRS antenna switching in delay/TP, SRS antenna switching back delay/TP only.
  + Option 7 (LGE):
    - The components within interruption time is
      * Time to antenna switching before SRS transmission and SRS transmission time for ‘aperiodic’ SRS-ResourceSet
      * Time to antenna switching before SRS transmission for ‘periodic’ or ‘semi-persistent’ SRS-ResourceSet
      * Additionally, the time to switch back after SRS transmission depending on UE ehaviour
  + Option 8 (Nokia):
    - The interruption at SRS antenna switching shall be defined at least within the guard period in Table 6.2.1.2-1 of [TS38.214].
      * The interruption requirement shall be defined when the SRS resources of a set in a slot are configured on the symbols which separated by exactly the minimum guard period.
      * RAN4 shall discuss if the interruption requirements are defined when the SRS resources of a set in a slot are separated by a length larger than a minimum guard period.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| --- | --- |
| **Company** | **Comments** |
| Apple | Option 1 and option 4 is quite similar. We think the SRS transmission time and transient time shall be counted in, and transient time includes transient before and after SRS occasion and transient between SRS symbols. Eventually, the total time could be 6 symbols for SRS transmission time and two transient times. |
| LG | For ‘aperiodic’ SRS-ResourceSet, SRS transmission time and SRS antenna switching time could be considered since SRS resources are within a slot. However, if single SRS resource within a slot in case of ‘periodic’ or ‘semi-persistence’ SRS-ResourceSet, only SRS antenna switching time could be considered.  Additionally, RAN4 needs to clarify the UE behavior for SRS antenna port switching whether UE should switch back after SRS transmission. |
| OPPO | Support option 4 |
| Huawei | Support option 1. |
| Xiaomi | We prefer to define the interruption time according to *txSwitchImpactToRx* and *txSwitchWithAnotherBand* separately.  For UE reporting *txSwitchWithAnotherBand*, the interruption occurs in the UL band only when the SRS antenna port is switching.  For UE reporting *txSwitchImpactToRx*, the DL band is interrupted by other switching UL band(s) and the interruption time should include the SRS antenna port switching time and SRS transmission time. |
| QC | We support option 4. The only difference between option 1 and 4 is “Transient time before and after SRS transmission occasion”. We suggest checking the supporter of option 1 and see if they can agree addition of this transient time, then combine option 1 and 4.  For option 2,3,5,6,7 the common issues is that these options fail to specify a meaningful interruption requirement for the SRS antenna switching pattern T0-T1-T0, which involves two antenna port switches with one SRS symbol in between.   * Besides the correctness of the principle in option 2, the interruption requirement specified based on option 2 might be complicated. Consider a switching pattern of Tx0 -Tx1-Tx0. There are two antenna switches and one SRS symbol in between. How do we specify this interruption based on option 2, for the two groups specified by the two IEs? * For option 3, it is based on the example explained in CATT’s contribution R4-2104758. We saw the following issues (1) going back from y to x requires guard symbol (2) according to RF spec, there is a transient period between PUSCH and SRS. * For option 5, if SRS transmission is T0-T1-T0, can gNB utilize the transmission time of the two T0s and one T1, while still avoid the two switch periods between T0 and T1? * For option 6, (1)instead “one the same/different” antenna, RAN4 should use the RAN2 IEs to determine interruption. (2)Another issue is if there is two consecutive antenna switching, we don’t understand in practice how gNB can utilize the SRS symbol time in between, when the alignment between carriers and between UL and DL are not guaranteed, and possibly victims/aggressor are not with the same SCS. We also believe that a TDD pattern with 2 or 3 UL symbols with flexible or DL symbols in between each UL symbol is not a common configuration, which is the only pattern that might be able to utilize the SRS symbol time in between antenna switches and the interruption specified in the unit of symbol.   For option 8, we suggest that RAN4 can conclude that no more than minimum guard period between SRS antenna switching symbols is allowed. |
| vivo | We prefer option 1 but is ok with option 4. We are not sure about the definition of SRS switching time and the transient time, since only transient period is defined RF spec and gap is defined in RAN1 spec. Therefore we think some clarification to requirement is needed as we discussed in issue 1-1-1. |
| CMCC | We agree that transient periods need to be considered. But for SRS transmission, since UE stay connection with the serving CCs, in our view, there is no interruption during this period. We just want to check companies’ views and have clear understanding on whether data transmission is impacted or not during the SRS transmission period. As for the total length of interruption, and whether it is specified in slot level or symbol level, it can be discussed separately. |
| Ericsson | We support option 1a but option 1 which is broader is also fine |
| CATT | Support option 3. If UE need to switch back and the switching also need guard symbols, then we suggest the interruption requirements should be 2\*guard symbol(s)+SRS transmission time. The switching time should be included in the guard symbols i.e. the switching occurs in the guard period. |
| Intel | Fine with option 1 and option 4. |
| Nokia | We support Option 8.  We may need start from specific configuration scenarios to clarify how the interruption would be. Especially for those scenarios where there is no clear reference from RAN1/RF, we may discuss if we shall define the interruption requirements in Rel17. |
| MediaTek | Option 1 and 4. Share the same view as Apple, i.e., the total time could be 6 symbols for SRS transmission time and two transient times (before and after SRS occasion). |
| NEC | Firstly we need to confirm SRS antenna switch delay is equal to transient period and contains within or outside of transient period. Looking at option 4, our understanding is antenna switching time is outside of transient period.  We also need to clarify the terminology a bit here. Does SRS antenna transmission including SRS symbols and in between Guard period? Or only SRS symbols.  As we discussed in our paper when same antenna or different antenna are used on aggressor and victim CC, interruption requirement could be different. May be we should further study how to capture them.  At this stage we support option 6. |
| QC | One question to proponent of option 2,3,5,6,7:  For option 2,3,5,6,7, when there is a SRS antenna switching pattern as T0-T1-T0, then if the interruption time exclude the T1 SRS symbol transmission time, is it possible for gNB to utilize the SRS symbol transmission time to schedule anything on other carriers? If transient period before and after SRS transmission is taken into consideration, even in this case: T0-T1, the transient period before and after SRS transmission and the antenna switching guard period in between T0 and T1 becomes 3 non-consecutive interruptions. Is it possible for gNB to utilize the SRS symbol transmission time to schedule anything on other carriers?  Excluding SRS transmission time in interruption calculation implies that there could be multiple non-consecutive interruptions in the same slots. Before discussing this methodology to specify the interruption requirement, the proponents of these option should first clarify: **how gNB utilize the resource in between multiple non-consecutive interruptions within 1 slot?**  If gNB can’t utilize the resource, the SRS transmission in between these non-consecutive interruptions, RAN4 should consider these non-consecutive interruptions in a slot as one single interruption period and the SRS transmissions in between are included. |

**Issue 1-3-3: if option 1 or option 4 is adopted in issue 1-3-2, details of the interruption time in FR1**

* Proposals
  + Option 1 (MTK, QC, Apple, LG, OPPO, Huawei, vivo): Interruption time is specified based on 2 transient period (2\*15us) and 6 symbol time
  + Option 2 (Apple): Interruption time is specified based on 2 transient period (2\*10us) and 6 symbol time
  + Option 3 (OPPO): Interruption time is specified based on SRS Transmission time (up to 7 symbols), SRS antenna switching time (15us \*2) and transient period (10us\*2)
  + Option 4 (Ericsson, CATT, Nokia, NEC): depends on the conclusions from other issues.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Fine with option 1. |
| LG | Support option 1, and further check whether transient period time after SRS transmission should be counted. |
| OPPO | OK with either option 1 or option 3. |
| Huawei | We are fine with option 1. |
| QC | Support option 1. |
| vivo | Generally we are fine with the principle of option 1. |
| Ericsson | In FR1 the transient time is 10 us. Therefore the interruption due to transient/switching should be 2\*10µs.  The SRS transmission time need further investigation as it may depend on other aspects in issues 1-2-2 (patterns) and 1-2-4 (sync vs async). |
| CATT | Depending on the issue 1-3-2. And we think the switching time should be included in the guard symbols, but we don’t know where the transient period exactly located in the guard symbols, so all the guard symbols should be considered. |
| Nokia | We shall conclude on the components of interruption before discussing the concrete values. |
| MediaTek | Support option 1 |
| NEC | Depends on other issue conclusion. We prefer discussing it at later stage. |

**Issue 1-3-4: If option 2 in issue 1-1-2 is adopted, the components within interruption time of SRS antenna port switching in FR2**

* Proposals
  + Option 1 (Intel):
    - Clarify that Current SRS antenna switching time of 15us is applied for FR2 case where SRS antenna switch in the same panel.
    - For the case that SRS antenna switching happens between different panels for FR2, it needs further discussion whether extra ramp up timing for other panels are needed.
* Recommended WF
  + Based on the conclusion in issue 1-1-2, this issue can be skipped
* 1st round Comment collection:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | We prefer to only discuss SRS antenna port switching in FR1 only, but can wait the conclusion from issue 1-1-2. |
| LG | Support recommended WF |
| OPPO | Support recommended WF |
| Xiaomi | Support recommended WF |
| QC | Same comment as Apple |
| vivo | Support recommended WF |
| Ericsson | Support the recommended WF. |
| CATT | Support recommended WF |
| Intel | Support recommended WF |
| Nokia | This can be discussed after the transcient period in FR2 gets clarified in RF session. |
| MediaTek | Agree with recommended WF |
| NEC | Can be discussed later. |

**Issue 1-3-5: Interruption requirement proposals**

* Proposals
  + Option 1 (MTK): The SRS antenna switching interruption requirement should be specified as follows.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Victim cell SCS(KHz) | Aggressor Cell SCS (KHz) | | | |
| 15 | 30 | 60 | 120 |
| 15 | 2 | 2 | 2 | 2 |
| 30 | 2 | 2 | 2 | 2 |
| 60 | 3 | 2 | 2 | 2 |
| 120 | 5 | 3 | 3 | 2 |

* + Option 2 (Xiaomi): The SRS antenna switching interruption requirement for FR1 is shown as follow.

Table 1. Interruption length (slots) due to SRS antenna switching for DC

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Victim cell SCS(KHz) | Aggressor Cell SCS (KHz) | | | | | |
| signalling txSwitchWithAnotherBand | | | signalling txSwitchImpactToRx | | |
| 15 | 30 | 60 | 15 | 30 | 60 |
| 15 | 1 | 1 | 1 | 1 | 1 | 1 |
| 30 | 2 | 1 | 1 | 2 | 1 | 1 |
| 60 | 3 | 2 | 1 | 4 | 2 | 1 |

Table 2. Interruption length (slots) due to SRS antenna switching for CA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Victim cell SCS(KHz) | Aggressor Cell SCS (KHz) | | | | | |
| signalling txSwitchWithAnotherBand | | | signalling txSwitchImpactToRx | | |
| 15 | 30 | 60 | 15 | 30 | 60 |
| 15 | 1 | 1 | 1 | 1 | 1 | 1 |
| 30 | 1 | 1 | 1 | 1 | 1 | 1 |
| 60 | 1 | 1 | 1 | 2 | 1 | 1 |

* + Option 3 (Apple, QC, OPPO): the interruption requirement of SRS antenna port switching is summarized as:

|  |  |  |  |
| --- | --- | --- | --- |
| Victim CC SCS(kHz) | Aggressor CC SCS (kHz) | | |
| 15 | 30 | 60 |
| 15 (NR or LTE) | 2 | 2 | 2 |
| 30 | 2 | 2 | 2 |
| 60 | 3 | 2 | 2 |

Unit of interruption requirement is slot for NR and subframe for LTE.

* + Option 4 (LGE): Interruption requirements for SRS antenna port switching are shown in Table 1 and Table 2.

Table 1 Proposed interruption requirements per *SRS-ResourceSet* (‘aperiodic’)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Victim cell SCS [kHz] | Interruption length [slot] | | | | | |
| Aggressor cell SCS [kHz] | | | | | |
| 15 | | 30 | | 60 | |
| Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| 15 | 2 | 1 | 2 | 1 | 2 | 1 |
| 30 | 2 | 1 | 2 | 1 | 2 | 1 |
| 60 | 3 | 2 | 2 | 1 | 2 | 1 |
| Case 1: UL-UL slot configuration for synchronous case, and UL-UL or UL-DL slot configuration for asynchronous case  Case 2: UL-DL slot configuration for synchronous case  Note 1: If SRS resource is configured in flexible symbols within a slot in synchronous case, the interruption requirements apply to uplink symbols. | | | | | | |

Table 2 Proposed interruption requirements per SRS resource (‘periodic’ or ‘semi-persistent’)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Victim cell SCS [kHz] | Interruption length [slot] | | | | | |
| Aggressor cell SCS [kHz] | | | | | |
| 15 | | 30 | | 60 | |
| Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| 15 | 2 | 1 | 2 | 1 | 2 | 1 |
| 30 | 2 | 1 | 2 | 1 | 2 | 1 |
| 60 | 2 | 1 | 2 | 1 | 2 | 1 |
| Case 1: UL-UL slot configuration for synchronous and asynchronous cases  Case 2: UL-DL slot configuration for and asynchronous cases  Note 1: If SRS resource is configured in flexible symbols within a slot in synchronous case, the interruption requirements apply to uplink symbols. | | | | | | |

* + Option 5 (OPPO):
    - For NR SRS antenna port switching impacting LTE CC, the interruption is 2 subframes.
    - For NR SRS antenna port switching impacting NR CC, the interruption should be specified as the following table based on the SCS of the victim CC.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Interruption Length (slots) | | |
| Victim SCS (kHz) | 15 | 30 | 60 |
| 15 | 2 | 2 | 2 |
| 30 | 3 | 2 | 2 |
| 60 | 4 | 3 | 2 |

* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF .
* 1st round Comment collection:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Option 3, and this issue is based on the conclusions from other issues. |
| LG | Wait the conclusion from other open issues |
| OPPO | Support option 5, and can also compromise to option 3. FFS the cases for FR2. |
| Huawei | Depend on the conclusions from other issues. |
| Xiaomi | Wait the conclusion from other open issues |
| QC | Same as apple. |
| vivo | FFS |
| Ericsson | We cannot agree on any figures. There are lots of other issues which should be address first e.g. issues 1-2-1, 1-2-4, 1-3-1, 1-3-3 etc. |
| CATT | Wait for the conclusion of other issues. |
| Nokia | This can be discussed after we conclude on the components of interruption. |
| MediaTek | Wait for the conclusion in other issues. |
| NEC | Can be discussed later. |

### Sub-topic 1-4: Others

*Sub-topic description*

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

**Issue 1-4-1: if option 2 in issue 1-1-1 is adopted, how to define the SRS antenna port switching delay requirement**

* Proposals
  + Option 1 (vivo): For SRS antenna port switching delay, RAN4 should consider to specify UE capability to differentiate the needed minimal separation between SRSs and/or between SRS-PUSCH/PUCCH, similar to the transient period capability defined in R16
* Recommended WF
  + Wait the conclusion from issue 1-1-1
* 1st round Comment collection:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | We propose to not have delay requirement for SRS antenna port switching and we could wait the conclusion from issue 1-1-1. |
| Xiaomi | Wait the conclusion from issue 1-1-1 |
| vivo | In our understanding this is not necessarily linked to issue 1-1-1.  In issue 1-3-3, if capability is introduced, then the calculated time should be based on UE capability. |
| Ericsson | Discuss after the conclusion of the issue 1-1-1. |
| CATT | Support recommended WF |
| Nokia | We are fine with the recommended WF. |
| MediaTek | Agree with recommended WF |
| NEC | Can be discussed later. |

**Issue 1-4-2: LS to RAN1 to check the prioritization rule for SRS antenna switching**

* Proposals
  + Option 1 (vivo): Send LS to RAN1 to check the prioritization rule for SRS antenna switching, especially for the case in CA/DC operation.

RAN4 respectfully ask RAN1 that for CA/DC scenarios, whether SRS transmission for antenna port switching in one of the active serving cell can be prioritized over the following transmissions/receptions on any other active serving cells

• SSB/CSI-RS for L1/L3 measurements

• PUSCH/PUCCH transmission with priority index 1 or DL pre-emption transmission

• PUSCH/PUCCH transmission carrying HARQ-ACK/positive SR/RI/CRI/SSBRI and/or PRACH

• PUSCH transmission carrying aperiodic CSI (if periodic/semi-persistent SRS resources are configured)

Option 2 (OPPO): do not send this LS in option 1.

Option 3 (Apple, HW, QC, Ericsson, Nokia): needs more discussion.

* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | This issue is related with the discussion in issue 1-1-3. If RAN4 agrees to prioritize NR measurement, then SSB/CSI-RS based measurement shall not be impacted. For other channels’ priority, in current RAN1 TS38.213, the prioritization is applied when the UE Tx power is exceeded, and we did not have such prioritization in RAN4 requirement for previous SRS carrier based switching. So we think more justification is needed for this LS and we are open to discuss in RAN4 first. |
| OPPO | Do not see the urgency to send LS. |
| Huawei | Prefer to discuss the issue in RAN4 first. |
| QC | RAN4 needs to decide on measurement priority first. Then we can discuss whether to send LS to RAN1 for the rest issue. |
| vivo | We think LS is a better way to check RAN1 understanding. Regarding the last 3 bullets they are most likely to be captured in RAN1 spec.  However, we are fine to further check. |
| Ericsson | Not urgent to send LS at this stage. RAN4 should first identify impact on RRM. |
| Nokia | We would like to understand what prioritization rule is to be clarified. If this refers to the impact to other RRM measurements, it can be discussed after we conclude on the interruption aspects. |

## Companies views’ collection for 1st round

### Open issues

Comments are collected in section 1.2

### 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.*

Sub-topic 1-1: Scope of SRS antenna switching requirement

|  |  |
| --- | --- |
|  | **Status summary** |
| **Issue 1-1-1: whether delay requirement would be defined in RRM for SRS antenna port switching** | *Tentative agreements:*  *Candidate options:*   * Option 1 (MTK, CATT, Apple, QC, CMCC, LGE, OPPO, HW, Xiaomi): Do not define SRS antenna port switching delay requirement in RRM. * Option 1a (Nokia): Do not define SRS antenna port switching delay requirement in RRM if only RF returning time is considered. * Option 2 (NEC, Ericsson, vivo): Define SRS antenna port switching delay requirement in RRM   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 1-1-2: RAN4 defines the requirement only for SRS antenna port switching in FR1 or in both FR1 and FR2** | *Tentative agreements:*  Define the RRM requirements at SRS antenna switching only for FR1 unless the transient period in FR2 gets clarified in RF session (the scope of “RRM requirements” here depends on the conclusions from issue 1-1-1)  *Candidate options:*  *Recommendations for 2nd round:*  This issue is closed, and agreements would be captured in the WF. |
| **Issue 1-1-3: Impact of SRS antenna port switching to other RRM requirements** | *Tentative agreements:*  *Candidate options:*   * Option 1 (CATT): No RRM requirement would be impacted by SRS antenna port switching. * Option 2 (Apple, OPPO, Ericsson): Regarding the impact of SRS antenna port switching to other RRM requirements, RAN4 would clarify the relaxation or applicability in those RRM requirements whose wanted DL RS or UL RS could be interrupted by SRS antenna port switching, e.g., the delay requirement could be extended if SRS antenna port switching happens during the UE procedure, or the requirement only applies when SRS antenna port switching is not colliding with the reference signal. * Option 3 (QC, Apple, vivo, Xiaomi):   + No impact to NR measurement requirements relevant to measurements based on SSB/CSI-RS due to NR SRS antenna switching, as NR measurements are always prioritized.   + In EN-DC and NE-DC operation,     - NR SRS antenna switching colliding with E-UTRA measurement       * Interruptions on E-UTRA measurement in the interrupted carrier group are allowed due to NR SRS antenna switching, but NOT allowed due to NR SRS antenna switching for the carriers not in the interrupted carrier group.       * Additional delay can be expected on E-UTRA measurement in the interrupted carrier group when UE is configured to perform NR SRS antenna switching.       * NR SRS antenna switching is allowed to be dropped when colliding with E-UTRA measurement in the interrupted carrier group.     - E-UTRA SRS antenna switching colliding with NR measurement: FFS * Option 4 (NEC): For impact on other RRM requirements due to SRS antenna port switching, RAN4 shall consider SRS carrier switching as the baseline. RAN4 should first discuss and agree on timing misalignment value before discussion of SRS antenna port switch impact on gNB measurements. * Option 5(Nokia): Add one note indicating the DL may be affected due to SRS antenna switching if *txSwitchImpactToRx* is configured. * Option 6 (Ericsson): Further look into performance impact on timing-based measurements from SRS antenna port switching, and if needed, identify how to mitigate performance degradation (e.g. by avoiding switching during timing-based measurements). * Option 7 (vivo, Huawei, CATT): Do not consider impact to timing measurements in R17 SRS antenna port switching. * Option 8 (Nokia, NEC) : TBD after the interruption of SRS antenna port switching is clarified   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 1-1-4: Impact of SRS antenna port switching to positioning related requirements** | *Tentative agreements:*  *Candidate options:*   * Option 1 (Huawei, Apple, OPPO, Xiaomi, QC, vivo, CATT): Discuss the impact of SRS antenna switching on positioning related measurement in Rel-17 position session. * Option 2 (Nokia): Discuss the impact of SRS antenna switching on positioning related measurement in this Rel-17 FeRRM.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |

Sub-topic 1-2: Interruption requirement applicability

|  |  |
| --- | --- |
|  | **Status summary** |
| **Issue 1-2-1: Interruption requirement applicability** | *Tentative agreements:*  *Candidate options:*   * Option 1 (MTK, Xiaomi, CATT, Apple, QC, OPPO, HW, vivo, LGE, CMCC, Ericsson, Intel, Nokia, MTK, NEC): The interruption requirement should be defined based on the band combination capability reported by UE, i.e., *txSwitchImpactToRx* or *txSwitchWithAnotherBand*. * Option 1b (QC): SRS antenna switching interruptions on both DL and UL applies to the band combinations signaled in *txSwitchImpactToRx* or *txSwitchWithAnotherBand*.   *Recommendations for 2nd round:*  Continue discussion on option 1 and option 1b, and agreements would be captured in the WF. |
| **Issue 1-2-2: whether same interruption requirement applies to different SRS antenna port switching patterns** | *Tentative agreements:*  *Candidate options:*   * Option 1 (CATT, Apple, OPPO, vivo, Huawei, Xiaomi, QC, Intel, MTK): use same set of requirements for different SRS antenna switch patterns * Option 2 (LGE): The interruption could be different according to ‘resourceType’.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 1-2-3: Would the interruption requirement based on different SCS?** | *Tentative agreements:*  Interruption requirement is based on the aggressor CC and victim CC SCS.  *Candidate options:*  *Recommendations for 2nd round:*  This issue is closed, and agreements would be captured in the WF. |
| **Issue 1-2-4: Would the interruption requirement differentiate between sync and async cases?** | *Tentative agreements:*  *Candidate options:*   * Option 1 (MTK, Apple, Intel, vivo, OPPO, Xiaomi, QC): No; one single requirement to cover the synchronous and asynchronous scenarios with or without UL TA.   + Option 1a (Apple, Xiaomi, QC): No, interruption requirement is based on the async case for the minimum requirement. * Option 2 (CATT, Ericsson, LG, Nokia, NEC): Yes, the interruption requirement can differentiate between sync and async cases.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 1-2-5: Interruption requirement for UE with or without per-FR MG capability** | *Tentative agreements:*  *Candidate options:*   * Option 1 (MTK, CATT, HW, vivo, Ericsson, Intel): Interruption requirement of SRS antenna port switching will not depend on for per-UE or per-FR gap capability. * Option 2 (Apple, OPPO, Xiaomi): No need to differentiate the requirement for the UE with or without capability of per-FR gap for SRS antenna port switching in RAN4. But in the interruption requirement applicability condition, RAN4 shall clarify that the indication of *txSwitchImpactToRx* or *txSwitchWithAnotherBand* is not allowed to indicate any band combination cross FR1 and FR2 if UE is capable of per-FR MG. * Option 3 (OPPO): Different impact should be considered for UE capable of per UE gap or per FR gap if FR1+FR2 SRS antenna port switching was to be specified. * Option 4 (Ericsson, Nokia, NEC): Potential impact of UE capability for per-FR gap on interruption requirements can be further studied once the other aspects influencing the interruption time have been settled.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |

Sub-topic 1-3: Interruption requirement design

|  |  |
| --- | --- |
|  | **Status summary** |
| **Issue 1-3-1: The interruption requirement is defined based on slot level or symbol level** | *Tentative agreements:*  *Candidate options:*   * Option 1 (MTK, Xiaomi, CATT, Apple, QC, vivo, OPPO, Huawei, Intel): based on slot level * Option 2 (CMCC): if the interruption time only includes transient periods before and after SRS transmission, and considering that the transient period specified in FR session is 15us, it is suggested to specify the interruption requirements based on symbol level. * Option 3 (LGE, Huawei, Ericsson): The interruption requirement can be defined based on slot level for full uplink symbols within a slot and based on symbol level for flexible symbols with in slot. * Option 4 (NEC, Ericsson, HW, CMCC, Nokia): based on symbol level   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 1-3-2: The components within interruption time of SRS antenna port switching in FR1** | *Tentative agreements:*  *Candidate options:*   * Option 1 (MTK, Intel, vivo, Apple, Huawei, Ericsson): includes antenna switching time and SRS transmission time   + Option 1a(Ericsson): The interruption time for SRS antenna port switching comprises at least antenna switching time and SRS transmission time. * Option 2 (Xiaomi): The guard period defined in TS 38.214 is considered as the antenna switching time when defining the interruption requirement.   + If the signalling of *txSwitchWithAnotherBand* is reported, the interruption requirement at SRS antenna switching should be the guard period defined in TS 38.214 for the aggressor CCs in the band combination.   + If the signalling of *txSwitchImpactToRx* is reported, the interruption requirement should include the guard period defined in TS 38.214 and SRS transmission time for the aggressor CCs in the band combination. * Option 3 (CATT): The interruption time of SRS antenna port switching in FR1 includes all guard symbols, all SRS symbols transmitted on other antenna port, and only one switching time. * Option 4 (Apple, OPPO, QC, vivo, Intel, MTK): The components within interruption time of SRS antenna port switching in FR1 include:   + SRS antenna port switching time (transient time)   + SRS transmission time   + Transient time before and after SRS transmission occasion * Option 5 (CMCC):   + Since UE stay connection with the serving CCs, the interruption time for SRS antenna port switching delay includes transient periods before and after SRS transmission, and it is not necessary to consider SRS transmission time. * Option 6 (NEC):   + If victim CC and SRS transmission on aggressor CC are transmitted on the same antenna, interruption requirement shall include SRS antenna switching in delay/TP, SRS transmission, GP, SRS antenna switching back delay/TP.   + If victim CC and SRS transmission on aggressor CC are transmitted on the different antenna, interruption requirement shall include SRS antenna switching in delay/TP, SRS antenna switching back delay/TP only. * Option 7 (LGE):   + The components within interruption time is     - Time to antenna switching before SRS transmission and SRS transmission time for ‘aperiodic’ SRS-ResourceSet     - Time to antenna switching before SRS transmission for ‘periodic’ or ‘semi-persistent’ SRS-ResourceSet     - Additionally, the time to switch back after SRS transmission depending on UE ehaviour * Option 8 (Nokia):   + The interruption at SRS antenna switching shall be defined at least within the guard period in Table 6.2.1.2-1 of [TS38.214].     - The interruption requirement shall be defined when the SRS resources of a set in a slot are configured on the symbols which separated by exactly the minimum guard period.     - RAN4 shall discuss if the interruption requirements are defined when the SRS resources of a set in a slot are separated by a length larger than a minimum guard period.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 1-3-3: if option 1 or option 4 is adopted in issue 1-3-2, details of the interruption time in FR1** | *Tentative agreements:*  *Candidate options:*   * Option 1 (MTK, QC, Apple, LG, OPPO, Huawei, vivo): Interruption time is specified based on 2 transient period (2\*15us) and 6 symbol time * Option 2 (Apple): Interruption time is specified based on 2 transient period (2\*10us) and 6 symbol time * Option 3 (OPPO): Interruption time is specified based on SRS Transmission time (up to 7 symbols), SRS antenna switching time (15us \*2) and transient period (10us\*2) * Option 4 (Ericsson, CATT, Nokia, NEC): depends on the conclusions from other issues.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 1-3-4: If option 2 in issue 1-1-2 is adopted, the components within interruption time of SRS antenna port switching in FR2** | *Tentative agreements:*  Based on the conclusion in issue 1-1-2, this issue can be skipped.  *Candidate options:*  *Recommendations for 2nd round:*  This issue is closed. |
| **Issue 1-3-5: Interruption requirement proposals** | *Tentative agreements:*  *Candidate options:*  The options are in section 1.2.3 for issue 1-3-5 (not paste here because of too many tables)  *Recommendations for 2nd round:*  Wait for the conclusions from other issues. Continue discussion in 2nd round, and agreements would be captured in the WF |

Sub-topic 1-4: others

|  |  |
| --- | --- |
|  | **Status summary** |
| **Issue 1-4-1: if option 2 in issue 1-1-1 is adopted, how to define the SRS antenna port switching delay requirement** | *Tentative agreements:*  *Candidate options:*   * + Option 1 (vivo): For SRS antenna port switching delay, RAN4 should consider to specify UE capability to differentiate the needed minimal separation between SRSs and/or between SRS-PUSCH/PUCCH, similar to the transient period capability defined in R16   *Recommendations for 2nd round:*  Wait the conclusion from issue 1-1-1. Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 1-4-2: LS to RAN1 to check the prioritization rule for SRS antenna switching** | *Tentative agreements:*  *Candidate options:*   * + Option 1 (vivo): Send LS to RAN1 to check the prioritization rule for SRS antenna switching, especially for the case in CA/DC operation.   RAN4 respectfully ask RAN1 that for CA/DC scenarios, whether SRS transmission for antenna port switching in one of the active serving cell can be prioritized over the following transmissions/receptions on any other active serving cells  • SSB/CSI-RS for L1/L3 measurements  • PUSCH/PUCCH transmission with priority index 1 or DL pre-emption transmission  • PUSCH/PUCCH transmission carrying HARQ-ACK/positive SR/RI/CRI/SSBRI and/or PRACH  • PUSCH transmission carrying aperiodic CSI (if periodic/semi-persistent SRS resources are configured)   * + Option 2 (OPPO): do not send this LS in option 1.   + Option 3 (Apple, HW, QC, Ericsson, Nokia): needs more discussion.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |

### CRs/TPs

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

|  |  |
| --- | --- |
| **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)

**Issue 1-1-1: whether delay requirement would be defined in RRM for SRS antenna port switching**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We can compromise to Option 1a, i.e., if only RF retuning time is considered, no separate delay requirement need to be specified. |
| Xiaomi | Follow GTW conclusion. |
| Apple | Follow the GTW conclusion |

**Issue 1-1-3: Impact of SRS antenna port switching to other RRM requirements**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We support Option 2 and Option 6. RAN4 need further analysis on detailed impact e.g. on requirements that uses SRS signals (e.g. positioning measurement requirements). If to avoid impact on other RRM measurement requirements then the UE behaviour for SRS antenna switching may need to be specified in such manner that SRS antenna switching is delayed to avoid impact on RSs used for measurements. We are fine with clarifying the interruption due to SRS antenna switching before looking into the impact on different requirements, and potential mitigation, but the impact analysis should be added as a part of the planned RAN4 work. |
| Xiaomi | Prefer Option 3. NR measurements could be prioritized following the SRS carrier based switching requirement. We can further discuss the impact to other RRM requirements. |
| Apple | We support option 2 and and option 3 without LTE ant port switching. Regarding option 3 NR part, in the previous discussion for SRS carrier based switching (WF R4-2002246):   * No impact to NR measurement requirements relevant to measurements based on SSB/CSI-RS due to NR SRS carrier switching   + NR measurements are always prioritized   + the interruption requirement due to SRS carrier switching does not apply   + Impact of NR SRS carrier switching on requirements based on other NR uplink or downlink signals in RRM specifications is FFS   So we think this principle could also be used for SRS antenna port switching. |
| CATT | Support option 7. There is no impact on the UL timing measurement. As for other RRM requirement, we are fine to further clarify the interruption and delay applicability due to SRS antenna port switching. |

**Issue 1-1-4: Impact of SRS antenna port switching to positioning related requirements**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We support Option 2. Our view is that the impact on positioning due to SRS antenna switching (the current feature) shall be the responsibility of the R17 NR RRM further enhancements work item, i.e., the present WI. Work can be done within the Rel-17 Positioning WI, but responsibility to put such work on the agenda and evaluate the outcome of such work shall be with the present WI. |
| Xiaomi | Prefer Option 1. |
| Apple | Prefer option 1. We are open to further discuss whether we need to consider NR SRS antenna port switching impacting positioning measurement, but we cannot agree to discuss the antenna port switching for positioning SRS in this R17 FeRRM WI. |
| CATT | Support option 1. |

**Issue 1-2-1: Interruption requirement applicability**

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| **Company** | **Comments** |
| Ericsson | We support Option 1. |
| LG | We prefer option 1. |
| Xiaomi | Support Option 1. |
| Apple | Support option 1; and option 1b could be FFS. |
| CATT | Support option 1. |

**Issue 1-2-2: whether same interruption requirement applies to different SRS antenna port switching patterns**

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| **Company** | **Comments** |
| Ericsson | As mentioned in first round we would like that before concluding, RAN4 should study more carefully the difference between interruptions due to different patterns. |

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| LG | For this issue, we think that option 1 and option 2 is different category. We are fine with option 1 for different SRS antenna port switching patterns. In here, switching pattern represents 1T2R, 2T4R, and 1T4R. However, the ‘resourceType’ as option 2 means ‘aperiodic’, ‘periodic’, and ‘semi-persistent’ for SRS-resourceSet. Since there are no any restriction to configure SRS resources within one slot for SRS antenna port switching, the interruption length could be different according to ‘resourceType’. So we need further discussion for this. |

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| Xiaomi | Option 1 |
| Apple | Option 1, but can FFS on option 2. |
| CATT | Support option 1. |

**Issue 1-2-4: Would the interruption requirement differentiate between sync and async cases?**

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| **Company** | **Comments** |
| Ericsson | We support analysing this matter from a perspective of Option 2. If it after analysis would turn out that there is no significant difference between async and sync, then we are open to discuss having a common requirement for sync and async cases. But up until then we support Option 2. |

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| LG | we support option 2 and have same view with Ericsson |

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| Xiaomi | Support Option 1 and Option1a. |
| Apple | Support option 1 and option 1a. But agree with what Ericsson said, we can do some analysis based on TA/MTTD/MRTD and etc. |
| CATT | We think the interruption between sync and async is different. But we can further discuss whether to define different requirements for sync and async cases. |

**Issue 1-2-5: Interruption requirement for UE with or without per-FR MG capability**

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| **Company** | **Comments** |
| Ericsson | We are fine with Option 1. |
| Xiaomi | Prefer Option 2, we can further discuss. |
| Apple | Option 2. As we discussed in the first round, RAN4 still needs to clarify whether the indication of *txSwitchImpactToRx* or *txSwitchWithAnotherBand* is allowed to indicate any band combination cross FR1 and FR2 if UE is capable of per-FR MG; otherwise, it could have confliction between per-FR MG capability and this SRS interruption capability, e.g., UE supports per-FR MG but still indicates interruption between FR1 CC and FR2 CC in *txSwitchImpactToRx* or *txSwitchWithAnotherBand*. |
| CATT | Support option 1. We are fine to further discuss option 2 considering the indication restriction. |

**Issue 1-3-1: The interruption requirement is defined based on slot level or symbol level**

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| **Company** | **Comments** |
| Ericsson | We support Option 4, i.e., symbol level granularity, but can also support Option 3. |

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| LG | We support option 3 and need further analysis. For the clarification ‘slot’ in option 3, ‘full UL or DL symbols within a slot’ means that all symbols in a slot are DL or UL. ‘Flexible symbols with in a slot’ means that symbols in a slot are DL symbols + UL symbols. |

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| Xiaomi | Prefer Option 1. |
| Apple | We prefer option 1 for simplicity. Option 3 may have some relation with option 1b in issue 1-2-1, that is, if the interruption is to both DL and UL symbols no matter which signaling(*txSwitchImpactToRx* or *txSwitchWithAnotherBand*) is used to indicate, then slot level interruption can also apply for flexible symbol case. |
| CATT | Support option 1. As we commented in 1st round, symbol level interruption will introduce more complexity for the test cases. |

**Issue 1-3-2: The components within interruption time of SRS antenna port switching in FR1**

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| **Company** | **Comments** |
| Ericsson | We support Option 1. |

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| LG | I’d like to know common understanding for UE behavior of SRS antenna port switching in RAN4 requirement. Should a UE always switch back after SRS transmission?  And as commented in Issue 1-2-2, it could be different interruption time according to resourceType for SRS-resourceSet, so we support option 7. |

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| Xiaomi | In our understanding, the two IE *txSwitchImpactToRx* and *txSwitchWithAnotherBand* would cause different length of interruption on the victim CC. But after checking QC’s comments, we can support RAN4 to consider the non-consecutive interruptions in a slot as one single interruption period.  In this way, Option 1 and Option 4 are both fine to us. |
| Apple | We prefer option 4, and would like to check with proponent of option 1 if the transient time before and after SRS transmission occasion has been considered in the antenna switching time in option 1. |
| CMCC | Could companies help to clarify why SRS transmission is considered as one of the components of interruption? In our understanding, UE stay connection with the CCs during SRS transmission. |
| CATT | Support Option 3. |

**Issue 1-3-3: if option 1 or option 4 is adopted in issue 1-3-2, details of the interruption time in FR1**

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| **Company** | **Comments** |
| Ericsson | For this issue we first need to conclude on Issue 1-2-2 (patterns) and Issue 1-2-4 (sync/async). |
| Xiaomi | We are fine with Option 1. |
| Apple | Option 1. To Ericsson, we think this issue is not relevant to sync/async, because this is the absolute interruption time that UE used for RF adjustment and SRS transmission on one CC, for analysis purpose. The sync/async could be considered when we use this absolute interruption time to design the interruption requirement if issue 1-2-4 has such conclusion. |
| CATT | Support option 4. We should first conclude on issue 1-3-2. And the interruption time should be specified based on all the guard symbols and transmission time. |

**Issue 1-3-5: Interruption requirement proposals**

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| **Company** | **Comments** |
| Ericsson | We support the recommended WF. We first need to settle a number of other issues before working on detailed requirements. |

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| LG | We support the recommended WF. |

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| Xiaomi | We can come back to this issue after other open issue settled down. |
| Apple | Need to wait the conclusions from other issues. |

**Issue 1-4-1: if option 2 in issue 1-1-1 is adopted, how to define the SRS antenna port switching delay requirement**

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| **Company** | **Comments** |
| Ericsson | We support the recommended WF. |
| Apple | Delay requirement is not needed based on GTW meeting conclusion, but instead the scheduling restriction could be FFS. |

**Issue 1-4-2: LS to RAN1 to check the prioritization rule for SRS antenna switching**

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| **Company** | **Comments** |
| Ericsson | As mentioned in first round, our view is that it is not urgent to send this LS. Before potentially sending such LS, RAN4 should better understand the impact on RRM. |
| Apple | Need more discussion. |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: HO with PSCell (8.4.2.2)

*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** |
| [**R4-2104685**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104685.zip) | Xiaomi | Proposal 1: For HO with PSCell, it is assumed that the following procedures should be performed in sequentially order:   1. Cell search; 2. Fine time tracking; 3. UE processing time; 4. Time for interruption uncertainty in acquiring the first available PRACH occasion in the new cell; 5. Time for SSB post-processing   Proposal 2: the timeline of the delay requirement for HO with PSCell should be the time when the UE receives a RRC message implying handover with PSCell the UE shall be capable to transmit PRACH preamble towards target PSCell within Thandover\_with\_PSCell from the end of the last TTI containing the RRC command. Where Thandover\_with\_PSCell is the delay requirement of HO with PSCell.  Proposal 3: When the configured PSCell is the same as the original one or not, the requirements and UE’s ehaviour are the same.  Proposal 4: No interruption requirement should be defined during HO with PSCell. |
| [**R4-2104759**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104759.zip) | CATT | Proposal 1: In Rel-17, RAN4 only considers legacy FR1+FR2 NR-DC for HO with PSCell from NR-DC to NR-DC, and only considers FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC.  Proposal 2: The starting point of the delay requirement for HO with PSCell is the end of the last TTI containing the RRC command implying handover with PSCell. The ending point should be defined the later PRACH transmission on Pcell or PSCell.  Proposal 3: UE will perform in parallel the Pcell handover process and PSCell addition process.  Proposal 4: The optimization for the case when PSCell is unchanged may not be necessary.  Proposal 5: Tprocessing for HO with PSCell can be used the values for handover requirements and for PSCell addition requirement.  Proposal 6: The HO with PSCell delay requirement can be defined as longer delay requirement between legacy handover delay requirement and legacy PSCell addition delay requirement, with HO with PSCell RRC procedure delay replacing the legacy RRC procedure delay separately.  Proposal 7: Interruption in legacy handover delay requirement can be applied for Pcell. No interruption is defined on PSCell.  Proposal 8: The delay requirements for HO with PSCell are not relative with 2 step or 4 step RACH if the ending point of delay is defined as PRACH transmission of UE.  Proposal 9: There is no need to further consider the RO collision issue between Pcell and PSCell from RAN4’s perspective.  Proposal 10: RAN4 specified delay requirements HO with PSCell by UE sent PRACH on Pcell and PSCell. Failure cases should not defined in RAN4 specification. |
| [**R4-2104832**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104832.zip) | Apple | Proposal 1: RAN4 specifies RRM requirement for HO with PSCell for following scenarios:   * from NR SA to EN-DC * from EN-DC to EN-DC * from NE-DC to NE-DC * from NR-DC to NR-DC   Proposal 2: In R17 RAN4 only considers legacy FR1+FR2 NR-DC for HO with PSCell from NR-DC to NR-DC, and only considers FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC.  Proposal 3: A new R17 UE capability is introduced to indicate whether UE can support sequential processing or parallel processing for HO with PSCell.  Proposal 4: For delay requirement of HO with PSCell,   * reuse the starting point definition from legacy HO, i.e., the end of the last TTI containing the RRC command implying handover with PSCell. * the ending point is:   + the timing when UE shall be capable to transmit PRACH preamble towards target PSCell if sequential processing is used   + the later timing between “timing when UE shall be capable to transmit PRACH preamble towards target Pcell” and “the timing when UE shall be capable to transmit PRACH preamble towards target PSCell” if the parallel processing is used   Proposal 5: for UE which is already configured with DC, the UE’s ehavior is same regardless of whether the configured PSCell is same as the original one or not.  Proposal 6:  If UE only supports sequential processing for HO with PSCell, the total UE processing time for HO with PSCell is the sum of UE processing timing of HO and UE processing timing of PSCell addition.  If UE can support parallel processing for HO with PSCell, the total UE processing time for HO with PSCell could be the maximum one between UE processing timing of HO and UE processing timing of PSCell addition  Proposal 7: the UE processing time for HO with PSCell is:   |  |  |  | | --- | --- | --- | | UE processing margin (Tprocessing) | Target Pcell and PSCell is in the same FR as old Pcell | Target Pcell and/or target PSCell is in the different FR from old Pcell | | Sequential processing capable UE | 40ms | 60ms | | Parallel processing capable UE | 20ms | 40ms |   Proposal 8: for requirement of HO with PSCell, RAN4 starts the discussion with 4 step RACH first and FFS on 2 step RACH.  Proposal 9: If sequential processing is used, there is no need to consider RACH occasion (RO) collision between Pcell and PSCell.  If parallel processing is used:   * for FR1+FR1 EN-DC, an additional uncertainty delay due to PSCell RACH collision with Pcell UL channels may be introduced if the PSCell RACH cannot be transmitted based on the criteria in TS38.213 section 7.6.1; * for FR1+FR1 NE-DC, an additional uncertainty delay due to Pcell RACH collision with PSCell RACH may be introduced if the Pcell RACH cannot be transmitted based on the criteria in TS38.213 section 7.6.2; * otherwise, if the Pcell and PSCell are on the different FRs, no need to consider RO collision issue.   Proposal 10:  If sequential processing is used, UE transmits PSCell RACH later than Pcell RACH.  If parallel processing is used, there is no time order limitation between Pcell RACH and PSCell RACH for HO with PSCell.  Proposal 11: For sequential processing capable UE, RAN4 assumes that UE performs target PSCell addition after receiving RAR (msg 2) from target Pcell in the requirement of HO with PSCell.  Proposal 12: For parallel processing capable UE, RAN4 assumes that UE performs target Pcell HO and target PSCell addition independently after decoding the HO command.  Proposal 13:  If sequential processing is used for HO with PSCell, UE would have an interruption on new Pcell due to the PSCell addition.  If parallel processing is used for HO with PSCell and PSCell addition is completed earlier than Pcell HO, no need to define interruption requirement since interruption has been reflected by HO delay.  If parallel processing is used for HO with PSCell and PSCell addition is completed later than Pcell HO, UE may have an interruption on new Pcell due to RF tuning for PSCell addition. |
| [**R4-2104932**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104932.zip) | NTT DOCOMO, INC. | Proposal 1: Some of procedures of HO with PSCell should be able to be performed in parallel.  Proposal 2: HO to the Pcell and random access to the PSCell should be performed sequentially. |
| [**R4-2104943**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104943.zip) | CMCC | Proposal 1: the starting point of the delay requirement for HO with PSCell is the end of last TTI containing the RRC command implying handover with PSCell.  Proposal 2: the ending point is the last one between HO and PSCell addition to transmit PRACH preamble.  Proposal 3: for HO with PSCell, it is proposed to consider parallel way to perform HO and PSCell addition.  Proposal 4: delay requirement for HO with PSCell is maximum (PSCell addition delay, HO delay)   * PSCell addition delay= TRRC\_delay + Tprocessing + Tsearch + T∆ + TPSCell\_ DU + 2 ms * HO delay = TRRC\_delay +Tinterrupt = TRRC\_delay +Tsearch + TIU + Tprocessing + T∆ + Tmargin ms |
| [**R4-2104980**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104980.zip) | NEC | Proposal 1: RAN4 to consider defining requirements for NR SA to NE-DC, NR SA to NR-DC and LTE SA to EN-DC.  Proposal 2: RAN4 to consider FR1+FR1 mode, FR1+FR2 mode for HO with PSCell from NR-DC to NR-DC and FR1+LTE mode for HO with PSCell from NE-DC to NE-DC.  Proposal 3: For NR SA to EN-DC and NE-DC to NE-DC, RAN4 to agree that cell search of Pcell and PSCell is performed in sequential order. For NR-DC to NR-DC, RAN4 to agree that cell search is performed in parallel for FR1+FR2 NR-DC and FR1+FR1 NR-DC.  Proposal 4: RAN4 to agree that components that contribute to TIU delay are the TA acquisition delay in Pcell, delay uncertainty in acquiring resources for RRC connection Reconfiguration Complete message on Pcell and PRACH acquisition uncertainty delay in PSCell.  Proposal 5: RAN4 to agree that interruption uncertainty (TIU) for Pcell and PSCell is sequential process.  Proposal 6: Tprocessing is the UE processing time. Tprocessing is the maximum value of Pcell HO and PSCell addition; and T∆ is time for fine time tracking and acquiring full timing information of the Pcell and PSCell.  Proposal 7: RAN4 to define both 2-step and 4-step RACH requirements for handover with PSCell. |
| [**R4-2106463**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106463.zip) | Intel Corporation | Proposal 1: Consider FR1+FR2, FR1+FR1 NR-DC for HO with PSCell and FR1+LTE NE-DC for HO with PSCell.  Observation 1: RACH procedure of PSCell will happen after the RACH procedure of Pcell.  Observation 2: Cell search, timing tracking, UE processing can still be processed in parallel.  Proposal 2: RACH procedure of PSCell will happen after the RACH procedure of Pcell. While Cell search, timing tracking, UE processing can still be processed in parallel.  Proposal 3: The ending point of delay requirement for HO with PSCell will be the time when PSCell is capable to transmit PRACH preamble.  Proposal 4: For HO with PSCell from NR-DC to NR-DC, Tprocessing can be split into software processing (Tprocessing\_SW) and RF warm up time(Tprocessing\_RF). Tprocessing\_SW=[20]ms needs further discussion if some extension is needed. Tprocessing\_RF will be dependent on different scenarios, i.e. whether Pcell or PSCell change across FRs.  Proposal 5: For HO with PSCell from NR SA to EN-DC, Tprocessing only includes software processing time (Tprocessing\_SW). Tprocessing\_SW=[20]ms needs further discussion if some extension is needed. |
| [**R4-2106533**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106533.zip) | OPPO | Observation 1: The components of procedures for Pcell HO and PSCell addition/change can be allowed partially overlapped during “HO with PSCell” procedure.  Proposal 1: FR1+FR2 NR-DC for HO with PSCell from NR-DC to NR-DC, and FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC are suggested to be considered.  Proposal 2: The timeline of “HO with PSCell” procedure should be longer than either that of Pcell HO standalone or PSCell addition/change standalone.  Proposal 3: The delay of HO with PSCell starts from   * + the end of the last TTI containing the RRC command implying handover with PSCell,   and ends with   * + transmission of the available PRACH preambles of both Pcell and Pscell.   Proposal 4: Wait for the reply LS from RAN2 on RRC processing delay for HO with PSCell and failure case definition for HO with PSCell before RAN4’s decision.  Proposal 5: UE’s behaviour is supposed to be the same no matter the configured PSCell is same as the original one or not. |
| [**R4-2106882**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106882.zip) | Ericsson | Proposal 1: RAN4 to derive RRM requirements for the following NR-DC and NE-DC scenarios: FR1+FR2 NR-DC to NR-DC, FR1+FR1 NR-DC to NR-DC, and FR1+LTE NE-DC to NE-DC. FFS on FR2+LTE NE-DC to NE-DC.  Proposal 2: The delay requirement for handover with PSCell is using the following starting and ending points. Starting point: same as for conventional handover. Ending point: whichever comes last of PRACH preamble transmission towards Pcell and PSCell. In case RAN4 defines scenarios where PRACH preamble transmission towards PSCell is not needed, ending point for those scenarios is PRACH preamble transmission towards Pcell.  Proposal 3: When source and target PSCell is the same cell, then fine time tracking T∆=0 shall apply.  Proposal 4: The value of Tprocessing\_SW for PSCell is as follows:   * + Tprocessing\_SW\_PSCell = 0 ms, when source and target PSCells are the same cell,   + Tprocessing\_SW\_PSCell = 20 ms, when source and target PSCells are different cells but in same FR   + Tprocessing\_SW\_PSCell = 40 ms, when source and target PSCells are different cells in different FRs   How Tprocessing\_SW\_PSCell impacts the handover with PSCell timeline depends on assumptions on parallel or sequential processing.  Proposal 5: The handover with PSCell delay (interruption) requirement shall have two checkpoints: time until the UE is transmitting PRACH preamble in Pcell, and time until later of UE transmitting PRACH preamble in Pcell and UE transmitting PRACH preamble in PSCell.  Proposal 6: Both 2-step RA and 4-step RA shall be supported in RRM requirements for Handover with PSCell.  Proposal 7: RAN4 to further study whether RA for spCell on unlicensed carrier with CCA shall be prioritized over RA for spCell on licensed carrier, once CCA is successful. |
| [**R4-2106924**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106924.zip) | ZTE Corporation | Observation 1: Procedures for handover with PSCell addition is similar to handover followed by PSCell addition immediately after.  Proposal 1: For the starting point of the delay, reuse the starting point definition from legacy HO, i.e., the end of the last TTI containing the RRC command implying handover with PSCell.  Proposal 2: For interruption requirements, consider the following options:  - Specify a total interruption for handover and PSCell addition  - Specify separate interruptions for handover and PSCell addition.  Proposal 3: Include both 2-step RA and 4-step RA into the new requirements made for handover with PSCell. |
| [**R4-2106987**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106987.zip) | Huawei, HiSilicon | Proposal 1: Define RRM requirement for HO with PSCell for following scenarios:   * from NR SA to EN-DC * from EN-DC to EN-DC * from NE-DC to NE-DC * from NR-DC to NR-DC   Observation 1: Upon receiving HO and PSCell command, all serving CC will be released, and UE is capable to perform HO and PSCell addition/change in parallel.  Proposal 1: Define the requirements for HO with PSCell based on the assumption that the procedure is performed in parallel.  Observation 2: Separate delay requirements shall be define for HO and PSCell addition/change. The same starting point is assumed for Pcell and Pscell and then ending points should be defined as Pcell PRACH and PSCell PRACH respectively.  Proposal 2: Define delay requirements for HO and PSCell addition/change separately with the ending points defined as Pcell PRACH and PSCell PRACH respectively. No need to define overall delay requirement.  Observation 3: There is no other serving CCs in the HO with PSCell procedure.  Proposal 3: Not to have interruption requirements for HO with PSCell as there is no other serving CCs during the procedure.  Observation 4: UE shall transmit RRC complete message no matter whether the synchronization to the PSCell is completed or not.  Observation 5: UE will report SCG failure If UE fails to synchronize to the target PSCell. |
| [**R4-2107080**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107080.zip) | vivo | Proposal 1 RAN4 consider parallel processing capable UE in R17 as baseline and further identify the needed sequential processing during HO with PSCell.  Proposal 2 PRACH occasion collision is considered as one factor in the requirements for HO with PSCell, if UE only supports single uplink in the NE-DC or EN-DC.  Proposal 3 RF chain activation and retuning time needs to be considered in the timeline of HO with PSCell.  Proposal 4 For the delay requirement, the ending point of handover with PSCell can be considered separately for Pcell and PSCells.  Proposal 5 For NR-DC and NE-DC mode in HO with PSCell, we support Option 2 from last meeting, i.e. in R17 RAN4 considers FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC, and only considers FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC.  Proposal 6 Even if PSCell is not changed during HO with PSCell, T∆ reduction seems not necessary, considering the multi-TRP deployment.  Proposal 7 RAN4 do not need to specify interruptions for handover with PSCell.  Proposal 8 RAN4 start the discussion with 4 step RACH, and the applicability rule for 2-step RACH can be updated later, considering the same expression of requirements will be used. |
| [**R4-2107123**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107123.zip) | MediaTek inc. | Observation 1: HO procedure and PSCell change procedure might be performed in parallel for DC capable UE  Proposal 1: RAN4 to clarify whether requirements from LTE-SA to EN-DC and from NR-SA to NR-DC are needed  Proposal 2: For the scenario from NR-DC to NR-DC, the overall delay requirement of HO with PSCell procedure might be specified as DHO\_with\_PSCell = TRRC\_delay + max(Dhandover- TRRC\_delay, Tconfig\_PSCell - TRRC\_delay)  Proposal 3: RAN4 to specify the PCell interruption time for the overall HO with PSCell procedure  Proposal 4: For the scenario from NE-DC to NE-DC, RAN4 to clarify whether to remove the delay uncertainty of PCell PRACH preamble transmission from the delay requirement of HO with PSCell procedure |
| [**R4-2107224**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107224.zip) | Nokia, Nokia Shanghai Bell | 1. RAN4 specifies RRM requirements for handover with PSCell for following scenarios besides of the agreed scenarios in RAN4#98e:  * From NR SA to NR-DC * From NR SA to NE-DC * From E-UTRAN to EN-DC  1. Both FR1+FR2 NR-DC and FR1+FR1 NR-DC should be supported for RRM requirements for handover with PSCell in “from NR-DC to NR-DC” scenario. 2. Both FR1+LTE NE-DC and FR2+LTE NE-DC should be supported for RRM requirements for handover with PSCell in “from NE-DC to NE-DC” scenario and “from NR SA to NE-DC” scenario. 3. Starting point of the delay requirements for HO with PSCell can reuse the starting point of legacy HO. 4. Once the UE is ready to transmit PRACH preamble towards target PSCell marks the ending point for HO with PSCell procedure. 5. In HO with PSCell, legacy HO and PSCell addition operations can be performed partly in parallel while RA procedure for first for the target Pcell and then for the target PSCell will be performed sequentially. 6. The delay requirements for HO with PSCell can be described as: DHO\_with\_PSCell = TRRC\_delay + Tsearch + Tprocessing + T∆ + Tmargin +TFFS + TPcell\_IU + TPSCell\_DU.Where TFFS is the delay related to performing and finalizing the Pcell random access procedure before the RA preamble can be transmitted on the PSCell |
| [**R4-2107249**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107249.zip) | Qualcomm CDMA Technologies | Proposal1: For issue 2-2-3 raised in 98-e, parallel HO and PSCell change/addition operations shall be assumed for defining RAN4 requirements.  Observation1: RAN4 agrees when there is a mode switch of frequency ranges, the maximum UE processing time Tprocessing is doubled.  Observation2: DC capable Ues can handle the tasks of ACQ, loops and RACH independently for both Pcell and PSCell since this is already the case in the connection mode.  Proposal2: Reuse the same time for Tsearch, Tmargin, T∆ and TIU as the Pcell only handover per 38.133 6.1.1 for the joint Pcell w/ PSCell handover.  Observation3: Longer RRC procedural delay TRRC shall beconsidered for NRSA to EN-DC HO w/ PSCell.  Proposal3: RAN4 to adopt RAN2 recommended numbers for TRRC.  Proposal4: Extending the UE processing time for NRSA to EN-DC joint handover by [FFS]ms and [FFS] can be 10ms as the starting point, i.e. Tprocessing = [30]ms.  Proposal5: For NRDC to NRDC, the UE processing time to be 20ms without FR mode switch on PSCell; otherwise, the UE processing time shall be 40ms as the legacy PSCell change requirement.  Proposal5.1: For NRDC to NRDC, only consider FR1 for Pcell.  Proposal6: Re-use the same definitions of starting point and end point as legacy HO. |

## 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 Scenarios for RRM requirement of HO with PSCell

*Sub-topic description:*

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

**Issue 2-1-1:** Scenarios for RRM requirement of HO with PSCell

* Proposals
  + Option 1(Apple, HW, QC, OPPO, Xiaomi, vivo, CATT, MTK): RAN4 specifies RRM requirement for HO with PSCell for following scenarios:
    - from NR SA to EN-DC
    - from EN-DC to EN-DC
    - from NE-DC to NE-DC
    - from NR-DC to NR-DC
  + Option 2(NEC, Nokia): RAN4 specifies RRM requirement for HO with PSCell for following scenarios:
    - from NR SA to EN-DC
    - from EN-DC to EN-DC
    - from NE-DC to NE-DC
    - from NR-DC to NR-DC
    - from NR SA to NE-DC (newly added)
    - from NR SA to NR-DC (newly added)
    - from LTE SA to EN-DC (newly added)
  + Option 3(MTK): RAN4 specifies RRM requirement for HO with PSCell for following scenarios:
    - from NR SA to EN-DC
    - from EN-DC to EN-DC
    - from NE-DC to NE-DC
    - from NR-DC to NR-DC

And RAN4 to clarify whether requirements from LTE-SA to EN-DC and from NR-SA to NR-DC are needed

* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | We support option 1, but we are open to hear views from operators. One more thing is, in WID only 4 scenarios were listed for selecting, if companies want more scenarios, it needs to be added into WID in RAN plenary first. |
| Qualcomm | Option1 is supported in line with the scope defined in WID. |
| OPPO | Agree with Apple’s view. |
| Xiaomi | Support option 1, for the new added scenarios in option 2, need to clarify whether these scenarios are needed from real network implementation and are supported in RAN2 from configuration and signaling perspective. |
| Vivo | Agree with QC and Apple. |
| CMCC | We are positive to the newly added scenario. And we would like to know is there any potential issues to support the new scenarios. |
| Docomo | Agree with Apple’s opinion. Other scenarios should be discussed. |
| CATT | Support option 1. |
| Nokia | We support Option 2. The supported scenarios for MR-DC handover including PSCell should be applicable for HO with PSCell in MR-DC, which are defined in RAN2 specification. |
| MediaTek | Agree with APPLE |
| NEC | We support option 2. Our understanding is we use common framework for all the scenarios. Since it is common framework, we feel RAN4 workload is not impacted. Hence we propose to consider other scenarios.  However, we also agree with part of Apple comment that we like to hear views from operators regarding this issue. |

**Issue 2-1-2: NR-DC and NE-DC mode in HO with PSCell**

* Proposals
  + Option 1(CATT, Apple, OPPO, MTK): In R17 RAN4 only considers:
    - FR1+FR2 NR-DC for HO with PSCell from NR-DC to NR-DC,
    - FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC.
  + Option 2 (NEC, Intel, vivo, QC, Ericsson, MTK):
    - FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC,
    - FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC.
  + Option 3 (Ericsson):
    - FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC,
    - FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC,
    - FFS on FR2+LTE NE-DC for HO with PSCell from NE-DC to NE-DC.
  + Option 4 (Nokia):
    - FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC,
    - FR1+LTE and FR2+LTE NE-DC for HO with PSCell from NE-DC to NE-DC,
    - FR1+LTE and FR2+LTE NE-DC for HO with PSCell from NR SA to NE-DC.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Option 1 is preferable, since so far RAN4 had no baseline RRM PSCell addition or measurement requirement for FR1+FR1 NR-DC or FR2+LTE NE-DC. We think HO with PSCell is an optimized feature based on legacy PSCell addition and HO requirement, and therefore it makes more sense to first discuss FR1+FR1 NR-DC or FR2+LTE NE-DC in baseline RRM requirement, and then we could extend them to this WI. |
| Qualcomm | Option2 can be supported. |
| OPPO | Support option 1 as baseline. For FR1+FR1 NR-DC, clear demands from operators could be important for further discussion. |
| Vivo | Option 2. |
| Ericsson | OK with Option 2 as baseline.  Further discuss additional combinations if the need is raised by operators or it gets clarified in the WID. |
| CATT | Support option 1. In TS38.101-3 [2], only band combinations between FR1 and FR2 are defined for inter-band NR-DC. Although there are FR1+FR1+FR2 three or four band combination for NR-DC, there are not band combinations FR1+FR1 only. So FR1+FR1 NR-DC should not be considered currently. For NE-DC, the FR1+LTE and FR2+LTE NE-DC band combination are defined. But we think that FR1 +LTE is more typical and higher priority, and FR2+LTE can be deal with low priority. |
| Intel | Support option 2. |
| Nokia | We support Option 4. FR1+FR1 NR-DC supported in R16, FR2+LTE NE-DC supported in RF R17, it is no doubt to exclude them. |
| MediaTek | Support option 1 and option 2 |
| NEC | We support option 2. |

### Sub-topic 2-2 Delay requirement design of HO with PSCell

*Sub-topic description*

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

**Issue 2-2-1: timeline for HO with PSCell**

* Proposals
  + Option 1 (Xiaomi, Apple, ZTE, OPPO): Pcell HO and PSCell addition is performed in a sequential order.
  + Option 2 (CATT, CMCC, Huawei, MTK, QC, ZTE, NEC): Pcell HO and PSCell addition is performed in parallel.
    - Option 2a (vivo): RAN4 consider parallel processing capable UE in R17 as baseline and further identify the needed sequential processing during HO with PSCell.
    - Option 2b (Qualcomm): Pcell HO and PSCell addition are performed in parallel after UE side processing (e.g. RF and SW preparations) is completed.
  + Option 3 (Apple): A new R17 UE capability is introduced to indicate whether UE can support sequential processing or parallel processing for HO with PSCell.
  + Option 4 (NTT DOCOMO, Intel, OPPO, Nokia, Ericsson, NEC): Some of procedures of HO with PSCell should be able to be performed in parallel, but RACH processing is performed in a sequential order (RACH procedure of PSCell will happen after the RACH procedure of Pcell).
  + Option 5 (NEC): For NR SA to EN-DC and NE-DC to NE-DC, RAN4 to agree that cell search of Pcell and PSCell is performed in sequential order. For NR-DC to NR-DC, RAN4 to agree that cell search is performed in parallel for FR1+FR2 NR-DC and FR1+FR1 NR-DC.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | We prefer option 1 since both of sequential and parallel processing are UE implementation methods and RAN4 shall consider the minimum requirement. But in order to move forward, we propose a compromised solution in option 3 with UE capability indication. |
| Qualcomm | Overall Option2 is supported.  1. Beyond legacy, R17 evolves to facilitate the joint handover. A sequential flow results in substantially longer HO delay which defies the motivation of this WI.  2. RAN2 defines the HO command with SCG configuration for UE to initiate both MCG and SCG procedures sooner.  3. In our view, while search, loops, RACH may parallelize, the UE processing for RF/SW preparations may have certain dependency. Thus, minimum requirements may be discussed for Tprocessing. Regarding this, we propose option2b. Can Moderator please include it? This could be an alternative compromise. Thanks!  ***Option 2b (Qualcomm): Pcell HO and PSCell addition are performed in parallel after UE side processing (e.g. RF and SW preparations) is completed.***  Note the parallel assumption saves RAN4’s effort to discuss applicability of 2-step v.s. 4-step RACH in the process because the unified definition of the end points for Pcell and PSCell.  Also note in legacy, NW can already sequentially issue commands for Pcell HO and add PSCell and direct a UE to follow a two-step flow. There is no tangible purpose to introduce/define the requirements again. |
| ZTE | We can support Option 2. Agree that the new feature should demand the UE capable of handling the two processes in parallel. |
| OPPO | Support option 4 that the procedures of physical layer are performed in a sequential order, while procedures of high layer can be in parallel.  We can also compromise to option 1, with some clarification of the timeline/procedures for physical layer.  Besides, UE capability is not preferred from our side. We prefer to have one single delay requirement for HO with PSCell to ensure the flexibility of UE implementation. |
| Huawei | Support option 2. For option 4, the uncertainty could be considered but it has been defined in TS 38.213. |
| Xiaomi | Support option 1, for the low-cost Ues, they may be implemented by single RF chain and not have the capability to perform the cell search and fine time tracking in parallel. Thus, the minimum delay requirement should be defined assumed these procedures are performed in sequentially for these low capability Ues. Regarding the RRC processing time, we think they can be shared for Pcell HO and PSCell addition. |
| Vivo | Support option 2a. For RACH procedure mentioned in Option 4, we think parallel processing is ONLY impossible for the single uplink cases for some of the EN-DC/NE-DC band combinations. Therefore, we propose to agree on option 2a, which is a reasonable compromise between option 2 and option 4. |
| CMCC | Our preference is option 2. In our understanding, the motivation of introducing HO with PSCell is to reduce the total delay, parallel way is preferred. |
| Ericsson | Support Option 2 and Option 4. |
| Docomo | We prefer option 4. But if it is clarified that there is no processing problem when all of the procedures are performed in parallel, option 2 seems also fine. |
| CATT | Support option 2. For the UE supporting DC, it can work inevitably on PCC and SCC, and make normal intra frequency measurement on the two CCs including cell search, and can transmit UL signal on two CCs at same time. During HO with PSCell, UE works only on Pcell and PSCell search and measurement, and transmit PRACHs on the two Cells separately. So UE should have capability to perform in parallel the Pcell handover process and PSCell addition process. |
| Intel | Support option 4. Suggest to identify which part can be processed in parallel currently. We can compromise to option 3 if no agreement is achieved at last. |
| Nokia | We support option 4. When UE receive the RRC message, UE can start HO procedure and PSCell addition procedure. According to RAN2 specification, RACH procedure toward target Pcell and PSCell will be performed sequentially, while others like UE SW processing, cell search, timing tracking for PSCell addition and for Pcell HO can be performed in parallel. |
| MediaTek | Support option 2. We share the same view with Huawei |
| NEC | Based on our discussion paper, to align with the options here, our view is, in broad sense we support option 2 and option 4. Our proposal of option 5 is combination of option 2 and option 4.  May be we could agree on Option 2 as baseline and further discuss which of the procedures needs sequential execution. |

**Issue 2-2-2: starting point of the delay requirement for HO with PSCell**

* Proposals: For delay requirement of HO with PSCell, the starting point definition is:
  + Option 1 (Xiaomi, CATT, Apple, CMCC, OPPO, Ericsson, ZTE, HW, Nokia, QC):
    - the end of the last TTI containing the RRC command implying handover with PSCell
* Recommended WF
  + For delay requirement of HO with PSCell, the starting point is the end of the last TTI containing the RRC command **of** handover with PSCell.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Support the recommended WF |
| Qualcomm | Option1 is supported and agreeable.  Recommended WF is NOT clear to us due to the wording “implying”. |
| ZTE | Support the recommended WF. Wording can be slightly updated by changing *implying* to *commanding*. |
| OPPO | Support the recommended WF |
| Huawei | Support the recommended WF. |
| Xiaomi | Agree with the recommended WF. |
| Vivo | Support the recommended WF. |
| CMCC | Support the recommended WF. |
| Ericsson | Option 1. |
| Docomo | Support the recommended WF. |
| CATT | Support the recommended WF. |
| Intel | Agree with the recommended WF. |
| Nokia | We are fine with the recommended WF. |
| MediaTek | Agree the recommended WF |
| NEC | Agree with recommended WF |

**Issue 2-2-3: ending point of the delay requirement for HO with PSCell**

* Proposals: For delay requirement of HO with PSCell, the ending point definition is:
  + Option 1 (Xiaomi, Intel, ZTE, Nokia):
    - When the UE shall be capable to transmit PRACH preamble towards target PSCell within Thandover\_with\_PSCell from the end of the last TTI containing the RRC command implying handover with PSCell. Where Thandover\_with\_PSCell is the delay requirement of HO with PSCell.
  + Option 2 (CATT, CMCC, OPPO, QC, Ericsson, MTK):
    - the later timing between “timing when UE shall be capable to transmit PRACH preamble towards target Pcell” and “the timing when UE shall be capable to transmit PRACH preamble towards target PSCell”
  + Option 2a (Ericsson):
    - the later timing between “timing when UE shall be capable to transmit PRACH preamble towards target Pcell” and “the timing when UE shall be capable to transmit PRACH preamble towards target PSCell”
    - In case RAN4 defines scenarios where PRACH preamble transmission towards PSCell is not needed, ending point for those scenarios is PRACH preamble transmission towards Pcell.
  + Option 3 (Apple, OPPO):
    - if sequential processing is used, the timing when UE shall be capable to transmit PRACH preamble towards target PSCell
    - if the parallel processing is used, the later timing between “timing when UE shall be capable to transmit PRACH preamble towards target Pcell” and “the timing when UE shall be capable to transmit PRACH preamble towards target PSCell”
  + Option 4 (HW, vivo, ZTE, CMCC):
    - Define delay requirements for HO and PSCell addition/change separately with the ending points defined as Pcell PRACH and PSCell PRACH respectively. No need to define overall delay requirement.
  + Option 5 (QC):
    - same definitions of end point as legacy HO
* Recommended WF
  + Up to the conclusion from issue 2-2-1.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Support option 3. It’s up to the issue 2-2-1. If the sequential processing is used, the ending point would be PSCell RACH without any doubt. But if parallel processing is supported, our original understanding is there is no limitation of timing order between Pcell RACH and PSCell RACH since they are handled independently, but we are fine to have more discussion. We prefer to have one single delay requirement for each processing of HO with PSCell; and with one single delay requirement UE could be more flexible to coordinate the processing between HO and PSCell as long as the whole HO with PSCell could be completed within the required delay. |
| Qualcomm | We can compromise to Option2.  Option4 can be further discussed. |
| ZTE | Can support Option 4. |
| OPPO | Agree with the recommended WF. Option 3 can be used as guideline. |
| Huawei | We support option 4 based on the parallel processing assumption. |
| Xiaomi | Pending on the conclusion of issue 2-2-1. And we support option 1 based on the assumption that Pcell HO and PSCell addition will be performed in sequentially. |
| Vivo | We support option 4. Moderator proposal is fine. This is also linked to issue 2-3-1 |
| CMCC | Both option 2 and option 4 are OK for us if parallel order is considered. |
| Ericsson | Support Option 2. (Option 2a in case RAN4 identifies cases where PSCell RA is not needed.) |
| Docomo | Agree with the recommended WF. |
| CATT | Support option 2 and agree with the recommended WF. |
| Intel | Dependent on conclusion of issue 2-2-1. |
| Nokia | We are fine with the recommended WF. RA towards Pcell is always prioritized than PSCell, the ending point should be when UE shall be capable to transmit PRACH preamble towards target PSCell, which option 1 said. |
| MediaTek | Support option 2. |
| NEC | We agree with recommended WF. In principle as per 37.340, PRACH on PSCell can be considered as ending point. |

**Issue 2-2-4: checking point of the delay requirement for HO with PSCell**

* Proposals
  + Option 1(Ericsson): The handover with PSCell delay (interruption) requirement shall have two checkpoints: time until the UE is transmitting PRACH preamble in Pcell, and time until later of UE transmitting PRACH preamble in Pcell and UE transmitting PRACH preamble in PSCell.
  + Option 2(Apple, OPPO, HW, vivo, CATT, Nokia): FFS until we have conclusions on other relevant issues.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | It’s up to the discussion in issue 2-2-3. |
| Qualcomm | The intention of option1 is a bit vague to us. In real deployment, we expect Pcell and PSCell RACH can happen in parallel mostly. Option1 implies the order of Pcell firstly completes and PSCell follows. More clarifications are appreciated. |
| OPPO | Up to the discussion in issue 2-2-3. |
| Huawei | Depend on issue 2-2-3. |
| Vivo | Similar discussion as 2-2-2. |
| Ericsson | @Qualcomm: The intention was to avoid having a requirement where e.g. due to very different SMTCs etc the UE would be inactive on Pcell until having done RA on PSCell. The intention is not to force sequential RA. Essentially we would like the UE to start communicate in Pcell even if PSCell addition has not yet been fully completed, i.e. the Pcell handover should not be gated by the PSCell addition. (This is also related to Issue 2-3-1). |
| CATT | Depending on issue 2-2-2 and 2-2-3. |
| Nokia | We need to have conclusion on Issue 2-2-1 for timeline of HO with PSCell firstly. |
| MediaTek | We have 1 question to be clarified.  Does it mean that UE can send *RRCConnectionReconfigurationComplete* message after HO is completed and that is the first check point? The second check is PRACH preamble transmission towards Pcell, right?  If answers of above 2 questions are yes, then we are fine with the proposal |
| NEC | We do not fully understand the proposal. We mean what is the implication of checkpoints on requirements definition. Can we request further clarification? |

**Issue 2-2-5: optimisation for the case when PSCell is not changed during HO with PSCell**

* Proposals
  + Option 1(Xiaomi, CATT, Apple, OPPO, vivo, QC, HW, Intel, MTK, NEC): For UE which is already configured with DC, the UE’s ehavior is same when the configured PSCell is same as the original one or not.
  + Option 2 (Ericsson, Nokia, NEC): When source and target PSCell is the same cell, then fine time tracking T∆=0 shall apply.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Support option 1. |
| Qualcomm | Option1 can be supported.  Note during the joint HO, PSCell may be suspended, so it may be needed to restart the tracking rather than resume it. |
| OPPO | Support option 1. |
| Huawei | Prefer option 1. If the PSCell before and after is same, it could be handled as a known cell if the corresponding conditions are met. |
| Xiaomi | Support option1 |
| vivo | Option 1 |
| Ericsson | If fully parallel activation can be assumed then probably Option 1 can be fine. |
| CATT | Support option 1. |
| Intel | Fine with option 1. |
| Nokia | We support option 2. If the source and target PSCell is the same cell, UE should have known the timing, then it is no need for fine time tracking. |
| MediaTek | Support option 1. |
| NEC | In principle both option 1 and option2 is fine. Depends on other issue conclusions. |

**Issue 2-2-6: RRC processing delay for HO with PSCell**

* Proposals
  + Option 1 (OPPO, QC): Wait for the reply LS from RAN2 on RRC processing delay for HO with PSCell.
* Recommended WF
  + RAN4 waits for the reply LS from RAN2 on RRC processing delay for HO with PSCell.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Support recommend WF |
| Qualcomm | Support recommend WF |
| OPPO | Support option 1. |
| Huawei | Support the recommended WF. |
| Xiaomi | Agree with the recommended WF. |
| Vivo | Support recommend WF |
| CMCC | OK with the recommended WF. |
| Ericsson | Agree with Option 1. This is for RAN2 to decide. |
| Docomo | Agree with the recommended WF. |
| CATT | Support the recommended WF. |
| Nokia | We are fine with the recommended WF. |
| MediaTek | Agree with the recommended WF. |
| NEC | Agree with recommended WF. |

**Issue 2-2-7: UE SW processing and RF warm-up(if needed) time for HO with PSCell**

* Proposals
  + Option 1 (CATT): Tprocessing for HO with PSCell can be used the values for handover requirements and for PSCell addition requirement
  + Option 2 (Apple):
    - If UE only supports sequential processing for HO with PSCell, the total UE processing time for HO with PSCell is the sum of UE processing timing of HO and UE processing timing of PSCell addition.
    - If UE can support parallel processing for HO with PSCell, the total UE processing time for HO with PSCell could be the maximum one between UE processing timing of HO and UE processing timing of PSCell addition

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| UE processing margin (Tprocessing) | Target Pcell and PSCell is in the same FR as old Pcell | Target Pcell and/or target PSCell is in the different FR from old Pcell |
| Sequential processing capable UE | 40ms | 60ms |
| Parallel processing capable UE | 20ms | 40ms |

* + Option 3 (NEC, Huawei):
    - Tprocessing is the UE processing time. Tprocessing is the maximum value of Pcell HO and PSCell addition;
  + Option 4 (Intel):
    - For HO with PSCell from NR-DC to NR-DC, Tprocessing can be split into software processing (Tprocessing\_SW) and RF warm up time(Tprocessing\_RF). Tprocessing\_SW=[20]ms needs further discussion if some extension is needed. Tprocessing\_RF will be dependent on different scenarios, i.e. whether Pcell or PSCell change across FRs.
    - For HO with PSCell from NR SA to EN-DC, Tprocessing only includes software processing time (Tprocessing\_SW). Tprocessing\_SW=[20]ms needs further discussion if some extension is needed.
  + Option 5 (Ericsson):
    - The value of Tprocessing\_SW for PSCell is as follows:
      * Tprocessing\_SW\_PSCell = 0 ms, when source and target PSCells are the same cell,
      * Tprocessing\_SW\_PSCell = 20 ms, when source and target PSCells are different cells but in same FR
      * Tprocessing\_SW\_PSCell = 40 ms, when source and target PSCells are different cells in different FRs
    - How Tprocessing\_SW\_PSCell impacts the handover with PSCell timeline depends on assumptions on parallel or sequential processing.
  + Option 6 (vivo): RF chain activation and retuning time needs to be considered in the timeline of HO with PSCell.
  + Option 7 (QC, MTK):
    - Extending the UE processing time for NRSA to EN-DC joint handover by [FFS]ms and [FFS] can be 10ms as the starting point, i.e. Tprocessing = [30]ms.
    - For NRDC to NRDC, the UE processing time to be 20ms without FR mode switch on PSCell; otherwise, the UE processing time shall be 40ms as the legacy PSCell change requirement.
      * For NRDC to NRDC, only consider FR1 for Pcell.
* Recommended WF
  + Up to the conclusion from issue 2-2-1.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Support option 2 for all possible cases. We think the shortest processing time for SW and RF warm-up shall be 20ms based on the requirement in legacy HO and legacy PSCell addition. Regarding the different processing capability and different serving cell’s FR status, the processing delay shall be differentiated. |
| Qualcomm | Option7 is supported. |
| Huawei | Support option 3. |
| Xiaomi | Pending on whether the UE processing timing can be performed in parallel or in sequentially |
| vivo | FFS |
| Ericsson | Support Option 5. |
| CATT | Support option 1. The UE SW processing and RF warm-up has been included in Tprocessing time in HO or PSCell addition. |
| Intel | Option 4. Suggest to split into RF warming up time and UE software processing time. For UE software processing time, we are open to check if parallel processing can be applied.  For RF warming up time, it depends on whether RF changes cross FR and not related to parallel processing. |
| Nokia | We are fine with the recommended WF. From our view, UE processing can be performed in parallel for HO and PSCell addition, Option 1 and Option 3 are fine. For detail values of UE processing time, we can discuss further. |
| MediaTek | Agree with the recommended WF. We prefer option 7. |
| NEC | Agree with recommended WF and in principle, we support option 3. |

**Issue 2-2-8: Delay requirement design if sequential processing is assumed (from issue 2-2-1)**

* Proposals
  + Option 1 (Xiaomi):
    - For HO with PSCell, it is assumed that the following procedures should be performed in sequentially order:
      * Cell search;
      * Fine time tracking;
      * UE processing time;
      * Time for interruption uncertainty in acquiring the first available PRACH occasion in the new cell;
      * Time for SSB post-processing
  + Option 2 (Apple):
    - For sequential processing capable UE, RAN4 assumes that UE performs target PSCell addition after receiving RAR (msg 2) from target Pcell in the requirement of HO with PSCell.
    - If sequential processing is used, UE transmits PSCell RACH later than Pcell RACH.
    - The delay requirement is summarized as:

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| When the UE receives a RRC message implying handover to EN-DC on slot n, the delay of HO with PSCell for NR SA to EN-DC could be,  Thandover\_with\_PSCell = TRRC\_procedure\_delay + Tinterrupt + Tmsg2 + Tconfig\_PSCell – 20ms  Where,  Tinterrupt is as defined in TS38.133 section 6.1.2.1.3 (HO from NR to LTE).  Tmsg2 is delay from slot n + (TRRC\_procedure\_delay + Tinterrupt)/NR slot length until UE has obtained RACH response (msg2) from the target Pcell.  Tconfig\_PSCell is as defined in TS36.133 section 7.31.2 (PSCell addition for EN-DC). TPSCell\_ DU in Tconfig\_PSCell is the delay uncertainty in acquiring the first available PRACH occasion in the NR PSCell.  When the UE receives a RRC message implying handover to EN-DC on slot n, the delay of HO with PSCell for EN-DC to EN-DC could be,  Thandover\_with\_PSCell = TRRC\_procedure\_delay + Tinterrupt + Tmsg2 + Tconfig\_PSCell – 20ms  Where,  Tinterrupt is as defined in TS36.133 section 5.1.2.1.2.1 (HO from LTE to LTE).  Tmsg2 is delay from slot n + (TRRC\_procedure\_delay + Tinterrupt)/NR slot length until UE has obtained RACH response (msg2) from the target Pcell.  Tconfig\_PSCell is as defined in TS36.133 section 7.31.2 (PSCell addition for EN-DC). TPSCell\_ DU in Tconfig\_PSCell is the delay uncertainty in acquiring the first available PRACH occasion in the NR PSCell.  When the UE receives a RRC message implying handover to NE-DC on slot n, the delay of HO with PSCell for NE-DC to NE-DC could be,  Thandover\_with\_PSCell = TRRC\_procedure\_delay + Tinterrupt + Tmsg2 + Tconfig\_EUTRAN-PSCell – 20ms  Where,  Tinterrupt is as defined in TS38.133 section 6.1.1.2.2 (HO from NR FR1 to NR FR1).  Tmsg2 is delay from slot n + (TRRC\_procedure\_delay + Tinterrupt)/NR slot length until UE has obtained RACH response (msg2) from the target Pcell.  Tconfig\_EUTRAN-PSCell is as defined in TS38.133 section 8.8.2 (PSCell addition for NE-DC).  When the UE receives a RRC message implying handover to NR-DC on slot n, the delay of HO with PSCell for NR-DC to NR-DC could be,  Thandover\_with\_PSCell = TRRC\_procedure\_delay + Tinterrupt + Tmsg2 + Tconfig\_PSCell – 16ms  Where,  Tinterrupt is as defined in TS38.133 section 6.1.1.2.2 (HO from NR FR1 to NR FR1).  Tmsg2 is delay from slot n + (TRRC\_procedure\_delay + Tinterrupt)/NR slot length until UE has obtained RACH response (msg2) from the target Pcell.  Tconfig\_PSCell is as defined in TS38.133 section 8.9.2 (PSCell addition for NR-DC). |

* Recommended WF
  + Up to the conclusion from issue 2-2-1 and other issues.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Can hold on until we have conclusions on other issues. |
| OPPO | Agree with the recommended WF. |
| Xiaomi | Agree with the recommended WF. |
| Vivo | FFS |
| Ericsson | Details on delay requirements have to wait until issues pertaining to the execution of the procedure have been settled. |
| CATT | Support with the recommended WF. |
| Nokia | We are fine with the recommended WF. In our view, when UE receive the RRC msg implying HO with PSCell, UE can start Pcell HO and PSCell addition in parallel. |
| MediaTek | Agree with the recommended WF. |
| NEC | Agree with the recommended WF |

**Issue 2-2-9: Delay requirement design if parallel processing is assumed (from issue 2-2-1)**

* Proposals
  + Option 1 (CATT, OPPO):
    - The HO with PSCell delay requirement can be defined as longer delay requirement between legacy handover delay requirement and legacy PSCell addition delay requirement, with HO with PSCell RRC procedure delay replacing the legacy RRC procedure delay separately.
  + Option 2 (Apple):
    - If parallel processing is used, there is no time order limitation between Pcell RACH and PSCell RACH for HO with PSCell.
    - For parallel processing capable UE, RAN4 assumes that UE performs target Pcell HO and target PSCell addition independently after decoding the HO command.
    - The delay requirement is summarized as:

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| When the UE receives a RRC message implying handover to EN-DC on slot n, the delay of HO with PSCell for NR SA to EN-DC could be,  Thandover\_with\_PSCell = TRRC\_procedure\_delay + max {Tinterrupt, Tconfig\_PSCell – 20ms}  Where,  Tinterrupt is as defined in TS38.133 section 6.1.2.1.3 (HO from NR to LTE).  Tconfig\_PSCell is as defined in TS36.133 section 7.31.2 (PSCell addition for EN-DC). TPSCell\_ DU in Tconfig\_PSCell is the delay uncertainty in acquiring the first available PRACH occasion in the NR PSCell.  When the UE receives a RRC message implying handover to EN-DC on slot n, the delay of HO with PSCell for EN-DC to EN-DC could be,  Thandover\_with\_PSCell = TRRC\_procedure\_delay + max {Tinterrupt, Tconfig\_PSCell – 20ms}  Where,  Tinterrupt is as defined in TS36.133 section 5.1.2.1.2.1 (HO from LTE to LTE).  Tconfig\_PSCell is as defined in TS36.133 section 7.31.2 (PSCell addition for EN-DC). TPSCell\_ DU in Tconfig\_PSCell is the delay uncertainty in acquiring the first available PRACH occasion in the NR PSCell.  When the UE receives a RRC message implying handover to NE-DC on slot n, the delay of HO with PSCell for NE-DC to NE-DC could be,  Thandover\_with\_PSCell = TRRC\_procedure\_delay + max{Tinterrupt, Tconfig\_EUTRAN-PSCell – 20ms}  Where,  Tinterrupt is as defined in TS38.133 section 6.1.1.2.2 (HO from NR FR1 to NR FR1). TIU in Tinterrupt is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell.  Tconfig\_EUTRAN-PSCell is as defined in TS38.133 section 8.8.2 (PSCell addition for NE-DC).  When the UE receives a RRC message implying handover to NR-DC on slot n, the delay of HO with PSCell for NR-DC to NR-DC could be,  Thandover\_with\_PSCell = TRRC\_procedure\_delay + max{Tinterrupt, Tconfig\_PSCell – 16ms}  Where,  Tinterrupt is as defined in TS38.133 section 6.1.1.2.2 (HO from NR FR1 to NR FR1).  Tconfig\_PSCell is as defined in TS38.133 section 8.9.2 (PSCell addition for NR-DC). TPSCell\_DU in Tconfig\_PSCell is the delay uncertainty in acquiring the first available PRACH occasion in the PSCell. |

* + Option 3 (CMCC):
    - delay requirement for HO with PSCell is maximum (PSCell addition delay, HO delay)
      * PSCell addition delay= TRRC\_delay + Tprocessing + Tsearch + T∆ + TPSCell\_ DU + 2 ms
      * HO delay = TRRC\_delay +Tinterrupt = TRRC\_delay +Tsearch + TIU + Tprocessing + T∆ + Tmargin ms
  + Option 4 (MTK):
    - For the scenario from NR-DC to NR-DC, the overall delay requirement of HO with PSCell procedure might be specified as DHO\_with\_PSCell = TRRC\_delay + max(Dhandover- TRRC\_delay, Tconfig\_PSCell – TRRC\_delay).
  + Option 5 (Nokia):
    - The delay requirements for HO with PSCell can be described as: DHO\_with\_PSCell = TRRC\_delay + Tsearch + Tprocessing + T∆ + Tmargin +TFFS + TPcell\_IU + TPSCell\_DU.Where TFFS is the delay related to performing and finalizing the Pcell random access procedure before the RA preamble can be transmitted on the PSCell.
  + Option 6 (QC):
    - Reuse the same time for Tsearch, Tmargin, T∆ and TIU as the Pcell only handover per 38.133 6.1.1 for the joint Pcell w/ PSCell handover.
* Recommended WF
  + Up to the conclusion from issue 2-2-1 and other issues.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Can hold on until we have conclusions on other issues. |
| OPPO | Agree with the recommended WF. |
| Xiaomi | Agree with the recommended WF. |
| Vivo | FFS |
| Ericsson | Details on delay requirements have to wait until issues pertaining to the execution of the procedure have been settled. |
| CATT | Support with the recommended WF. |
| Nokia | We are fine with the recommended WF. If it is agreed that Pcell HO and PSCell addition can be performed in parallel except RA procedure towards target Pcell and target PSCell will be in sequence way, we support option 5. |
| MediaTek | Agree with the recommended WF. |
| NEC | Agree with the recommended WF |

### Sub-topic 2-3 Interruption requirement design of HO with PSCell

*Sub-topic description*

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

**Issue 2-3-1: whether or not RAN4 assumes PCC could be scheduled for UE when Pcell HO is completed but PSCell addition is not completed**

* Proposals
  + Option 1 (Apple, QC, vivo, CMCC, Ericsson, Nokia, MTK, NEC): Yes
  + Option 2 (OPPO, Xiaomi): No.
  + Option 3 (CATT): wait for RAN2 reply LS about error case handling
* Recommended WF
  + - Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Option 1. In RAN2 TS38.133 it defined that “NOTE 1: The order the UE sends the *RRCConnectionReconfigurationComplete* message and performs the Random Access procedure towards the SCG is left to UE implementation.” So, after UE sending RRC complete for HO, network can schedule the data on new Pcell while PSCell addition is still under processing, for both sequential processing and parallel processing implementation. |
| Qualcomm | Option1 is supported |
| OPPO | For HO with Pscell, the agreements in RAN2 that “it is left to UE implementation” should also apply. It is more feasible that the network can be not allowed to schedule data on Pcell to ensure all Ues can meet the minimum requirements. |
| Xiaomi | From our perspective, we think the interruption is not needed, as if RAN4 define the overall delay requirement for HO with PSCell, and the ending point is the PRACH transmission on PSCell, then UE is not expected to be scheduled before the completion of Pcell HO and PSCell addition. Hence, no interruption requirement is needed. |
| Vivo | Option 1. |
| CMCC | Support option 1, |
| Ericsson | We support Option 1. This was also the reason we were proposing potentially using two check points in the delay requirement (Issue 2-2-4). |
| CATT | It may be related to UE behavior defined in RAN2 which is also included in the LS in issue 2-2-6. Can be further discussed after receiving the reply LS. |
| Nokia | We support option 1. |
| MediaTek | Support option 1. |
| NEC | Support option 1 |

**Issue 2-3-2: Interruption requirement for HO with PSCell**

* Proposals
  + Option 1 (Xiaomi, HW, vivo, QC, ZTE, DOCOMO, CATT): No interruption requirement should be defined during HO with PSCell
  + Option 2 (CATT): Interruption in legacy handover delay requirement can be applied for Pcell. No interruption is defined on PSCell.
  + Option 3(Apple):
    - If sequential processing is used for HO with PSCell, UE would have an interruption on new Pcell due to the PSCell addition.
    - If parallel processing is used for HO with PSCell and PSCell addition is completed earlier than Pcell HO, no need to define interruption requirement since interruption has been reflected by HO delay.
    - If parallel processing is used for HO with PSCell and PSCell addition is completed later than Pcell HO, UE may have an interruption on new Pcell due to RF tuning for PSCell addition.
  + Option 4 (ZTE): For interruption requirements, consider the following options:
    - Specify a total interruption for handover and PSCell addition
    - Specify separate interruptions for handover and PSCell addition.
  + Option 5 (MTK): RAN4 to specify the Pcell interruption time for the overall HO with PSCell procedure.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Up to issue 2-2-1 and issue 2-3-1. |
| Qualcomm | Option1 can be supported that no new interruptions are identified. |
| ZTE | Can support Option 1 not to define new interruptions. |
| OPPO | Agree with the recommended WF. If issues 2-3-1 goes to “No”, then no interruption (Option 1) is allowed; Otherwise, an interruption on new Pcell would be expected due to Pscell addition. |
| Huawei | Support option 1. |
| Xiaomi | Support option 1, as commented in issue 2-3-1, the interruption is not needed. |
| Vivo | Option 1. |
| Docomo | Agree with option 1. |
| CATT | Fine with option 1. There is no new interruption requirement for HO with PSCell. Our proposal is the RRC connection interruption due to HO on Pcell is still applied. |
| Nokia | We are fine with the recommended WF. |
| MediaTek | Agree with the recommended WF. |
| NEC | Agree with recommended WF |

### Sub-topic 2-4 Generic RACH assumption for HO with PSCell

*Sub-topic description*

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

**Issue 2-4-1: 2 step and 4 step RACH for HO with PSCell**

* Proposals
  + Option 1 (CATT, QC, Ericsson(if parallel is agreed)): The delay requirements for HO with PSCell are not relative with 2 step or 4 step RACH if the ending point of delay is defined as PRACH transmission of UE.
  + Option 2 (Apple, vivo, OPPO, Xiaomi, MTK): for requirement of HO with PSCell, RAN4 starts the discussion with 4 step RACH first and FFS on 2 step RACH.
  + Option 3 (NEC, Ericsson, ZTE, Nokia): RAN4 to define both 2-step and 4-step RACH requirements for handover with PSCell.
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Option 2. |
| Qualcomm | Option1 is supported |
| ZTE | Option 3. On Option 1: the end point is not settled yet. If the delay requirements are specified in a way that is identical with 2-step RACH and 4-step RACH, we can further check whether we need to mention the RACH type. |
| OPPO | Support option 2. |
| Xiaomi | Support option 2 |
| vivo | Option 2 |
| CMCC | We would like to know what’s the impact on delay requirements from different UE type. |
| Ericsson | Option 1 in case parallel processing is agreed. Otherwise Option 3. If parallel processing is used then it does not matter whether 2 or 4-step RA is used, as one leg is not gating the other. |
| CATT | Support option 1. |
| Nokia | We support option 3. 2-step or 4-step RACH is invisible in HO requirements, and RAN4 already defined the applicability of 2-step RA and 4-step RACH in RRM requirements both for the HO requirements and PSCell addition requirements. It is no need to distinguish them. |
| MediaTek | Agree with option 2. |
| NEC | We support option 3. |

**Issue 2-4-2: RACH occasion collision between Pcell and PSCell**

* Proposals
  + Option 1 (CATT, Nokia): There is no need to further consider the RO collision issue from RAN4’s perspective.
  + Option 2 (Apple, OPPO(support sequential part), HW(support 2nd bullet), MTK(support 2nd bullet)):
    - If sequential processing is used, there is no need to consider RACH occasion (RO) collision between Pcell and PSCell.
    - If parallel processing is used:
      * for FR1+FR1 EN-DC, an additional uncertainty delay due to PSCell RACH collision with Pcell UL channels may be introduced if the PSCell RACH cannot be transmitted based on the criteria in TS38.213 section 7.6.1;
      * for FR1+FR1 NE-DC, an additional uncertainty delay due to Pcell RACH collision with PSCell RACH may be introduced if the Pcell RACH cannot be transmitted based on the criteria in TS38.213 section 7.6.2;
      * otherwise, if the Pcell and PSCell are on the different FRs, no need to consider RO collision issue.
  + Option 3 (NEC):
    - RAN4 to agree that components that contribute to TIU delay are the TA acquisition delay in Pcell, delay uncertainty in acquiring resources for RRC connection Reconfiguration Complete message on Pcell and PRACH acquisition uncertainty delay in PSCell.
    - RAN4 to agree that interruption uncertainty (TIU) for Pcell and PSCell is sequential process.
  + Option 4 (vivo): PRACH occasion collision is considered as one factor in the requirements for HO with PSCell, if UE only supports single uplink in the NE-DC or EN-DC.
  + Option 5 (MTK): For the scenario from NE-DC to NE-DC, RAN4 to clarify whether to remove the delay uncertainty of Pcell PRACH preamble transmission from the delay requirement of HO with PSCell procedure
* Recommended WF
  + Continue discussion in 2nd round, and agreements would be captured in the WF.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Support option 2. If parallel processing is used, the RO colliding case has been clarified in RAN1 spec TS38.213, and RAN4 shall follow RAN1 definition to add some RO uncertainty for Tx power limitation issue and single Tx issue. |
| Qualcomm | FFS |
| OPPO | Partially agree with option 2, if sequential processing is used then no need to consider RACH occasion (RO) collision. |
| Huawei | Agree with the second bullet in option 2. It has been clearly defined in RAN1 spec. |
| Xiaomi | Pending on whether the sequential processing or parallel processing is assumed for RACH procedure. |
| Vivo | Option 4. |
| Docomo | Agree with Xiaomi’s view. We should conclude sequential/parallel issue firstly. |
| CATT | FFS. We think the time limitation is not needed to be considered and the Tx power limitation should be FFS. |
| Nokia | We support option 1. According to RAN2 specification, RA procedure towards target Pcell and PSCell will be performed sequentially, hence we do not need to consider RO collision. |
| MediaTek | Agree with the second bullet in option 2. |
| NEC | Can be FFS at this stage. |

**Issue 2-4-3: RACH occasion on NR-U CC for HO with PSCell**

* Proposals
  + Option 1 (Ericsson): RAN4 to further study whether RA for spCell on unlicensed carrier with CCA shall be prioritized over RA for spCell on licensed carrier, once CCA is successful.
  + Option 2 (Apple, QC, OPPO, HW, vivo, DCM, CATT, MTK): The NR-U scenario is out of scope of this WID, no need to discuss.
* Recommended WF
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | We think the NR-U scenario is out of scope of this WID, no need to discuss. |
| Qualcomm | Agree with the recommended WF |
| OPPO | Agree with the recommended WF. |
| Huawei | Agree with the recommended WF. |
| Vivo | Agree with the recommended WF. |
| Ericsson | We do not agree with the WF. According to the WID RAN4 needs to define requirements for HO with PSCell for listed scenarios. It does not limit that NR is only in licensed band (see below the objective). These are RAN2 procedures. If there is no consensus then RAN4 should ask RAN2 whether HO with PSCell excludes NR-U or not. If not excluded then RAN4 should define requirements also for NR-U cases.  *(2) HO with PSCell [RAN4]*  o *Determine the scenarios for HO with PSCell for which RRM requirements are to be specified*  *- from NR SA to EN-DC*  *- from EN-DC to EN-DC*  *- from NE-DC to NE-DC*  *- from NR-DC to NR-DC*  *o Study the UE behavior for HO with PSCell*  *- Existing requirements for HO and PSCell addition as baseline*  *- Timeline and interaction between HO and PSCell addition*  *o Specify RRM requirements for HO with PSCell based on agreed UE behavior*  --- UPDATED ---  The RAN2 specifications do not preclude MR-DC operation in shared spectrum. Rather it is seen as a normal case.  TS 37.340 16.5.0 clause 4.4.1 Common MR-DC principles:  [...]  The MN and/or the SN can be operated with shared spectrum channel access.  [...]  TS 37.340 16.5.0 clause 6.1 MAC Sublayer:  [...]  In MR-DC, consistent LBT failure recovery procedure as described in clause 5.6.1 in TS 38.300 [3] can be configured for both MAC entities of MCG and/or SCG when operating with shared spectrum channel access.  [...]  TS 37.340 16.5.0 clause 7.7 SCG/MCG failure handling:  [...]  The following SCG failure cases are supported:  -     SCG RLF;  -     SN change failure;  -     For EN-DC, NGEN-DC and NR-DC, SCG configuration failure or CPC configuration failure (only for messages on SRB3);  -     For EN-DC, NGEN-DC and NR-DC, SCG RRC integrity check failure (on SRB3);  -     For EN-DC, NGEN-DC and NR-DC, consistent UL LBT failure on PSCell;  -    For IAB-MT, reception of a BH RLF indication from SCG;  -     CPC execution failure.  [...] |
| Docomo | Agree with the recommended WF. |
| CATT | Support the recommended WF. |
| Nokia | RO collision will not be considered. According to RAN2 specification, RA procedure towards target Pcell and PSCell will be performed sequentially. It does not matter if Pcel/PSCell is on licensed or unlicensed. RA towards Pcell always prioritized. |
| MediaTek | Agree with the recommended WF. |

### Sub-topic 2-5 Others

*Sub-topic description*

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

**Issue 2-5: Failure case definition for HO with PSCell**

* Proposals
  + Option 1 (CATT): RAN4 specified delay requirements HO with PSCell by UE sent PRACH on Pcell and PSCell. Failure cases should not defined in RAN4 specification.
  + Option 2 (Huawei, Ericsson): UE shall transmit RRC complete message no matter whether the synchronization to the PSCell is completed or not. UE will report SCG failure If UE fails to synchronize to the target PSCell.
  + Option 3 (Apple, QC, OPPO, Xiaomi, vivo, CATT, Nokia, MTK): RAN4 waits for the reply LS from RAN2 before any decision
* Recommended WF
  + RAN4 waits for the reply LS from RAN2 before any decision.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Support recommended WF. |
| Qualcomm | Support recommended WF. |
| OPPO | Support recommended WF. |
| Xiaomi | Support recommended WF. |
| Vivo | Agree with the recommended WF. |
| Ericsson | In our view, Option 2 is capturing the correct and expected UE ehavior. |
| CATT | Support recommended WF. |
| Nokia | We are fine with the recommended WF. |
| MediaTek | Agree with the recommended WF. |

## Companies views’ collection for 1st round

### Open issues

Comments are collected in section 2.2

### 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.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
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## Summary for 1st round

### Open issues

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

**Sub-topic 2-1 Scenarios for RRM requirement of HO with PSCell**

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|  | **Status summary** |
| **Issue 2-1-1: Scenarios for RRM requirement of HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * + Option 1(Apple, HW, QC, OPPO, Xiaomi, vivo, CATT, MTK): RAN4 specifies RRM requirement for HO with PSCell for following scenarios:     - from NR SA to EN-DC     - from EN-DC to EN-DC     - from NE-DC to NE-DC     - from NR-DC to NR-DC   + Option 2(NEC, Nokia): RAN4 specifies RRM requirement for HO with PSCell for following scenarios:     - from NR SA to EN-DC     - from EN-DC to EN-DC     - from NE-DC to NE-DC     - from NR-DC to NR-DC     - from NR SA to NE-DC (newly added)     - from NR SA to NR-DC (newly added)     - from LTE SA to EN-DC (newly added)   + Option 3(MTK): RAN4 specifies RRM requirement for HO with PSCell for following scenarios:     - from NR SA to EN-DC     - from EN-DC to EN-DC     - from NE-DC to NE-DC     - from NR-DC to NR-DC   And RAN4 to clarify whether requirements from LTE-SA to EN-DC and from NR-SA to NR-DC are needed  *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 2-1-2: NR-DC and NE-DC mode in HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * Option 1(CATT, Apple, OPPO, MTK): In R17 RAN4 only considers:   + FR1+FR2 NR-DC for HO with PSCell from NR-DC to NR-DC,   + FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC. * Option 2 (NEC, Intel, vivo, QC, Ericsson, MTK):   + FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC,   + FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC. * Option 3 (Ericsson):   + FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC,   + FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC,   + FFS on FR2+LTE NE-DC for HO with PSCell from NE-DC to NE-DC. * Option 4 (Nokia):   + FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC,   + FR1+LTE and FR2+LTE NE-DC for HO with PSCell from NE-DC to NE-DC,   + FR1+LTE and FR2+LTE NE-DC for HO with PSCell from NR SA to NE-DC.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |

**Sub-topic 2-2 Delay requirement design of HO with PSCell**

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|  | **Status summary** |
| **Issue 2-2-1: timeline for HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * Option 1 (Xiaomi, Apple, ZTE, OPPO): Pcell HO and PSCell addition is performed in a sequential order. * Option 2 (CATT, CMCC, Huawei, MTK, QC, ZTE, NEC, Ericsson): Pcell HO and PSCell addition is performed in parallel.   + Option 2a (vivo): RAN4 consider parallel processing capable UE in R17 as baseline and further identify the needed sequential processing during HO with PSCell.   + Option 2b (Qualcomm): Pcell HO and PSCell addition are performed in parallel after UE side processing (e.g. RF and SW preparations) is completed. * Option 3 (Apple): A new R17 UE capability is introduced to indicate whether UE can support sequential processing or parallel processing for HO with PSCell. * Option 4 (NTT DOCOMO, Intel, OPPO, Nokia, Ericsson, NEC): Some of procedures of HO with PSCell should be able to be performed in parallel, but RACH processing is performed in a sequential order (RACH procedure of PSCell will happen after the RACH procedure of Pcell). * Option 5 (NEC): For NR SA to EN-DC and NE-DC to NE-DC, RAN4 to agree that cell search of Pcell and PSCell is performed in sequential order. For NR-DC to NR-DC, RAN4 to agree that cell search is performed in parallel for FR1+FR2 NR-DC and FR1+FR1 NR-DC.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 2-2-2: starting point of the delay requirement for HO with PSCell** | *Tentative agreements:*  For delay requirement of HO with PSCell, the starting point is the end of the last TTI containing the RRC command **of** handover with PSCell.  *Candidate options:*  *Recommendations for 2nd round:*  The issue is closed, and agreements would be captured in the WF. |
| **Issue 2-2-3: ending point of the delay requirement for HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * Option 1 (Xiaomi, Intel, ZTE, Nokia):   + When the UE shall be capable to transmit PRACH preamble towards target PSCell within Thandover\_with\_PSCell from the end of the last TTI containing the RRC command implying handover with PSCell. Where Thandover\_with\_PSCell is the delay requirement of HO with PSCell. * Option 2 (CATT, CMCC, OPPO, QC, Ericsson, MTK):   + the later timing between “timing when UE shall be capable to transmit PRACH preamble towards target Pcell” and “the timing when UE shall be capable to transmit PRACH preamble towards target PSCell” * Option 2a (Ericsson):   + the later timing between “timing when UE shall be capable to transmit PRACH preamble towards target Pcell” and “the timing when UE shall be capable to transmit PRACH preamble towards target PSCell”   + In case RAN4 defines scenarios where PRACH preamble transmission towards PSCell is not needed, ending point for those scenarios is PRACH preamble transmission towards Pcell. * Option 3 (Apple, OPPO):   + if sequential processing is used, the timing when UE shall be capable to transmit PRACH preamble towards target PSCell   + if the parallel processing is used, the later timing between “timing when UE shall be capable to transmit PRACH preamble towards target Pcell” and “the timing when UE shall be capable to transmit PRACH preamble towards target PSCell” * Option 4 (HW, vivo, ZTE, CMCC):   + Define delay requirements for HO and PSCell addition/change separately with the ending points defined as Pcell PRACH and PSCell PRACH respectively. No need to define overall delay requirement. * Option 5 (QC):   + same definitions of end point as legacy HO   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 2-2-4: checking point of the delay requirement for HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * Option 1(Ericsson): The handover with PSCell delay (interruption) requirement shall have two checkpoints: time until the UE is transmitting PRACH preamble in Pcell, and time until later of UE transmitting PRACH preamble in Pcell and UE transmitting PRACH preamble in PSCell. * Option 2(Apple, OPPO, HW, vivo, CATT, Nokia): FFS until we have conclusions on other relevant issues.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 2-2-5: optimisation for the case when PSCell is not changed during HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * Option 1(Xiaomi, CATT, Apple, OPPO, vivo, QC, HW, Intel, MTK, NEC): For UE which is already configured with DC, the UE’s ehavior is same when the configured PSCell is same as the original one or not. * Option 2 (Ericsson, Nokia, NEC): When source and target PSCell is the same cell, then fine time tracking T∆=0 shall apply.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 2-2-6: RRC processing delay for HO with PSCell** | *Tentative agreements:*  RAN4 waits for the reply LS from RAN2 on RRC processing delay for HO with PSCell  *Candidate options:*  *Recommendations for 2nd round:*  This issue is closed, and agreements would be captured in the WF. |
| **Issue 2-2-7: UE SW processing and RF warm-up(if needed) time for HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * + Option 1 (CATT): Tprocessing for HO with PSCell can be used the values for handover requirements and for PSCell addition requirement   + Option 2 (Apple):     - If UE only supports sequential processing for HO with PSCell, the total UE processing time for HO with PSCell is the sum of UE processing timing of HO and UE processing timing of PSCell addition.     - If UE can support parallel processing for HO with PSCell, the total UE processing time for HO with PSCell could be the maximum one between UE processing timing of HO and UE processing timing of PSCell addition  |  |  |  | | --- | --- | --- | | UE processing margin (Tprocessing) | Target Pcell and PSCell is in the same FR as old Pcell | Target Pcell and/or target PSCell is in the different FR from old Pcell | | Sequential processing capable UE | 40ms | 60ms | | Parallel processing capable UE | 20ms | 40ms |  * + Option 3 (NEC, Huawei):     - Tprocessing is the UE processing time. Tprocessing is the maximum value of Pcell HO and PSCell addition;   + Option 4 (Intel):     - For HO with PSCell from NR-DC to NR-DC, Tprocessing can be split into software processing (Tprocessing\_SW) and RF warm up time(Tprocessing\_RF). Tprocessing\_SW=[20]ms needs further discussion if some extension is needed. Tprocessing\_RF will be dependent on different scenarios, i.e. whether Pcell or PSCell change across FRs.     - For HO with PSCell from NR SA to EN-DC, Tprocessing only includes software processing time (Tprocessing\_SW). Tprocessing\_SW=[20]ms needs further discussion if some extension is needed.   + Option 5 (Ericsson):     - The value of Tprocessing\_SW for PSCell is as follows:       * Tprocessing\_SW\_PSCell = 0 ms, when source and target PSCells are the same cell,       * Tprocessing\_SW\_PSCell = 20 ms, when source and target PSCells are different cells but in same FR       * Tprocessing\_SW\_PSCell = 40 ms, when source and target PSCells are different cells in different FRs     - How Tprocessing\_SW\_PSCell impacts the handover with PSCell timeline depends on assumptions on parallel or sequential processing.   + Option 6 (vivo): RF chain activation and retuning time needs to be considered in the timeline of HO with PSCell.   + Option 7 (QC, MTK):     - Extending the UE processing time for NRSA to EN-DC joint handover by [FFS]ms and [FFS] can be 10ms as the starting point, i.e. Tprocessing = [30]ms.     - For NRDC to NRDC, the UE processing time to be 20ms without FR mode switch on PSCell; otherwise, the UE processing time shall be 40ms as the legacy PSCell change requirement.       * For NRDC to NRDC, only consider FR1 for Pcell.   *Recommendations for 2nd round:*  Up to the conclusion from issue 2-2-1. Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 2-2-8: Delay requirement design if sequential processing is assumed (from issue 2-2-1)** | *Tentative agreements:*  Up to the conclusion from issue 2-2-1 and other issues.  *Candidate options:*  *Recommendations for 2nd round:*  Up to the conclusion from issue 2-2-1 and other issues. Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 2-2-9: Delay requirement design if parallel processing is assumed (from issue 2-2-1)** | *Tentative agreements:*  Up to the conclusion from issue 2-2-1 and other issues.  *Candidate options:*  *Recommendations for 2nd round:*  Up to the conclusion from issue 2-2-1 and other issues. Continue discussion in 2nd round, and agreements would be captured in the WF. |

**Sub-topic 2-3 Interruption requirement design of HO with PSCell**

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|  | **Status summary** |
| **Issue 2-3-1: whether or not RAN4 assumes PCC could be scheduled for UE when Pcell HO is completed but PSCell addition is not completed** | *Tentative agreements:*  *Candidate options:*  **Issue 2-3-1: whether or not RAN4 assumes PCC could be scheduled for UE when Pcell HO is completed but PSCell addition is not completed**   * Proposals   + Option 1 (Apple, QC, vivo, CMCC, Ericsson, Nokia, MTK, NEC): Yes   + Option 2 (OPPO, Xiaomi): No.   + Option 3 (CATT): wait for RAN2 reply LS about error case handling   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 2-3-2: Interruption requirement for HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * Option 1 (Xiaomi, HW, vivo, QC, ZTE, DOCOMO, CATT): No interruption requirement should be defined during HO with PSCell * Option 2 (CATT): Interruption in legacy handover delay requirement can be applied for Pcell. No interruption is defined on PSCell. * Option 3(Apple):   + If sequential processing is used for HO with PSCell, UE would have an interruption on new Pcell due to the PSCell addition.   + If parallel processing is used for HO with PSCell and PSCell addition is completed earlier than Pcell HO, no need to define interruption requirement since interruption has been reflected by HO delay.   + If parallel processing is used for HO with PSCell and PSCell addition is completed later than Pcell HO, UE may have an interruption on new Pcell due to RF tuning for PSCell addition. * Option 4 (ZTE): For interruption requirements, consider the following options:   + Specify a total interruption for handover and PSCell addition   + Specify separate interruptions for handover and PSCell addition. * Option 5 (MTK): RAN4 to specify the Pcell interruption time for the overall HO with PSCell procedure.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |

**Sub-topic 2-4 Generic RACH assumption for HO with PSCell**

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|  | **Status summary** |
| **Issue 2-4-1: 2 step and 4 step RACH for HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * Option 1 (CATT, QC, Ericsson(if parallel is agreed)): The delay requirements for HO with PSCell are not relative with 2 step or 4 step RACH if the ending point of delay is defined as PRACH transmission of UE. * Option 2 (Apple, vivo, OPPO, Xiaomi, MTK): for requirement of HO with PSCell, RAN4 starts the discussion with 4 step RACH first and FFS on 2 step RACH. * Option 3 (NEC, Ericsson, ZTE, Nokia): RAN4 to define both 2-step and 4-step RACH requirements for handover with PSCell.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 2-4-2: RACH occasion collision between Pcell and PSCell** | *Tentative agreements:*  *Candidate options:*   * Option 1 (CATT, Nokia): There is no need to further consider the RO collision issue from RAN4’s perspective. * Option 2 (Apple, OPPO(support sequential part), HW(support 2nd bullet), MTK(support 2nd bullet)):   + If sequential processing is used, there is no need to consider RACH occasion (RO) collision between Pcell and PSCell.   + If parallel processing is used:     - for FR1+FR1 EN-DC, an additional uncertainty delay due to PSCell RACH collision with Pcell UL channels may be introduced if the PSCell RACH cannot be transmitted based on the criteria in TS38.213 section 7.6.1;     - for FR1+FR1 NE-DC, an additional uncertainty delay due to Pcell RACH collision with PSCell RACH may be introduced if the Pcell RACH cannot be transmitted based on the criteria in TS38.213 section 7.6.2;     - otherwise, if the Pcell and PSCell are on the different FRs, no need to consider RO collision issue. * Option 3 (NEC):   + RAN4 to agree that components that contribute to TIU delay are the TA acquisition delay in Pcell, delay uncertainty in acquiring resources for RRC connection Reconfiguration Complete message on Pcell and PRACH acquisition uncertainty delay in PSCell.   + RAN4 to agree that interruption uncertainty (TIU) for Pcell and PSCell is sequential process. * Option 4 (vivo): PRACH occasion collision is considered as one factor in the requirements for HO with PSCell, if UE only supports single uplink in the NE-DC or EN-DC. * Option 5 (MTK): For the scenario from NE-DC to NE-DC, RAN4 to clarify whether to remove the delay uncertainty of Pcell PRACH preamble transmission from the delay requirement of HO with PSCell procedure.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |
| **Issue 2-4-3: RACH occasion on NR-U CC for HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * Option 1 (Ericsson): RAN4 to further study whether RA for spCell on unlicensed carrier with CCA shall be prioritized over RA for spCell on licensed carrier, once CCA is successful. * Option 2 (Apple, QC, OPPO, HW, vivo, DCM, CATT, MTK): The NR-U scenario is out of scope of this WID, no need to discuss.   *Recommendations for 2nd round:*  Continue discussion in 2nd round, and agreements would be captured in the WF. |

**Sub-topic 2-5 Others**

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|  | **Status summary** |
| **Issue 2-5: Failure case definition for HO with PSCell** | *Tentative agreements:*  *RAN4 waits for the reply LS from RAN2 before any decision.*  *Candidate options:*  *Recommendations for 2nd round:*  Agreements would be captured in the WF |

### CRs/TPs

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

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

**Issue 2-1-1: Scenarios for RRM requirement of HO with PSCell**

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| **Company** | **Comments** |
| Ericsson | We support Option 1, but are open to support Option 2, i.e., to support potentially all handover scenarios involving MR-DC configurations as indicated in Appendix B of TS 37.340. We agree with Apple on that the WID needs to be updated if new cases are added. We also agree with NEC that there might not be a significant impact on the RAN4 workload when adding cases since the framework is common for many of the scenarios. |
| Qualcomm | Option1 is supported.  We also hope to hear operator’s preference on introducing the following scenarios. Thanks,  from NR SA to NE-DC  from NR SA to NR-DC  from LTE SA to EN-DC |
| Xiaomi | Support option 1, the same comments in first round, for the new added scenarios in option 2, need to clarify whether these scenarios are needed from real network implementation and are supported in RAN2 from configuration and signaling perspective. |
| Apple | Option 1. The proponents of option 2 and option 3 need to propose to revise the WID first. |
| CMCC | We have the potential deployment of NE-DC and NR-DC. Since the requirements will be specified in a generic framework, if there is no significant impact on RAN4 workload, we support to include these new scenarios on HO with PSCell. |
| CATT | Support option 1. But we are open to discuss whether other scenarios can be supported considering signaling and RAN4 impact. |

**Issue 2-1-2: NR-DC and NE-DC mode in HO with PSCell**

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| **Company** | **Comments** |
| Ericsson | We are fine with Option 2 as baseline.  As pointed out by Nokia there are FR2+LTE NE-DC band combinations defined in Rel-17. In case there is operator interest, then we should consider supporting FR2+LTE too. But let us first check the operator interest. |
| Qualcomm | Option2 is supported.  The benefit of considering PCell on FR2 for the target cell may cause longer HO delay and potential coverage issue. Pcell on FR2 doesnot seem obvious in the context of joint HO. |
| Apple | Since many companies think FR1+FR1 NR-DC is very useful case, and we can compromise to option 2. But we still have concern on the absence of FR1+FR1 DC baseline requirement for PSCell addition. We can support option 1 and following option 2a:  Option 2a:   * FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC, * FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC.   Note: the baseline PSCell addition requirement for FR1+FR1 NR-DC would be discussed in TEI16. |
| CATT | Support option 1. Since there are not band combinations FR1+FR1 for NR-DC in 38.101-3, why we define RRM requirement for it? |
| Apple2 | To CATT, this FR1+FR1 NR-DC is in TS38.101-1 section 5.5B. |

**Issue 2-2-1: timeline for HO with PSCell**

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| **Company** | **Comments** |
| Ericsson | We are supporting both Options 2 and Options 4 from UE point of view, i.e., further discuss whether and under which conditions RA can be carried out in parallel or in sequence. Our understanding from TS 37.340 is however that UE can execute RA in PCell and PSCell in parallel. (See MSC in Figure 10.7.2-1: Inter-MN handover with/without MN initiated SN change procedure; pasted below). This since the MSC shows that the interaction between Target MN and Target SN in terms of *SN Reconfiguration Complete* message takes place *after* the UE has done RA towards Target SN. This means that once the UE has receoved the RRC connection reconfiguration message, it is up to the UE in which order it executes the steps. Particularly, we do not see that TS 37.340 would dictate that RA towards PCell has to be done before RA towards PSCell.  We propose to send an LS to RAN2 to ask about the execution order at random access towards PCell and PSCell. |
| Qualcomm | Option2 is supported overall.  In addition to our first-round comments, we think UE in support of DC is capable of doing 2DLs+2ULs in the connection mode anyway. It is reasonable to enable parallel search, loops, and RACH in general for ACQ.  Further given Ericsson’s observation “we do not see that TS 37.340 would dictate that RA towards PCell has to be done before RA towards PSCell.”, we think  1. Separate RACHs can be assumed, which implies there shall be separately defined end points of PCell and PSCell procedures.  2. For the LS, we are afraid RAN2 may reply it is up to RAN4. Then we have to make a decision anyway.  3. Assuming parallel RACH avoids the RAN4 effort to discuss further requirements and extra test cases. Therefore, it’s preferred. |
| Xiaomi | Prefer option 1 and option 4 |
| Apple | We prefer option 1. And as we commented online, could any company clarify what’s the essential difference on the design logic between R16 direct Scell activation with PSCell and this R17 HO with PSCell? We also have FR1+FR2 CA, but the requirement of direct SCell activation via HO is based on sequential order only. Thus, sequential order shall be used as a baseline assumption. |
| CATT | Support option 2. DC capable of UE should already support parallel behavior for Pcell and PSCell. |

**Issue 2-2-3: ending point of the delay requirement for HO with PSCell**

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| **Company** | **Comments** |
| Ericsson | We support Option 2. We can support Option 4 as well.  For Option 3 we do not agree that PSCell necessarily have to be last; please see our comment to Issue 2-2-1. |
| Qualcomm | Both option2 and option4 can be supported.  @Moderator, we are fine to remove option5 (QC) |
| Xiaomi | Fine with option 1 and option 3 |
| Apple | Option 3. To Ericsson, I guess your comment is to option 1. In option 3 we differentiated the two processing alternatives, if sequential order processing is used, PSCell RACH is after PCell RACH, but if parallel order processing is used, we agree with option 2 here. |
| CATT | Support option 2. |

**Issue 2-2-4: checking point of the delay requirement for HO with PSCell**

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| **Company** | **Comments** |
| Ericsson | We agree that we can keep this FFS until other issues have been solved. We note however that this is essentially similar to Option 4 in Issue 2-2-3. From our point it is fine to close this issue and focus on Issue 2-2-3 instead. |
| Qualcomm | Option2 is supported.  Option1 may be subject to complications when specifying the requirements. In our view, as long as PCell HO delay and PSCell add/change delay can be characterized in a consistent way, it should suffice. |

**Issue 2-2-5: optimisation for the case when PSCell is not changed during HO with PSCell**

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| **Company** | **Comments** |
| Ericsson | Our preference is Option 2.  We would like to further understand Qualcomm’s comment from first round. We do not see that UE would lose track of the PSCell timing when source and target PSCell is the same cell. PSCell timing is established in relation to the UE reference time and that would hardly change during the handover procedure. |
| Qualcomm | Option1 is supported.  We observe in the legacy spec, e.g. 8.9.2 “T∆ is time for fine time tracking and acquiring full timing information of the target cell. T∆ = 1\*Trs ms for a known or unknown PSCell.”  Same cell means a known cell too, so T∆ remains the same.  To Ericsson, thanks for the question. In my understanding a fine time tracking is always needed as the UE reference time can be an initial time to which UE latches. By UE reference time, do we refer to the time offset estimated from the same cell’s serving SSB? |
| Xiaomi | Support option 1 |
| Apple | Option 1. |
| CATT | Support option 1.  To Ericsson, from the figure you used in issue 2-2-1, before MN sent *RRCConnectionReconfiguration* command, the source MN will send SN Release Request command to source SN. So regardless PSCell is changed or not, the SN will be released and then be added by *RRCConnectionReconfiguration* command. |

**Issue 2-2-7: UE SW processing and RF warm-up(if needed) time for HO with PSCell**

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| **Company** | **Comments** |
| Ericsson | We are fine with the Recommended WF, i.e., firstly to establish what steps the UE can do in parallel, and then looking into the simultaneous software processing it calls for. |
| Qualcomm | Option7 is supported.  For option1 and 3, we feel it doesnot consider extra time needed for UE to accommodate preparing the two stacks. E.g. from NRSA to ENDC, LTE stack and processing chain are not active at all when UE is in NRSA. This is different from standalone PCell HO or PSCell addition.  For option6, we agree it is considered to be part of UE processing time, Tprocessing. |
| Xiaomi | Fine with option 7 |
| Apple | Option 2. Even for the parallel processing method, we need to find principle to design this requirement, our logic is to use the maximum between UE processing timing of HO and UE processing timing of PSCell addition, like option 3. |
| CATT | Can further discuss when the procedure of HO with PSCell is concluded. |

**Issue 2-2-8: Delay requirement design if sequential processing is assumed (from issue 2-2-1)**

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| **Company** | **Comments** |
| Ericsson | We are fine with the Recommended WF. |
| Qualcomm | Agree with the recommended WF |
| Xiaomi | Agree with the recommended WF |
| Apple | Agree with the recommended WF |

**Issue 2-2-9: Delay requirement design if parallel processing is assumed (from issue 2-2-1)**

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| **Company** | **Comments** |
| Ericsson | We are fine with the Recommended WF. |
| Qualcomm | Agree with the recommended WF  We believe an overall parallel HO flow is a reasonable assumption for any DC capable UE. |
| Xiaomi | Agree with the recommended WF |
| Apple | Agree with the recommended WF |

**Issue 2-3-1: whether or not RAN4 assumes PCC could be scheduled for UE when PCell HO is completed but PSCell addition is not completed**

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| **Company** | **Comments** |
| Ericsson | We support Option 1. We do not see that it would not be possible to schedule the UE on PCC while waiting for activation on PSCC to be completed. In fact, UE is scheduled already during the RA for reception of RAR etc. |
| Qualcomm | Option1 is supported |
| Xiaomi | Option 1 is fine |
| Apple | Option 1. |
| CATT | Fine with option 1. |

**Issue 2-3-2: Interruption requirement for HO with PSCell**

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| **Company** | **Comments** |
| Ericsson | Fine with Option 1 provided/conditioned on the explanation by CATT during first round, i.e. no new interruption requirement for HO with PSCell, RRC connection interruption due to HO on PCell is still applied. |
| Qualcomm | Option1 is supported |
| Xiaomi | Option 1 |
| Apple | Option 3. Do not understand the rationale for option 1. If HO is completed much earlier than PSCell addition, e.g., earlier than the first available SSB from the PSCell, the RF tuning for PSCell addition may interrupt the Pcell scheduling, unless we assume UE would tune the RF for both Pcell HO and PSCell addition at same time(but that assumption needs FFS). |
| CATT | Support option 1.  As for Apple’s example, we think this happens in sequential procedure or the HO delay is smaller the RF tuning time for parallel processing. |
| Apple2 | To CATT, even in parallel processing, if target PCell is known with short SSB periodicity(e.g. 5ms) and target PSCell is unknown with long SSB periodicity (e.g. 160ms), it may happens RF tuning for PSCell addition interrupt PCell. We are not sure about this as of now, so open to FFS. |

**Issue 2-4-1: 2 step and 4 step RACH for HO with PSCell**

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| **Company** | **Comments** |
| Ericsson | Support Option 3 in general, and Option 1 in particular if full parallel processing is agreed. (If parallel processing is used then it does not matter whether 2 or 4-step RA is used, as one leg is not gating the other.) |
| Qualcomm | Option1 is supported.  So same handling as legacy spec can be assumed for 2 or 4 step RACH. |
| Xiaomi | Support option 2 |
| Apple | Option 2 but can compromise to option 3. In fact, it also depends on the conclusion from issue 2-2-1. |
| CATT | Support option 1. |

**Issue 2-4-2: RACH occasion collision between PCell and PSCell**

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| **Company** | **Comments** |
| Ericsson | This issue is also depending on Issue 2-4-3. |
| Qualcomm | Support option2 bullet 2. Does it apply to FR1+FR1 NR-DC? |
| Apple | Option 2. To Qualcomm, yes, it shall contain FR1+FR1 NR-DC if we concluded in issue 2-1-2. |
| CATT | Further discuss whether the power restriction is needed. |

**Issue 2-4-3: RACH occasion on NR-U CC for HO with PSCell**

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| **Company** | **Comments** |
| Ericsson | Our view is that the WI has not excluded the scenario where PSCC is on a NR-U carrier. Checking with our RAN2 team, NR-U has not been excluded when RAN2 discussed Inter-MN handover with MN initiated SN change (i.e. HO with PSCell). Moreover, in our view neither RAN1 nor RAN2 specifications tell in which order or with which mutual priority PCell and PSCell RA shall be carried out for  We propose that RAN4 sends an LS to RAN2 where RAN2 is asked to clarify whether RAN4 is expected to derive requirements for Inter-MN handover with MN initiated SN change when PSCC is a NR-U carrier. The same LS can also address whether there is any expectation or limitation on the UE to execute RA on Pcell and PSCell in a particular order (see Issue 2-2-1). |
| Qualcomm | Option2 is supported.  If companies have strong interests in considering NR-U for HO w/ PSCell, we feel it needs to be firstly updated in the WID and approved.  For clarifying the RA procedures, our concern is by allowing a serial RA flow, we may create unnecessary constraint and/or requirement on UE to refrain the operations in one CG till the other CG finishes RACH. |
| Apple | Option 2. If NR-U is considered, it will not only impact on RA but also impact the DL synchronization on target Pcell or PSCell due to the LBT failure. |
| CATT | Support option 2. |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on further RRM enhancement for NR and MR-DC – SRS antenna port switching | Apple |  |
| WF on further RRM enhancement for NR and MR-DC – Handover with PSCell | Apple |  |
|  |  |  |

**Existing tdocs**

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| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | 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

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| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
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3. Do not include hyper-links in the documents