**3GPP TSG-RAN WG4 Meeting # 99-e R4-210xxxx**

**Electronic Meeting, 19th – 27th May 2021**

**Agenda item:** 9.9.2.2

**Source:** Moderator (vivo)

**Title:** Email discussion summary for [99-e][225] NR\_RRM\_enh2\_2

**Document for:** Information

# Introduction

This email discussion summary includes HO with PSCell (9.9.2.2).

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

* 1st round:
  + Stage 1: Moderators kick off email discussion (Wed. 8am UTC May 19)
  + Stage 2: Companies provide comments for the 1st round (May 1 – Friday 12pm UTC May 21)
  + 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 (Friday 7pm UTC May 21)
  + 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 8am UTC, May 24)
* 2nd round:
  + Stage 5: Companies provide comments for 2nd round starting from Monday 3am UTC May 24.
    - Draft WF/LS and revised CRs/TPs shall be shared by Monday 7pm UTC, May 24.
    - Formal tdocs of WF/LS/CRs/TPs shall be uploaded to the Inbox (except Cat A CRs) by Wednesday 3am UTC, May 26.
    - Commenting shall stop by Thursday 3am UTC, May 27.
  + Stage 6: Moderators provide 2nd round summary with a formal tdoc by Thursday 8am UTC, May 27.
  + Stage 7: Session chairs announce close of sessions (no later than 4pm UTC, May 27). Final decisions will be captured in Chairman meeting report (to be shared after the meeting is closed)

# Topic #1: HO with PSCell

*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** |
| [**R4-2108768**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2108768.zip) | ZTE Corporation | **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: The UE shall perform handover and PSCell addition in parallel.  **Proposal 3: Include both 2-step RA and 4-step RA into the new requirements made for handover with PSCell.**  **Proposal 4: For UE which is already configured with DC, the UE’s behaviour is same when the configured PSCell is same as the original one or not.** |
| [**R4-2109051**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109051.zip) | CATT | **Proposal 1: The scenarios extention should not be discussed in RAN4, and RAN4 work should following the WID, i.e. only to define RRM requirements 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 Rel-17, RAN4 only considers 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: UE will perform in parallel the PCell handover process and PSCell addition process. We should wait for RAN2 response for order of random access carried out towards PCell and PSCell.**  **Proposal 4: Waiting for RAN2 response for order of random access carried out towards PCell and PSCell.**  **Proposal 5: The UE’s behavior is same when the configured PSCell is same as the original one or not. If PSCell is not changed, it can be dealt with as a known cell.**  **Proposal 6: The value of processing time of handover and the PSCell addition can be reused separately. AndTprocessing for HO with PSCell including UE SW processing and RF warm-up time should be the maximum of the processing time of handover and the processing time of the PSCell addition.**  **Proposal 7: The delay requirement structure can be designed as above description, and decision will be made waiting for the conclusion of other issues and RAN2 LS response.**  **Proposal 8: Yes, PCell could schedule UE when PCell HO is completed but PSCell addition is not completed.**  **Proposal 9: No interruption requirement should be defined during HO with PSCell. RRC connection interruptions in normal handover requirements can be reused in HO with PSCell.**  **Proposal 10: Waiting RAN2 response and conclusions of other issues for 2 step and 4 step RACH.**  **Proposal 11: The NR-U scenario is out of scope of this WID, no need to discuss.** |
| [**R4-2109244**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109244.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.**  **Proposal 2: Considering the reply LS from RAN2, RRC processing delay for HO with PSCell is:**  **NR SA to EN-DC : 50ms**  **EN-DC to EN-DC: 20ms**  **NE-DC to NE-DC: 16ms**  **NR-DC to NR-DC: 16ms**  **Proposal 3:** **Tprocessing can be further split into software processing (Tprocessing\_SW) and RF warm up time(Tprocessing\_RF). For Tprocessing\_RF, it depends on whether PCell or PSCell changed across FR. For Tprocessing\_SW, PSCell can be processed in parallel with PCell handover, FFS if any extension is needed.**  **Proposal 4:** **Tsearch, Tmargin, T∆ can be processed in parallel for both PCell HO and PSCell addition.** |
| [**R4-2109250**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109250.zip) | Xiaomi | **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: For NR-DC and NE-DC mode in HO with PSCell, the following scenarios are considered to specify the RRM requirements:**   * + - * **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.**   **Proposal 3: RAN4 follow the RRC processing delay for HO with PSCell which is captured in reply LS (R4-2107622).**  **Proposal 4: For HO with PSCell, it is assumed that the preparation of synchronization 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**   **Proposal 5: The ending point of HO with PSCell is the timing when UE is capable to transmit PRACH preamble towards target PSCell.**  **Proposal 6: When the configured PSCell is the same as the original one or not, the requirements and UE’s behavior are the same.**  **Proposal 7: No interruption requirement should be defined for HO with PSCell.** |
| [**R4-2109309**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109309.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: NR-DC and NE-DC mode in HO with PSCell are:***   * ***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.***   ***Proposal 3: In HO with PSCell, if SMTC of target unknown PSCell is configured in targetcellSMTC-SCG-r16, sequential processing shall be assumed; otherwise parallel processing shall be assumed for all the other cases.***  ***Proposal 4: the ending point*** ***of the delay requirement for HO with PSCell is:***   * ***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”***   ***Proposal 5: For UE which is already configured with DC, the UE’s behaviour is same when the configured PSCell is same as the original one or not.***  ***Proposal 6: the RRC procedure delay in requirement of HO with PSCell is defined based on RAN2 reply LS R2-2104580.***  ***Proposal 7:***  ***For 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.***  ***For 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 8: the UE processing time for HO with PSCell is:***   |  |  |  | | --- | --- | --- | | ***UE processing margin (Tprocessing)*** | ***Target PCell and PSCell is in the same FR as old serving cell*** | ***Target PCell and/or target PSCell is in the different FR from old serving cell*** | | ***Sequential processing*** | ***40ms*** | ***60ms*** | | ***Parallel processing*** | ***20ms*** | ***40ms*** |   ***Proposal 9: for requirement of HO with PSCell, RAN4 starts the discussion with 4 step RACH first and FFS on 2 step RACH.***  ***Proposal 10: 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 or FR1+FR1 NR-DC, no need to consider RO collision issue.***   ***Proposal 11: RAN4 assumes PCC could be scheduled for UE when PCell HO is completed but PSCell addition is not completed.***  ***Proposal 12:***  ***If sequential processing is used for HO with PSCell, UE may have an interruption on new PCell due to the PSCell addition.***  ***If parallel processing is used for HO with PSCell, no need to define interruption requirement.*** |
| [**R4-2109510**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109510.zip) | CMCC | ***Proposal 1: for HO with PSCell, except the agreed scenario including HO from NR SA to EN-DC, HO from EN-DC to EN-DC, HO from NE-DC to NE-DC and HO from NR-DC to NR-DC, it is proposed to include the following new scenarios:***   * ***HO from NR SA to NE-DC*** * ***HO from NR SA to NR-DC*** * ***HO from LTE SA to EN-DC***   ***Proposal 2: supporting FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC, and the baseline PSCell addition requirement for FR1+FR1 NR-DC would be discussed in TEI16.***  ***Proposal 3: RRC processing delay for HO with PSCell is specified as following table according to RAN2 reply LS.***   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Scenario | Source PCell | Target PCell | Target PSCell | RRC procedure delay for HO with PSCell | | NR SA to EN-DC | NR (incl. FR1 and FR2) | LTE | NR (incl. FR1 and FR2) | [50ms] | | EN-DC to EN-DC | LTE | LTE | NR (incl. FR1 and FR2) | 20ms | | NE-DC to NE-DC | NR FR1 | NR FR1 | LTE | 16ms | | NR-DC to NR-DC | NR FR1 | NR FR1 | NR FR2 | 16ms |   ***Proposal 4: the ending point is related with whether RACH processing is performed in a sequential order or in a parallel order, and can be further discussed after we get the feedback from RAN2.***  ***Proposal 5: for HO with PSCell, it is proposed to consider parallel way to perform HO and PSCell addition except RACH processing, as for whether RACH processing can be performed in parallel or not, it depends on RAN2 reply and can be further discussed.***  ***Proposal 6: delay 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*** |
| [**R4-2109732**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109732.zip) | Qualcomm CDMA Technologies | **Proposal1: RAN4 to agree an overall parallel flow can be assumed for defining the requirements of HO with PSCell.**  **Proposal2: Parallel RACH is preferred for defining the RRM requirements.**  **Proposal2.1: It’s necessary to understand the network side’s limitation not to support parallel RACHs.** |
| [**R4-2109885**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109885.zip) | MediaTek inc. | **Proposal 1: RAN4 to specify the delay requirement for HO with PSCell based on the assumption that some of procedures should be able to be performed in parallel. FFS what kinds of components in the overall delay requirement, e.g., Tprocessing, will have dependency between PCell and PSCell.**  **Proposal 2: The overall Tprocessing for HO with PSCell should be max(Tprocessing for PCell HO, Tprocessing for PSCell addition) +10ms**  **Proposal 3: RAN4 to confirm that PCC could also be scheduled for UE when PCell HO is completed but PSCell addition is not completed**  **Proposal 4: No new interruption requirement for HO with PSCell is needed. Interruption in legacy handover delay requirement can still be applied for the PCell** |
| [**R4-2109891**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109891.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: RAN4 to confirm 50ms as RRC processing delay for NR SA to EN-DC scenario.**  **Proposal 4: RAN4 to agree that cell search is performed in parallel for HO with PSCell.**  **Proposal 5: RAN4 to postpone the discussion on interruption uncertainty (TIU) till reply LS from RAN2 is received.**  **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 and it can be performed parallel.**  **Proposal 7: RAN4 to define both 2-step and 4-step RACH requirements for handover with PSCell.** |
| [**R4-2110062**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110062.zip) | OPPO | **Proposal 1: 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.**   **Proposal 2: RRM requirements are defined as minimum requirements assuming PCell HO and PSCell addition is performed in a sequential order.**  **Proposal 3: The ending point of the delay requirements for HO with PSCell is the timing when UE shall be capable to transmit PRACH preamble towards target PSCell.**  **Proposal 4: For UE which is already configured with DC, the UE’s behaviour is same when the configured PSCell is same as the original one or not.**  **Proposal 5: Additional interruption may be expected on PCell due to PSCell addition, if PCC could be scheduled when PCell HO is completed but PSCell addition is not completed.** |
| [**R4-2110147**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110147.zip) | NTT DOCOMO, INC. | **Proposal 1: Ending point of the delay requirement should be defined as the timing when the UE shall be capable to transmit PRACH preamble towards target PSCell(i.e., option1).** |
| [**R4-2110344**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110344.zip) | Huawei, HiSilicon | **Observation 1: There is no baseline RRM requirements for FR1+FR1 NR-DC.**  **Proposal 1: Consider 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.**  **Proposal 2: RAN4 to define HO with PSCell requirements based on parallel processing assumption.**  **Observation 2: Based on the parallel processing assumption, the extra delay uncertainty of RACH to NR could be included for EN-DC and NE-DC.**  **Proposal 3: Wait for LS reply from RAN2 about whether there is strict order of RACH to PCell and RACH to PSCell before considering the RACH delay uncertainty.**  **Observation 3: Whether to consider additional delay for searching procedure depends on whether to include FR1+FR1 NR-DC case.**  **Observation 4: UE processing time is the maximum valure of PCell HO and PSCell addition, and FFS whether to extend the processing time for NR SA to EN-DC and the value if needed.**  **Proposal 4: 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.**  **Proposal 5: No interruption requirements to be defined during HO with PSCell.** |
| [**R4-2110971**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2110971.zip) | Ericsson | **Proposal 1:** As a starting point, RRM requirements are defined for the following handover 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:** As a starting point, RRM requirements are defined for the following NR-DC and NE-DC handover scenarios.   * FR1+FR2 NR-DC to NR-DC * FR1+FR1 NR-DC to NR-DC * FR1+LTE NE-DC to NE-DC   **Proposal 3:** RAN4 shall wait for LS reply from RAN2/RAN3 on whether RA can be carried out in parallel, before further discussing the detailed timeline and associated delay requirements.  **Proposal 4:** The delay requirement for HO with PSCell shall be specified separately for PCell and PSCell.  **Proposal 5:** HO with PSCell delay requirements shall allow UE to carry out fine time tracking (contributing with T∆ in the time line) regardless of whether source and target PSCell is the same cell.  **Proposal 6:** For software processing for PSCell, the following values are to be used.   * 0ms, when source and target PSCells are the same same NR or LTE cell, * 20ms, when source and target PSCells are different NR cells in same FR, * 40ms, when source and target PSCells are different NR cells in different FRs, * [40ms], when there is no source PSCell i.e. when it is a matter of PSCell addition.   **Proposal 7:** RAN4 shall assume that UE can be scheduled on PCC after RA towards PCell has been completed, even if RA towards PSCell has not been completed.  **Proposal 8:** Interruption in legacy handover delay requirement can be applied for PCell. No interruption is defined for PSCell.  **Proposal 9:** RAN4 shall define delay requirements for HO with PSCell for both 2-step and 4-step RA. Impact on delay requirements depends on timeline with respect to parallel processing of RA.  **Proposal 10:** 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. |
| [**R4-2111042**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111042.zip) | Nokia, Nokia Shanghai Bell | 1. In addition to the scenarios agreed RAN4#98e, RAN4 specifies RRM requirements for handover with PSCell for following scenarios:  * **From NR SA to NR-DC** * **From NR SA to NE-DC** * **From E-UTRAN to EN-DC**  1. RAN4 should define RRM requirements for handover with PSCell including FR1+FR2 NR-DC and FR1+FR1 NR-DC when considering “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. In HO with PSCell, legacy HO and PSCell addition operations can be performed in parallel except RA procedure. 4. The UE processing time in HO with PSCell can be 20ms if source & target PCell is in same frequency range and source & target PSCell in same frequency range, 40ms otherwise. 5. The cell searching time in HO with PSCell can be the maximum searching time of target PCell and PSCell. 6. The delay requirements for HO with PSCell can be described as: DHO\_with\_PSCell = TRRC\_delay + Tsearch + Tprocessing + T∆ + Tmargin +TFFS.Where TFFS is the delay in acquiring the first available PRACH occasion in the target cells 7. No additional interruption should be defined during HO with PSCell. 8. Both 2-step RA and 4-step RA are applicable for HO with PSCell and no need to mention 2-step or 4-step in HO with PSCell requirements. |
| [**R4-2111265**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2111265.zip) | vivo | **Proposal 1 Further discuss the newly added scenarios in the RAN plenary, and before that RAN4 will not discuss on this issue.**  **Proposal 2 For NR-DC and NE-DC mode in HO with PSCell, we support Option 2/2a 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 3 RAN4 proceed requirements discussion on HO with PSCell with 2 case: RACH is performed in sequential and RACH is performed in parallel.**  **Proposal 4 The requirements defined for the case RACH performed in sequential is only applicable for certain band combination and for some certain cases of the uplink PRACH power.**  **Proposal 5 RF chain activation and retuning time needs to be considered in the timeline of HO with PSCell.**  **Proposal 6 For the delay requirement, the ending point of handover with PSCell can be considered separately for PCell and PSCells.**  **Proposal 7 RAN4 assumes PCC could be scheduled for UE when PCell HO is completed but PSCell addition is not completed**  **Proposal 8 Even if PSCell is not changed during HO with PSCell, T∆ reduction seems not necessary, considering the multi-TRP deployment.**  **Proposal 9 RAN4 do not need to specify interruptions for handover with PSCell.**  **Proposal 10 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.** |

## 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(CATT, Xiaomi, Apple, MTK, Ericsson, vivo): 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
    - Note: The extension of WI scope should be discussed in RAN plenary.
  + Option 2(CMCC, 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)
* Recommended WF
  + RAN4 concludes that RRM requirements are needed for the additional scenarios for HO with PSCell. It is up to RAN plenary decision whether to extend the scope the WID.
* 1st round Comment collection:

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| **Company** | **Comments** |
| CMCC | We support option 2 and we are OK with moderator’s recommended WF. We have potential deployment of NR-DC, NE-DC, if there is no significant impact on RAN4 workload. it is suggested to specify the HO requirements for the additional scenarios to guarantee the performance. |
| CATT | Fine with recommended WF. |
| Apple | Support option 1. The necessity of the requirement shall be up to the scope of WID but not the other way round; so we suggest to discuss in RANP first. |
| Xiaomi | Support option 1, the extension of WI scope should be discussed in RAN plenary. |
| OPPO | Support the recommended WF. |
| Ericsson | We are fine with the Recommended WF. |
| Qualcomm | Recommended WF is agreeable to us. |
| Intel | Fine with the recommended WF. It’s better to discuss the extension of WI scope in the RAN plenary. |
| Docomo | We are fine with the Recommended WF. |
| NEC | Support option 2 and fine with recommended WF. |
| vivo | Support the recommended WF. |
| Nokia | We support option 2 and fine with the recommended WF. |
| MTK | Support option 1. |

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

* Proposals
  + Option 1(CATT, OPPO, Huawei): 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 (Intel, Xiaomi, Apple, MTK, NEC, Ericsson, vivo):
    - FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC
      * Note: the baseline PSCell addition requirement for FR1+FR1 NR-DC would be discussed in TEI16.
    - FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC.
  + Option 2a (CMCC, Nokia): For NR-DC to NR-DC:
    - FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC,
      * Note: the baseline PSCell addition requirement for FR1+FR1 NR-DC would be discussed in TEI16.
  + Option 3 (Nokia): For NE-DC to NE-DC and NR-SA to NE-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
  + FR1+FR2 NR-DC for HO with PSCell from NR-DC to NR-DC is supported.
  + FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC is supported.
  + FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC is FFS
    - the baseline PSCell addition requirement for FR1+FR1 NR-DC would be discussed in TEI16.
  + FR2+LTE NE-DC for HO with PSCell from NE-DC to NE-DC is FFS.

Companies are encouraged to provide comments on the FFS issues, including whether baseline PSCell addition requirement for FR1+FR1 NR-DC would be discussed in TEI16.

* 1st round Comment collection:

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| **Company** | **Comments** |
| CMCC | For HO with PSCell from NR-DC to NR-DC, we are OK with option 2 and option 2a. It seems that option 2 and option 2a are the same. |
| CATT | Support option 1. The FR1+FR1 PSCell addition requirements should be defined first. |
| Apple | Support option 2. |
| Xiaomi | Support option 2, from our perspective, it is benefit to consider the FR1+FR1 NR-DC case in HO with PSCell, as the joint HO procedure can reduce the delay compared with legacy HO procedure. |
| OPPO | OK with the recommended WF. Agree to define PScell addition requirements for FR1+FR1 NR-DC firstly, before discussing the scenario FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC. |
| Ericsson | We are fine with Option 2 as starting point. We do not see why we should exclude support for valid FR1+FR1 NR-DC band combinations. |
| Qualcomm | Option1 is supported as a starting point.  Further scenario depends on introducing the baseline PSCell addition requirement for FR1+FR1 NR-DC in TEI16. |
| Huawei | We support option 1/2/2b. But for the note about discussing the PSCell addition requirements for FR1+FR1 NR-DC in TEI 16, we wonder that does it mean in Rel-16 we only have this particular RRM requirements (PSCell addition) for FR1+FR1 NR-DC. |
| Intel | Support option 2. In order to reduce work load, suggest to only define PSCell addition related requirement for FR1+FR1 NR-DC. |
| Docomo | We are fine with the recommended WF. |
| NEC | We support option 2. |
| vivo | Support option 2. Also see the issue raised by Huawei. If only HO with PSCell and PSCell addition requirements are specified for FR1+FR1 NR-DC, the scenario still may not work. |
| Nokia | For NR-DC, option 2a is same as option 2. For NE-DC, we can compromise to option 2 and focus on FR1+LTE NE-DC. |
| MTK | OK with the recommended WF |

### 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 (CMCC, CATT, QC, ZTE, Intel, NEC, Huawei, Ericsson, Nokia, MTK, vivo): For HO with PSCell, PCell HO and PSCell addition are performed in parallel for at least some of procedures, except RACH processing
    - Note: How and what procedures, including RACH processing, can be performed in parallel are discussed in Issue 2-2-2, Issue 2-2-3 and Issue 2-2-4 respectively.
  + Option 2 (Apple): In HO with PSCell, if SMTC of target unknown PSCell is configured in targetcellSMTC-SCG-r16, sequential processing shall be assumed; otherwise parallel processing shall be assumed for all the other cases.
  + Option 3 (Xiaomi, OPPO): For HO with PSCell, it is assumed that the preparation of synchronization 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
* Recommended WF
  + Further discussion in the 1st round

* 1st round Comment collection:

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| **Company** | **Comments** |
| CATT | Support option 1. Except RACH procedure can wait for RAN2 reply LS, the other procedures should be performed in parallel. |
| Apple | Option 2. As we analyzed in our paper, for NR-DC to NR-DC case, when SMTC of new PSCell is configured in targetcellSMTC-SCG-r16, the new Pcell timing would be used as the reference for that SMTC; and therefore sequential processing shall be used in this case. Regarding NR SA to EN-DC, the SMTC configuration for new PSCell is in the LTE RRC container from old NR Pcell RRC signaling, and the SMTC reference timing is based on the new LTE Pcell timing; so sequential processing is also assumed for this case when SMTC of target PSCell is configured. For the other cases, parallel processing could be assumed. |
| Xiaomi | Our preference is option 3, as for the low cost Ues which is implemented with single RF chain, they may not be capable to perform cell search on target Pcell and target PSCell simultaneously. But we can compromise to option 1 to move forward. |
| OPPO | Support Option 3. Our main concern is about PRACH procedure. At least for some UE with single RF chain, or UE with certain band combinations not supporting simultaneous dual Tx(as metioned in issue 2-2-4), it is not feasible to perform PRACH procedure in parallel.  For option 1, we are open to further discuss other procedures in Issue 2-2-2 and 2-2-3. |
| Ericsson | We support Option 1. Whether RA for MCG and SCG can be run in parallel depends on whether RAN2/RAN3 confirms that the procedures can run in parallel.  Regarding Option 2, the logic behind the proposal might need to be elaborated a little more. It seems like the only case where it potentially would be required to firstly establish PCell timing would be when both a target PCell and target PSCell would be unknown. And even then it can be argued whether it would be a valid use case with e.g. a blind handover to a PCell for which one does not know where to search for synchronization signals. So we need to look more into this.  Regarding Option 3, if the intention is to have fully sequential procedures then it is better UE does not claim support of the “HO with PSCell” feature. Full sequential processing is already the baseline so nothing new and the feature would just become a paper product. |
| Qualcomm | Option1 is supported as a starting point.  As to Apple’s observation, we think it’s worth further checking based on RAN2 LS reply for RACH and if companies agree to define requirements for such case(s) when the target PSCell search is directed to depend on the target PCell’s timing reference. |
| Huawei | After checking RAN2 spec. We tend to agree option 2 in some degree. For NR-DC, when targetcellSMTC-SCG-r16 is configured, then UE may sync to the target PCell first and then search the target PSCell based on the timing of target PCell. But we would like to further check whether we will define requirements for both sequential processing and parallel processing. |
| Intel | Prefer to start with option 1. For option 2, we are open to it and needs to further check the scenario it applied. |
| Docomo | Support option1. Our understanding is that RA to PSCell should be performed after RA to PCell. |
| NEC | Support option 1 |
| ZTE | Option 1, this shall be the assumption to the UE. |
| vivo | Support option 1.  Regarding option 2, we share similar view as Qualcomm. Maybe we can simply add some applicability rules to the requirements so that for the case mentioned by Apple there are no requirements for HO with PSCell.  Regarding option 3, we are still not sure what is the motivation behind sequential processing for procedures other than RACH, given that the UE already supports DC. |
| Nokia | We support option 1. RACH procedure is pending for RAN2 response. The other procedures can be performed in parallel.  For option 2, we need further check if it is valid case for HO with PSCell and the impact. |
| MTK | Support option 1. We need some time to check whether option 2 is acceptable. |

**Issue 2-2-2: Parallel processing for HO with PSCell**

* Proposals
  + Option 1a (QC, Nokia, ZTE, CMCC, CATT, Ericsson, vivo):
    - PCell HO and PSCell addition are performed in parallel independently without considering RA procedures and Tprocessing.
  + Option 1b (Intel):
    - Tsearch, Tmargin, T∆ can be processed in parallel for both Pcell HO and PSCell addition. Tsearch is the time required to search the target cell. T∆ is time for fine time tracking and acquiring full timing information of the target cell. Tmargin is time for SSB post-processing.
  + Option 1c (Huawei):
    - Based on the parallel processing assumption
    - Whether to consider additional delay for searching procedure depends on whether to include FR1+FR1 NR-DC case
  + Option 2a (NEC):
    - T∆ is time for fine time tracking and acquiring full timing information of the Pcell and PSCell and it can be performed parallel.
    - Cell search is performed in parallel for HO with PSCell.
  + Option 2b (MTK):
    - RAN4 to specify the delay requirement for HO with PSCell based on the assumption that some of procedures should be able to be performed in parallel.
    - FFS what kinds of components in the overall delay requirement, e.g., Tprocessing, will have dependency between Pcell and PSCell.
* Recommended WF
  + Further discussion in the 1st round.
* 1st round Comment collection:

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| --- | --- |
| **Company** | **Comments** |
| CATT | Pcell HO and PSCell addition are performed in parallel independently except RA procedures and Tprocessing. RA procedure should wait for the reply LS from RAN2 and Tprocessing should be the maximum of processing time for HO and for PSCell addition. |
| Apple | When parallel processing is used, we agree with option 1a. |
| OPPO | Fine with Option 1a and 2b which are not contradictory, |
| Ericsson | We support Option 1a. |
| Qualcomm | Option1a is supported as a starting point. |
| Huawei | Support option 1c. |
| Intel | Support 1b, 2a, 2b. for RA procedures, it’s better to wait for the reply of LS from RAN2 first. |
| Docomo | Support Option 1a. |
| NEC | We share similar view as Intel. |
| ZTE | Option 1a. |
| vivo | Support option 1a. |
| Nokia | We support option 1a. |
| MTK | Support option 1a and 2b. |

**Issue 2-2-3: UE SW processing and RF warm-up(if needed) time for HO with PSCell**

* Proposals
  + Option 1 (CATT): The value of processing time of handover and the PSCell addition can be reused separately. And Tprocessing for HO with PSCell including UE SW processing and RF warm-up time should be the maximum of the processing time of handover and the processing time of the PSCell addition.
  + Option 2 (Intel): Tprocessing can be further split into software processing (Tprocessing\_SW) and RF warm up time(Tprocessing\_RF). For Tprocessing\_RF, it depends on whether Pcell or PSCell changed across FR. For Tprocessing\_SW, PSCell can be processed in parallel with Pcell handover, FFS if any extension is needed.
  + Option 3 (Apple):
    - For 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.
    - For 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
    - the UE processing time for HO with PSCell is:

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

* + Option 4 (Huawei): UE processing time is the maximum value of Pcell HO and PSCell addition, and FFS whether to extend the processing time for NR SA to EN-DC and the value if needed.
  + Option 5 (Ericsson): For software processing for PSCell, the following values are to be used.
    - 0ms, when source and target PSCells are the same same NR or LTE cell,
    - 20ms, when source and target PSCells are different NR cells in same FR,
    - 40ms, when source and target PSCells are different NR cells in different FRs,
    - [40ms], when there is no source PSCell i.e. when it is a matter of PSCell addition.
  + Option 6 (Nokia):
    - The UE processing time in HO with PSCell can be 20ms if source & target Pcell is in same frequency range and source & target PSCell in same frequency range, 40ms otherwise.
    - No additional RF retuning interruption should be defined during HO with PSCell..
  + Option 7 (NEC): Tprocessing is the UE processing time. Tprocessing is the maximum value of Pcell HO and PSCell addition
  + Option 8 (MTK): The overall Tprocessing for HO with PSCell should be max(Tprocessing for PCell HO, Tprocessing for PSCell addition) +10ms
  + Option 9 (vivo): RF chain activation and retuning time needs to be considered in the timeline of HO with PSCell.
  + Option 10:
    - 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.
* Recommended WF
  + Further discussion in the 1st round
* 1st round Comment collection:

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| **Company** | **Comments** |
| CATT | We think there is no need to differentiate the SW processing time and RF warm-up time. The total processing time is considered. |
| Apple | Option 3. We think it’s better to first align the philosophy on how to derive this processing time. Our understanding is:   * For sequential processing for HO with PSCell, the total UE processing time for HO with PSCell is the sum of ‘legacy UE processing timing of HO’ and ‘legacy UE processing timing of PSCell addition’. * For parallel processing for HO with PSCell, the total UE processing time for HO with PSCell could be the maximum one between ‘legacy UE processing timing of HO’ and ‘legacy UE processing timing of PSCell addition’. |
| Xiaomi | Prefer option 3 |
| OPPO | Option 8 is fine. We also agree to discuss how UE processing time is performed, in sequential or in parallel firstly. |
| Ericsson | We have discussed slightly different parameters. For parallel processing we agree that the SW processing time to account for shall be maximum what is required for HO and PSCell addition/change, respectively. Then the actual processing time depends on attributes of source and target cells, whether there is a source PSCell (not the case in NR-SA – EN-DC), etc.  Moreover, to be consistent with Issue 2-2-6 , we do not have to optimize with respect to whether source and target PSCell is the same PSCell. It is enough to optimize based on whether source and target cells are in same or different FRs. |
| Qualcomm | Share the similar view as CATT and we support Option10. |
| Huawei | One question for option 10 about the 10 ms extension. What is the difference from inter-RAT handover from NR to LTE, where the processing time is also 20 ms. |
| Intel | We are fine to define a total UE processing time which including both software processing and RF warming part. Our intention is to mention that RF warming up part is not related to parallel processing, and it can further check whether parallel processing can be performed for software processing and if any extension is needed. |
| vivo | Encourage companies to check whether we can move forward with option 10.  We agree RF warm-up does not need to be considered independently.  Regarding UE processing time for interRAT scenarios, our view is that different processing time needs to be considered for different RAT, different FR, etc. We are open to discuss whether it can be 5/8/10. |
| Nokia | We support option 6. We share the similar view as CATT that total UE processing time should be considered in HO with PSCell. The UE processing time will depend on if the source cell and target cell are in the same frequency range, generally the maximum UE processing time in PCell HO and PSCell addition can be applied for HO with PSCell. |
| MTK | Option 8 and 10 are acceptable. |

**Issue 2-2-4: RA processing for Pcell and PSCell**

* Proposals
  + Option 1 (CMCC, CATT, Intel, NEC, Huawei, Ericsson, Nokia, MTK): Whether RACH processing can be performed in parallel or not, it depends on RAN2 reply and can be further discussed.
  + Option 2 (vivo): The requirements defined for the case RACH performed in sequential is only applicable for certain band combination and for some certain cases of the uplink PRACH power. Otherwise, RACH is performed in parallel.
  + Option 3 (QC, ZTE): RA procedures for Pcell and PSCell are performed in parallel completely.
    - Note: It’s necessary to understand the network side’s limitation if parallel RACHs are not favoured.
* Recommended WF
  + Further discussion in the 1st round

* 1st round Comment collection:

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| **Company** | **Comments** |
| CATT | Support option 1. |
| Apple | Option 1. |
| Xiaomi | Support option 1 |
| OPPO | Agree with option 1 in principle. For option 2, as we discussed in issue 2-2-1, it also makes sense that RACH shall be performed in sequential for certain band combination. |
| Ericsson | Option 1. Our view is that parallel processing is not precluded by RAN2/RAN3, but it is better to have this confirmed by RAN2 so all companies are on the same page in RAN4. |
| Qualcomm | We can compromise to Option1 and wait for RAN2 reply. |
| Huawei | Option 1 |
| Intel | Support option 1. |
| Docomo | Basically we think that RA to PSCell should be performed after RA to PCell as we commented for Issue 2-2-1, but we can agree with option 1. |
| NEC | Support option 1 |
| ZTE | Can agree on Option 1 which is to wait for RAn2 response. |
| vivo | We can agree with option 1. |
| Nokia | We support option 1. |
| MTK | Support option 1. |

**Issue 2-2-5: Ending point of the delay requirement for HO with PSCell**

* Proposals:
  + Option 1 (CATT, CMCC): Waiting for RAN2 response for order of random access carried out towards PCell and PSCell.
  + Option 2 (Xiaomi, OPPO, DoCoMo): The ending point of HO with PSCell is the timing when UE is capable to transmit PRACH preamble towards target PSCell.
  + Option 3 (Apple): the ending point of the delay requirement for HO with PSCell is:
    - 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 (Huawei, Ericsson, QC, vivo):
    - 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.
* Recommended WF
  + Further discussion in the 1st round. Relevant to the conclusion of issue 2-2-4.
* 1st round Comment collection:

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| **Company** | **Comments** |
| CMCC | For option 4, we have one question for clarification. If we go with option 4, whether to define the total delay of HO with PSCell, e.g. maximum (delay for Pcell HO, delay for Pscell addition)? |
| CATT | Support option 1. If RACH procedure can be performed in parallel, the ending point should be the later PRACH towards Pcell and PSCell. If the RACH procedure is performed in order, the ending point should be the PRACH towards PSCell. |
| Apple | Option 3. If sequential processing is used, option 4 cannot be used. |
| Xiaomi | Option 2 is our preference. It is assumed HO with PSCell is performed in sequential. And we are also fine with option 3. |
| OPPO | Support Option 2 |
| Ericsson | Support Option 1. We need the feedback from RAN2. |
| Qualcomm | Option4 is preferred which is flexible to accommodate various cases. |
| Huawei | We support option4 for the parallel assumption. But it is relevant to whether to distinguish parallel processing and sequential processing in issue 2-2-1. |
| Intel | Fine with option 1. If sequential processing is applied for some steps, option 4 didn’t work. If parallel processing is assumed, whether the requirement is defined separately or based on the maximum delay can be further discussed. |
| Docomo | Support option 2. |
| NEC | Support option 1. |
| vivo | After double check with RAN2 colleagues, we changed our preference to option 2. However at current stage option 1 also make sense. |
| Nokia | We support option 1. |
| MTK | Support option 4. |

**Issue 2-2-6: Optimisation for the case when PSCell is not changed during HO with PSCell**

* Proposals
  + Option 1 (ZTE, CATT, Apple, OPPO, Ericsson, vivo): For UE which is already configured with DC, the UE’s behavior is same when the configured PSCell is same as the original one or not.
* Recommended WF
  + Agree on option 1.
* 1st round Comment collection:

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| **Company** | **Comments** |
| CATT | Support option 1. |
| Apple | Option 1 at this stage. But we understand there is an on-going discussion in RAN2 for PCell HO without PSCell change (whether RACH on the PSCell is needed or not), we may revisit this option when RAN2 has conclusion. |
| Xiaomi | Support the recommended WF. |
| OPPO | Support the recommended WF. |
| Ericsson | We support Option 1, i.e., we do not need to optimize at this point w.r.t. whether it is same source and target PSCell (only based on same or different FRs). |
| Qualcomm | Recommended WF is agreeable to us. |
| Huawei | Support the recommended WF. |
| Intel | Support option 1. |
| Docomo | Option 1 is OK for us. |
| NEC | OK with option 1 |
| ZTE | Seems all companies agree to Option 1. |
| vivo | Support the recommended WF. |
| Nokia | If the target PSCell is same as source PSCell, UE should have known the timing, then it is no need for fine time tracking for target PSCell. |
| MTK | Support option 1. |
|  |  |

**Issue 2-2-7: RRC processing delay for HO with PSCell**

* Proposals
  + Option 1 (Intel, Xiaomi, Apple, CMCC, NEC): Considering the reply LS from RAN2, RRC processing delay for HO with PSCell is:
    - NR SA to EN-DC : 50ms
    - EN-DC to EN-DC: 20ms
    - NE-DC to NE-DC: 16ms
    - NR-DC to NR-DC: 16ms
* Recommended WF
  + Agree on option 1.
* 1st round Comment collection:

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| **Company** | **Comments** |
| CMCC | We support the recommended WF. |
| CATT | Support the recommended WF. |
| Apple | Option 1 |
| Xiaomi | Support option 1. |
| OPPO | Support the recommended WF. |
| Ericsson | Agree with Recommended WF, i.e. the numbers provided by RAN2. |
| Qualcomm | Option1 is supported. |
| Huawei | Support recommended WF. |
| Intel | Support the recommended WF. |
| NEC | Support option 1 |
| vivo | Support the recommended WF. |
| Nokia | The RRC processing delay is defined in RAN2 specification, and in the RAN2 LS, RAN2 will clearly capture the RRC processing delay for other cases listed in the LS. From RAN4 perspective, we will refer to the definition in RAN2, there is no need to specify the exact value of RRC processing delay in RAN4 specification. |
| MTK | Support the recommended WF. |

**Issue 2-2-8: Delay requirement design if parallel processing is assumed**

* Proposals
  + Option 1 (CATT):
    - If parallel processing is assumed and having order limit of PRACH, the delay requirement can be defined as:
      * Delay = RRC processing time + max(Tprocessing for handove, Tprocessing for addition) + max(Tinterrupt –Tprocessing for handove , Tconfig\_PSCell – TRRC\_delay –Tprocessing for addition–TPSCell\_ DU) + TPSCell\_ DU
    - If parallel processing is assumed and having not order limit of PRACH, the delay requirement can be defined as:
      * Delay = RRC processing time + max(Tinterrupt , Tconfig\_PSCell – TRRC\_delay)
  + Option 2 (CMCC):
    - Delay 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 3 (Nokia):
    - The delay requirements for HO with PSCell can be described as: DHO\_with\_PSCell = TRRC\_delay + Tsearch + Tprocessing + T∆ + Tmargin +TFFS.Where TFFS is the delay in acquiring the first available PRACH occasion in the target cells.
      * The cell searching time in HO with PSCell can be the maximum searching time of target PCell and PSCell.
* Recommended WF
  + Further discussion in the 1st round. Relevant to outcome of previous issues in Sub-topic 2-2.
* 1st round Comment collection:

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| **Company** | **Comments** |
| CATT | Support option 1. |
| Apple | Up to the conclusions from other issues. |
| Ericsson | Prefer to discuss this further once we have RAN2 feedback on whether RA can be executed in parallel. |
| Huawei | Suggest to focus on the general assumptions of the frame work before stepping in to the detailed requirements. |
| vivo | Can be FFS based on outcome of other issues |
| Nokia | We understand that RACH procedure is pending on RAN2 feedback, for other procedures we think they can be performed in parallel, we can start the discussion for the procedures except RACH. Anyway, it will depend on the issue 2-2-1. |
| MTK | Up to the conclusions from other issues. |

**Issue 2-2-9: Delay requirement design if sequential processing is assumed**

* Proposals
  + Option 1 (CATT):
    - If sequential processing is assumed, the delay requirement can be defined as:
      * Delay = RRC processing time + max(Tprocessing for handove, Tprocessing for addition) + (Tinterrupt –Tprocessing for handove) + (Tconfig\_PSCell – TRRC\_delay –Tprocessing for addition)
  + Option 2:
    - Other options are not precluded.
* Recommended WF
  + Further discussion in the 1st round. Relevant to outcome of Issue 2-2-1
* 1st round Comment collection:

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| **Company** | **Comments** |
| CATT | Support option 1. |
| Apple | Up to the conclusions from other issues. |
| Xiaomi | This issue relate to outcome of issue 2-2-1 |
| Ericsson | Prefer to discuss this further once we have RAN2 feedback on whether RA can be executed in parallel. |
| Qualcomm | Option2 |
| Huawei | Suggest to focus on the general assumptions of the frame work before stepping in to the detailed requirements. |
| Docomo | We should conclude issue 2-2-1 firstly. |
| vivo | Can be FFS based on outcome of other issues |
| Nokia | It will depend on the conclusion of issue 2-2-1. |
| MTK | Up to the conclusions from other issues. |

### 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 (CATT, Apple, MTK, Ericsson, vivo): Yes
  + Option 1a (OPPO): Yes, but Additional interruption may be expected on PCell due to PSCell addition, if PCC could be scheduled when PCell HO is completed but PSCell addition is not completed.
* Recommended WF
  + Further discussion in the 1st round.
* 1st round Comment collection:

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| **Company** | **Comments** |
| CATT | Support option 1. We think only the RF adjustment will cause interruption, but the RF adjustment for PCell and PSCell should be performed in parallel. So after the RF adjustment, even the PSCell is not completed, there will be no interruption. |
| Apple | Option 1. |
| Xiaomi | Option 1 |
| OPPO | Option 1 is fine. Interruption requirements can be further discussed in issue 2-3-2. |
| Ericsson | We support Option 1.  For Option 1a our understanding is that for PCell and PSCell in different bands it shall be possible to start RF for PSCell at the same time as for PCell and hence to avoid additional interruptions. |
| Qualcomm | Option1 is supported. |
| Huawei | Option 1 |
| Intel | Support option 1. |
| vivo | Option 1 |
| Nokia | We support option 1. |
| MTK | Support option 1. |

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

* Proposals
  + Option 1 (CATT, Xiaomi, Huawei, Nokia, vivo): No interruption requirement should be defined during HO with PSCell
  + Option 2 (MTK, Ericsson): No new interruption requirement for HO with PSCell is needed. Interruption in legacy handover delay requirement can still be applied for the PCell
  + Option 3 (Apple): Interruption in legacy handover delay requirement can be applied for Pcell. No interruption is defined on PSCell.
    - If sequential processing is used for HO with PSCell, UE may have an interruption on new PCell due to the PSCell addition.
    - If parallel processing is used for HO with PSCell, no need to define interruption requirement.
  + Option 4 (OPPO): Additional interruption may be expected on PCell due to PSCell addition, if PCC could be scheduled when PCell HO is completed but PSCell addition is not completed.
  + Option 5 (NEC): RAN4 to postpone the discussion on interruption uncertainty (TIU) till reply LS from RAN2 is received.
* Recommended WF
  + Further discussion in the 1st round.
* 1st round Comment collection:

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| **Company** | **Comments** |
| CATT | Support option 1 and option 2. We think the option 1 and option 2 are the same. |
| Apple | Need to differentiate sequential and parallel processing cases. For sequential processing case, we think interruption is needed. |
| Xiaomi | Option 1 |
| OPPO | Support Option 3. If sequential processing is used for HO with PSCell, UE may have an interruption on new PCell due to the PSCell addition. |
| Ericsson | We support Option 2. |
| Qualcomm | This is pending on RAN2 LS reply. |
| Huawei | Support option 1, and option 3 is also reasonable if sequential process has to be considered for some particular cases. |
| Intel | If parallel processing is assumed, support option 2. For option 1, did it mean that there is no additional interruption caused by PSCell addition? |
| Docomo | Option 1. |
| vivo | We support option 1. |
| Nokia | We support option 2. We think no new interruption should be needed besides the interruption in legacy handover delay requirements, the interruption in legacy handover delay requirement can still be applied for the PCell. |
| MTK | Support option 2. We have same question as Intel. |

### 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 1a (ZTE, Nokia, vivo): Include both 2-step RA and 4-step RA into the new requirements made for handover with PSCell. No need to mention 2-step or 4-step in HO with PSCell requirements.
  + Option 1b (NEC, Ericsson): RAN4 to define both 2-step and 4-step RACH requirements for handover with PSCell.
  + Option 2 (Apple): for requirement of HO with PSCell, RAN4 starts the discussion with 4 step RACH first and FFS on 2 step RACH.
  + Option 3 (CATT): Waiting RAN2 response and conclusions of other issues for 2 step and 4 step RACH.
* Recommended WF
  + Further discussion in the 1st round.
* 1st round Comment collection:

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| **Company** | **Comments** |
| CATT | Support option 3. Only when the RA is performed in order, 2 step or 4 step should be considered |
| Apple | Option 2. |
| Xiaomi | Prefer option 2 |
| OPPO | Option 2. |
| Ericsson | We support Option 1b.  Whether this is same as Option 1a depends on RAN2 feedback on parallel RA processing. |
| Qualcomm | Option3 is supported |
| NEC | Support option 1b |
| ZTE | Support Option 1a and 1b, which are similar. |
| vivo | Support option 1a. |
| Nokia | We support option 1a and 1b, We think they are similar. RAN4 defines the applicability rule for 2-step and 4-step RA, and the applicability rule applied for legacy HO and PSCell. No need to distinguish 2-step and 4-step RA in HO with PSCell requirements. |
| MTK | Support Option 2 |

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

* Proposals
  + Option 1 (Apple):
    - 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.
* Recommended WF
  + Discussion option 1 in the 1st round.
* 1st round Comment collection:

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| **Company** | **Comments** |
| Apple | Option 1. |
| Ericsson | Prefer to discuss this further once we have RAN2 feedback on whether RA can be executed in parallel. |
| Huawei | Prefer to wait for the RAN2 LS reply. |
| vivo | We see the issue raised by Apple.  This could be FFS based on RAN2 reply. |
| Nokia | Agree with Ericsson and Huawei, it should be wait for the RAN2 feedback on RA order. |
| MTK | Prefer to wait for the RAN2 LS reply. |

**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 (CATT): The NR-U scenario is out of scope of this WID, no need to discuss.
* Recommended WF
  + Further discussion in the 1st round.
* 1st round Comment collection:

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| **Company** | **Comments** |
| CATT | Support option 2. |
| Apple | Option 2. |
| OPPO | Option 2 |
| Ericsson | We support Option 1, as we cannot see that the concerned band combinations would be precluded in the WID.  For Option 2, we ask CATT to point out where it is stated that band combinations with CCA are out-of-scope. |
| Qualcomm | Option2 is supported. |
| Huawei | Option 2 |
| vivo | We see the argument of option 1. The WID itself is not clear enough. In our view this can be FFS in RAN P, considering the overall RRM work load and the potential deployment demand of such feature. |
| MTK | Support option 2. |

## 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.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
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| 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** | *10 companies are fine with the recommended WF*  *3 companies support option 1*  *Tentative agreements:*  *Candidate options:*   * + Option 1 (CMCC, CATT, OPPO, Ericsson, Qualcomm, Intel, Docomo, NEC, vivo, Nokia)     - RAN4 concludes that RRM requirements are needed for the additional scenarios for HO with PSCell. It is up to RAN plenary decision whether to extend the scope the WID.   + Option 2 (Apple, Xiaomi, MTK)     - The extension of WI scope should be discussed in RAN plenary.   *Recommendations for 2nd round:*  This issue cannot be addressed by further email discussion. Online discussion is suggested. May Chair consider to treat this issue at GTW session? |
| **Issue 2-1-2: NR-DC and NE-DC mode in HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * + Option 1(CATT, Qualcomm, Huawei): 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 (CMCC, Apple, Xiaomi, Ericsson, Huawei, Intel, NEC, vivo, Nokia):     - FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC       * Note: the baseline PSCell addition requirement for FR1+FR1 NR-DC would be discussed in TEI16.     - FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC.   + Recommended WF (OPPO, Docomo, MTK)     - FR1+FR2 NR-DC for HO with PSCell from NR-DC to NR-DC is supported.     - FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC is supported.     - FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC is FFS       * the baseline PSCell addition requirement for FR1+FR1 NR-DC would be discussed in TEI16.     - FR2+LTE NE-DC for HO with PSCell from NE-DC to NE-DC is FFS.   **Issue 2-1-2a: Requirements for Rel-16 FR1+FR1 NR-DC**   * + Option 1:     - Limited set of RRM requirements, i.e., PSCell addition requirements, are specified       * The requirements are discussed in TEI16.   + Option 2:     - Full set of RRM requirements:       * Note: The requirements are specified under what agenda/WI?   *Recommendations for 2nd round:*  Further discuss the down-selected options for Issue 2-1-2.  Discuss the Issue 2-1-2a that is raised in the 1st round discussion. |

**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** | *All companies are fine that PCell HO and PSCell addition, except RACH procedure, are performed in parallel for at least some of procedures during HO with PSCell.*  *One company proposed that parallel processing during HO with PSCell is dependent on condition as in option 2. Some other companies think this may be valid and need further check.*  *One company raised a question whether requirements should be specified for both parallel processing and sequential processing, if there is condition to differentiate parallel processing and sequential processing based on moderator’s understanding.*  *Tentative agreements:*   * PCell HO and PSCell addition, except RACH procedure, are performed in parallel for at least some of procedures   + FFS condition of parallel processing in Issue 2-2-1a   *Candidate options:*   * + **Issue 2-2-1a: Condition of parallel processing**   + Option 1:     - If SMTC of target unknown PSCell is configured in targetcellSMTC-SCG-r16, sequential processing shall be assumed; otherwise, parallel processing shall be assumed   + Option 2:     - Parallel processing shall always be assumed.   **Issue 2-2-1b: Whether requirements for sequential processing are needed if parallel processing is only possible under certain condition**   * + Option 1: yes   + Option 2: no   *Recommendations for 2nd round:*  Company further check if tentative agreements are agreeable.  Discuss open issues of Issue 2-2-1a and Issue 2-2-1b. |
| **Issue 2-2-2: Parallel processing for HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * + Option 1a (QC, Nokia, ZTE, CATT, Ericsson, vivo, Apple, OPPO, Docomo, MTK):     - PCell HO and PSCell addition are performed in parallel independently without considering RA procedures and Tprocessing.   + Option 1b (Intel, NEC):     - Tsearch, Tmargin, T∆ can be processed in parallel for both Pcell HO and PSCell addition. Tsearch is the time required to search the target cell. T∆ is time for fine time tracking and acquiring full timing information of the target cell. Tmargin is time for SSB post-processing.   + Option 1c (Huawei):     - Based on the parallel processing assumption     - Whether to consider additional delay for searching procedure depends on whether to include FR1+FR1 NR-DC case   + Option 2a (NEC, Intel):     - T∆ is time for fine time tracking and acquiring full timing information of the Pcell and PSCell and it can be performed parallel.     - Cell search is performed in parallel for HO with PSCell.   + Option 2b (MTK, Intel, NEC):     - RAN4 to specify the delay requirement for HO with PSCell based on the assumption that some of procedures should be able to be performed in parallel.     - FFS what kinds of components in the overall delay requirement, e.g., Tprocessing, will have dependency between Pcell and PSCell.   *Recommendations for 2nd round:*  Discuss the issue in the 2nd round to further down-select.  Views on difference between option 1a and option 1b are encouraged. |
| **Issue 2-2-3: UE SW processing and RF warm-up(if needed) time for HO with PSCell** | *Tentative agreements:*  Tprocessing includes both software processing time and RF warm up time.  *Candidate options:*   * + Option 1 (CATT): The value of processing time of handover and the PSCell addition can be reused separately. And Tprocessing for HO with PSCell including UE SW processing and RF warm-up time should be the maximum of the processing time of handover and the processing time of the PSCell addition.   + Option 3 (Apple, Xiaomi):     - For 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.     - For 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     - the UE processing time for HO with PSCell is:  |  |  |  | | --- | --- | --- | | UE processing margin (Tprocessing) | Target Pcell and PSCell is in the same FR as old serving cell | Target Pcell and/or target PSCell is in the different FR from old serving cell | | Sequential processing | 40ms | 60ms | | Parallel processing | 20ms | 40ms |  * + Option 4 (Huawei): UE processing time is the maximum value of Pcell HO and PSCell addition, and FFS whether to extend the processing time for NR SA to EN-DC and the value if needed.   + Option 5 (Ericsson): For software processing for PSCell, the following values are to be used.     - 0ms, when source and target PSCells are the same same NR or LTE cell,     - 20ms, when source and target PSCells are different NR cells in same FR,     - 40ms, when source and target PSCells are different NR cells in different FRs,     - [40ms], when there is no source PSCell i.e. when it is a matter of PSCell addition.   + Option 6 (Nokia):     - The UE processing time in HO with PSCell can be 20ms if source & target Pcell is in same frequency range and source & target PSCell in same frequency range, 40ms otherwise.     - No additional RF retuning interruption should be defined during HO with PSCell..   + Option 7 (NEC): Tprocessing is the UE processing time. Tprocessing is the maximum value of Pcell HO and PSCell addition   + Option 8 (MTK, OPPO): The overall Tprocessing for HO with PSCell should be max(Tprocessing for PCell HO, Tprocessing for PSCell addition) +10ms   + Option 10 (Qualcomm, vivo, 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.   *Recommendations for 2nd round:*  Further discuss the open issue  Confirm the tentative agreement |
| **Issue 2-2-4: RA processing for PCell and PSCell** | *Tentative agreements:*  It depends on RAN2 reply whether RACH processing can be performed in parallel or not and it can be further discussed  *Candidate options:*  *Recommendations for 2nd round:*  No action. |
| **Issue 2-2-5: Ending point of the delay requirement for HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * + Option 1 (CATT, CMCC, Ericsson, Intel, NEC, vivo, Nokia): Waiting for RAN2 response for order of random access carried out towards PCell and PSCell.   + Option 2 (Xiaomi, OPPO, DoCoMo, vivo): The ending point of HO with PSCell is the timing when UE is capable to transmit PRACH preamble towards target PSCell.   + Option 3 (Apple): the ending point of the delay requirement for HO with PSCell is:     - 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 (Huawei, QC, MTK):     - 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.   *Recommendations for 2nd round:*  Further discuss the issue |
| **Issue 2-2-6: Optimisation for the case when PSCell is not changed during HO with PSCell** | *13 companies agree with option 1*  *1 company think if the target PSCell is same as source PSCell, UE should have known the timing, then it is no need for fine time tracking for target PSCell.*  *Tentative agreements:*  For UE which is already configured with DC, the UE’s behavior is same whether the configured PSCell is same as the original one or not.  *Candidate options:*  *Recommendations for 2nd round:*  *Nokia is encouraged to further check if the tentative agreement is acceptable.* |
| **Issue 2-2-7: RRC processing delay for HO with PSCell** | *Tentative agreements:*   * + Considering the reply LS from RAN2, RRC processing delay for HO with PSCell is:     - NR SA to EN-DC : 50ms     - EN-DC to EN-DC: 20ms     - NE-DC to NE-DC: 16ms     - NR-DC to NR-DC: 16ms   Note: RRC processing delay is defined in RAN2 specification.  *Candidate options:*  *Recommendations for 2nd round:*  *No action* |
| **Issue 2-2-8: Delay requirement design if parallel processing is assumed** | *Tentative agreements:*  *Delay requirements for parallel processing are discussed after there is conclusion on other issues in sub-topic 2-2.*  *Candidate options:*  *Recommendations for 2nd round:*  *Company is to check if the tentative agreement is agreeable* |
| **Issue 2-2-9: Delay requirement design if sequential processing is assumed** | *Tentative agreements:*  *Delay requirements for sequential processing are discussed after there is conclusion on other issues in sub-topic 2-2.*  *Candidate options:*  *Recommendations for 2nd round:*  *Company is to check if the tentative agreement is agreeable* |

**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:*  *PCC could be scheduled for UE when Pcell HO is completed but PSCell addition is not completed*  *Candidate options:*  *Recommendations for 2nd round:*  No action |
| **Issue 2-3-2: Interruption requirement for HO with PSCell** | *Tentative agreements:*  *Candidate options:*   * + Option 1 (CATT, Xiaomi, Huawei, vivo, Docomo): No interruption requirement should be defined during HO with PSCell   + Option 2 (MTK, Ericsson, CATT, Intel, Nokia): No new interruption requirement for HO with PSCell is needed. Interruption in legacy handover delay requirement can still be applied for the PCell   + Option 3 (Apple, OPPO, Huawei): Interruption in legacy handover delay requirement can be applied for Pcell. No interruption is defined on PSCell.     - If sequential processing is used for HO with PSCell, UE may have an interruption on new PCell due to the PSCell addition.     - If parallel processing is used for HO with PSCell, no need to define interruption requirement.   + Option 5 (NEC): RAN4 to postpone the discussion on interruption uncertainty (TIU) till reply LS from RAN2 is received.   + Option 6 (Qualcomm): Depending on RAN2 LS reply.   *Recommendations for 2nd round:*  *Further discuss the open issue.*  *Companies are encouraged to provide comments with clarification that it is for parallel processing or sequential processing.* |

**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 1a (ZTE, Nokia, vivo): Include both 2-step RA and 4-step RA into the new requirements made for handover with PSCell. No need to mention 2-step or 4-step in HO with PSCell requirements.   + Option 1b (NEC, Ericsson, ZTE, Nokia): RAN4 to define both 2-step and 4-step RACH requirements for handover with PSCell.   + Option 2 (Apple, Xiaomi, OPPO, MTK): for requirement of HO with PSCell, RAN4 starts the discussion with 4 step RACH first and FFS on 2 step RACH.   + Option 3 (CATT, Qualcomm): Waiting RAN2 response and conclusions of other issues for 2 step and 4 step RACH.   *Recommendations for 2nd round:*  Further discuss the open issue |
| **Issue 2-4-2: RACH occasion collision between Pcell and PSCell** | *Tentative agreements:*  *Candidate options:*   * + Option 1 (Apple):     - 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.   *Recommendations for 2nd round:*  *The issue is discussed after feedback from RAN2* |
| **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 (CATT, Apple, OPPO, Qualcomm, Huawei, MTK): The NR-U scenario is out of scope of this WID, no need to discuss.   + Option 3 (vivo): Discuss in RAN plenary.   *Recommendations for 2nd round:*  *Further discuss the open issue* |

### 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)

*Companies are encouraged to provide comments on the open issues and candidate options.*

*For Issue 2-1-2, please also take Issue 2-1-2a into consideration.*

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

* Proposals
  + Option 1(CATT, Qualcomm, Huawei): 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 (CMCC, Apple, Xiaomi, Ericsson, Huawei, Intel, NEC, vivo, Nokia):
    - FR1+FR2 NR-DC and FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC
      * Note: the baseline PSCell addition requirement for FR1+FR1 NR-DC would be discussed in TEI16.
    - FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC.
  + Recommended WF (OPPO, Docomo, MTK)
    - FR1+FR2 NR-DC for HO with PSCell from NR-DC to NR-DC is supported.
    - FR1+LTE NE-DC for HO with PSCell from NE-DC to NE-DC is supported.
    - FR1+FR1 NR-DC for HO with PSCell from NR-DC to NR-DC is FFS
      * the baseline PSCell addition requirement for FR1+FR1 NR-DC would be discussed in TEI16.
    - FR2+LTE NE-DC for HO with PSCell from NE-DC to NE-DC is FFS.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Apple | Option 2. The FR2+LTE NE-DC to NE-DC shall be precluded since this BC is introduced in R17 (parallel R17 RF WI is not in the scope of R17 FeRRM WI). |
| Xiaomi | Option 2 |
| Qualcomm | We can compromise to Option2 assuming FR1+FR1 NR-DC is subject to the completion of introducing the requirements for FR1 PSCell change. |
| Huawei | We are fine with option 1 or option 2. For option 2, the baseline requirements depend on issue 2-1-2a. |
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**Issue 2-1-2a: Requirements for Rel-16 FR1+FR1 NR-DC**

* Proposals
  + Option 1:
    - Limited set of RRM requirements, i.e., PSCell addition requirements, are specified
      * The requirements are discussed in TEI16.
  + Option 2:
    - Full set of RRM requirements:
      * Note: The requirements are specified under what agenda/WI?
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Apple | No strong view between option 1 and 2. If option1 is adopted TEI16 can handle this requirement, but if option 2 is needed, it would be feasible to contain it in a R17 WI. |
| Xiaomi | Either option is fine, similar view as Apple, if the requirement is discussed in TEI16, we prefer option 1, if in REl-17 WID, then option 2 is a better solution. |
| Qualcomm | Option1 is preferred as operator is interested in adding it in R16. |
| Huawei | We prefer to discuss the baseline requirement in this Rel-17 WI. Regarding to defining some baseline requirements in TEI 16, we are not sure whether we can complete it in one or two meetings as this is not just adding a single requirements but a completely new framework. If the purpose is to enable this HO with PSCell, then it is more appropriate to discuss it in this WI. For the scope of RRM requirements, we think it is not possible to have full set RRM requirements in this WI as we already have three very complicated objectives in parallel. So we prefer option 3 “Limited set of RRM requirements in Rel-17 FeRRM” |
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*For issue 2-2-1, company confirms if the tentative agreements in the 1st round is agreeable.*

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

* Proposals
  + PCell HO and PSCell addition, except RACH procedure, are performed in parallel for at least some of procedures
  + FFS condition of parallel processing in Issue 2-2-1a
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Apple | Fine with the proposal. The condition of sequential processing and parallel processing shall be clarified based on different SMTC configuration as we commented in the 1st round. |
| Xiaomi | We can compromise to the this proposal. |
| Qualcomm | The recommended proposals are agreeable to us. |
| Huawei | Fine with the proposal. |
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**Issue 2-2-1a: Condition of parallel processing**

* Proposals
  + Option 1:
    - If SMTC of target unknown PSCell is configured in targetcellSMTC-SCG-r16, sequential processing shall be assumed; otherwise, parallel processing shall be assumed
  + Option 2:
    - Parallel processing shall always be assumed.

**Issue 2-2-1b: Whether requirements for sequential processing are needed if parallel processing is only possible under certain condition**

* Proposals
  + Option 1: yes
  + Option 2: no
* 2nd round Comment collection for Issue 2-2-1a and 2-2-1b:

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| **Company** | **Comments** |
| Apple | Issue 2-2-1a: Condition of parallel processing  Option 1, we provided the analysis in the 1st round.  Issue 2-2-1b: Whether requirements for sequential processing are needed if parallel processing is only possible under certain condition  New option is proposed as below, we support either option 1 or 2a.  Option 1(Apple): yes  Option 2: no  Option 2a (Apple): no, but the applicability condition shall be clarified in the spec (e.g., no requirement applies when such configuration happens). |
| Xiaomi | Need more discussion |
| Qualcomm | Issue 2-2-1a: Condition of parallel processing  We prefer parallel processing as a starting point. So this could be FFS.  As we observe RAN2 still has an on-going discussion for the R16 maintenance WI to discuss the expected UE behavior when targetcellSMTC-SCG-r16 is configured, we are open to revisit the resulted RAN4 requirements when the RAN2 reaches the conclusion. For example, target PCell should mostly be a known cell which has been measured, so its cell timing could be employed for kicking off the PSCell search already. Such a UE behavior is being discussed by RAN2.  Issue 2-2-1b: Whether requirements for sequential processing are needed if parallel processing is only possible under certain condition  Option2 or option2a is fine. |
| Huawei | Issue 2-2-1a: Condition of parallel processing  Option 1 but also agreed with QC’s observation that this is under discussion in RAN2. We can comeback with more RAN2 conclusion.  Issue 2-2-1b: Whether requirements for sequential processing are needed if parallel processing is only possible under certain condition  Depend on issue 2-2-1a |
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*For Issue 2-2-2, views on potential difference between option 1a and option 1b are encouraged.*

**Issue 2-2-2: Parallel processing for HO with PSCell**

* Proposals
  + Option 1a (QC, Nokia, ZTE, CATT, Ericsson, vivo, Apple, OPPO, Docomo, MTK):
    - PCell HO and PSCell addition, without considering RA procedures and Tprocessing, are performed in parallel independently.
  + Option 1b (Intel, NEC):
    - Tsearch, Tmargin, T∆ can be processed in parallel for both Pcell HO and PSCell addition. Tsearch is the time required to search the target cell. T∆ is time for fine time tracking and acquiring full timing information of the target cell. Tmargin is time for SSB post-processing.
  + Option 1c (Huawei):
    - Based on the parallel processing assumption
    - Whether to consider additional delay for searching procedure depends on whether to include FR1+FR1 NR-DC case
  + Option 2a (NEC, Intel):
    - T∆ is time for fine time tracking and acquiring full timing information of the Pcell and PSCell and it can be performed parallel.
    - Cell search is performed in parallel for HO with PSCell.
  + Option 2b (MTK, Intel, NEC):
    - RAN4 to specify the delay requirement for HO with PSCell based on the assumption that some of procedures should be able to be performed in parallel.
    - FFS what kinds of components in the overall delay requirement, e.g., Tprocessing, will have dependency between Pcell and PSCell.
* 2nd round Comment collection:

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| --- | --- |
| **Company** | **Comments** |
| Apple | Option 1a. |
| Xiaomi | Option 1a is fine |
| Qualcomm | Option1a can be supported. |
| Huawei | General fine with option 1 with some clarification that Tsearch could be process in parallel but additional delay maybe considered for some cases as mentioned in option 1c. |
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*For Issue 2-2-3, following tentative agreement is reached. Company may further confirm.*

Tprocessing includes both software processing time and RF warm up time.

*In addition, comments on the possible principle to define processing time are encouraged. The potential principle raised in the 1st round discussion are as follows.*

* *For sequential processing for HO with PSCell, the total UE processing time for HO with PSCell is the sum of ‘legacy UE processing timing of HO’ and ‘legacy UE processing timing of PSCell addition’.*
* *For parallel processing for HO with PSCell, the total UE processing time for HO with PSCell could be the maximum one between ‘legacy UE processing timing of HO’ and ‘legacy UE processing timing of PSCell addition’.*
* *optimize based on whether source and target cells are in same or different FRs*

**Issue 2-2-3: UE SW processing and RF warm-up(if needed) time for HO with PSCell**

* Proposals
  + Option 1 (CATT): The value of processing time of handover and the PSCell addition can be reused separately. And Tprocessing for HO with PSCell including UE SW processing and RF warm-up time should be the maximum of the processing time of handover and the processing time of the PSCell addition.
  + Option 3 (Apple, Xiaomi):
    - For 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.
    - For 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
    - the UE processing time for HO with PSCell is:

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

* + Option 4 (Huawei): UE processing time is the maximum value of Pcell HO and PSCell addition, and FFS whether to extend the processing time for NR SA to EN-DC and the value if needed.
  + Option 5 (Ericsson): For software processing for PSCell, the following values are to be used.
    - 0ms, when source and target PSCells are the same same NR or LTE cell,
    - 20ms, when source and target PSCells are different NR cells in same FR,
    - 40ms, when source and target PSCells are different NR cells in different FRs,
    - [40ms], when there is no source PSCell i.e. when it is a matter of PSCell addition.
  + Option 6 (Nokia):
    - The UE processing time in HO with PSCell can be 20ms if source & target Pcell is in same frequency range and source & target PSCell in same frequency range, 40ms otherwise.
    - No additional RF retuning interruption should be defined during HO with PSCell..
  + Option 7 (NEC): Tprocessing is the UE processing time. Tprocessing is the maximum value of Pcell HO and PSCell addition
  + Option 8 (MTK, OPPO): The overall Tprocessing for HO with PSCell should be max(Tprocessing for PCell HO, Tprocessing for PSCell addition) +10ms
  + Option 10 (Qualcomm, vivo, 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.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Apple | Option 3:   * For 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. * For 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 |
| Xioami | Option 3 |
| Qualcomm | Option 10 is supported.  Difference of sequential v.s. parallel processing lies in the search, loops and RACH mainly due to RAN2 specification implications. It is not clear if the UE processing time would have to be fully serialized. |
| Huawei | We can support option 3 on parallel process, which is still under discussion.  We have one question to Option 1 which was also raised but no response received. What is the difference from inter-RAT handover from NR to LTE, where the processing time is also 20 ms. |
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*For Issue 2-2-5, the tentative agreement in the 1st round below may be relevant.*

It depends on RAN2 reply whether RACH processing can be performed in parallel or not and it can be further discussed

**Issue 2-2-5: Ending point of the delay requirement for HO with PSCell**

* Proposals
  + Option 1 (CATT, CMCC, Ericsson, Intel, NEC, vivo, Nokia): Waiting for RAN2 response for order of random access carried out towards PCell and PSCell.
  + Option 2 (Xiaomi, OPPO, DoCoMo, vivo): The ending point of HO with PSCell is the timing when UE is capable to transmit PRACH preamble towards target PSCell.
  + Option 3 (Apple): the ending point of the delay requirement for HO with PSCell is:
    - 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 (Huawei, QC, MTK):
    - 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.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Apple | Option 3 and option 1. |
| Xiaomi | Option 1 is fine |
| Qualcomm | Option4 |
| Huawei | Option 4 |
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*For issue 2-2-6, Nokia are welcome to check if the tentative agreement is acceptable.*

**Issue 2-2-6: Optimisation for the case when PSCell is not changed during HO with PSCell**

* Proposals
  + For UE which is already configured with DC, the UE’s behavior is same whether the configured PSCell is same as the original one or not.
* 2nd round Comment collection:

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| **Company** | **Comments** |
| Apple | Support above proposal |
| Xiaomi | Support the proposal |
| Qualcomm | Above proposals are agreeable. |
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*For Issue 2-2-8 and Issue 2-2-9, company may confirm if the tentative agreements in the 1st round is agreeable.*

**Issue 2-2-8: Delay requirement design if parallel processing is assumed**

* Proposals
  + Delay requirements for parallel processing are discussed after there is conclusion on other issues in sub-topic 2-2.

**Issue 2-2-9: Delay requirement design if sequential processing is assumed**

* Proposals
  + Delay requirements for sequential processing are discussed after there is conclusion on other issues in sub-topic 2-2.
* 2nd round Comment collection for Issue 2-2-8 and Issue 2-2-9:

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| **Company** | **Comments** |
| Apple | Wait until conclusions from other issues |
| Xiaomi | Pending on other issues in sub-topic 2-2 |
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*For Issue 2-3-2, companies are encouraged to provide comments with clarification that it is for parallel processing or sequential processing.*

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

* Proposals
  + Option 1 (CATT, Xiaomi, Huawei, vivo, Docomo): No interruption requirement should be defined during HO with PSCell
  + Option 2 (MTK, Ericsson, CATT, Intel, Nokia): No new interruption requirement for HO with PSCell is needed. Interruption in legacy handover delay requirement can still be applied for the PCell
  + Option 3 (Apple, OPPO, Huawei): Interruption in legacy handover delay requirement can be applied for Pcell. No interruption is defined on PSCell.
    - If sequential processing is used for HO with PSCell, UE may have an interruption on new PCell due to the PSCell addition.
    - If parallel processing is used for HO with PSCell, no need to define interruption requirement.
  + Option 5 (NEC): RAN4 to postpone the discussion on interruption uncertainty (TIU) till reply LS from RAN2 is received.
  + Option 6 (Qualcomm): Depending on RAN2 LS reply.
* 2nd round Comment collection

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| **Company** | **Comments** |
| Apple | Option 3. |
| Xiaomi | Option 1, if parallel processing is used, no interruption is needed. |
| Qualcomm | Can compromise to Option 5. |
| Huawei | Option 1 for parallel processing. Whether there is interruption for sequential processing (if needed) is FFS |
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**Issue 2-4-1: 2 step and 4 step RACH for HO with PSCell**

* Proposals
  + Option 1a (ZTE, Nokia, vivo): Include both 2-step RA and 4-step RA into the new requirements made for handover with PSCell. No need to mention 2-step or 4-step in HO with PSCell requirements.
  + Option 1b (NEC, Ericsson, ZTE, Nokia): RAN4 to define both 2-step and 4-step RACH requirements for handover with PSCell.
  + Option 2 (Apple, Xiaomi, OPPO, MTK): for requirement of HO with PSCell, RAN4 starts the discussion with 4 step RACH first and FFS on 2 step RACH.
  + Option 3 (CATT, Qualcomm): Waiting RAN2 response and conclusions of other issues for 2 step and 4 step RACH.
* 2nd round Comment collection

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| **Company** | **Comments** |
| Apple | Option 2. |
| Xiaomi | Option 2 |
| Qualcomm | Option3 |
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**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 (CATT, Apple, OPPO, Qualcomm, Huawei, MTK): The NR-U scenario is out of scope of this WID, no need to discuss.
  + Option 3 (vivo): Discuss in RAN plenary.
* 2nd round Comment collection

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| **Company** | **Comments** |
| Apple | Option 2 |
| Qualcomm | Option2  Or consider TEI17 when current WI is stable in requirements? |
| Huawei | Option 2 |
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## 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”* |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on further RRM enhancement for NR and MR-DC – HO with PSCell | vivo |  |
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**Existing tdocs**

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| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-2108768 | Discussion on handover with PSCell | ZTE Corporation | Noted |  |
| R4-2109051 | Further discussion on HO with PSCell | CATT | Noted |  |
| R4-2109244 | Discussion on HO with PSCell | Intel Corporation | Noted |  |
| R4-2109250 | Further discussion on RRM requirements for handover with PSCell | Xiaomi | Noted |  |
| R4-2109309 | On RRM requirement for handover with PSCell | Apple | Noted |  |
| [R4-2109510](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_99-e/Docs/R4-2109510.zip) | Discussion on HO with PSCell | CMCC | Noted |  |
| R4-2109732 | Further views on timeline assumptions for HO with PSCell | Qualcomm CDMA Technologies | Noted |  |
| R4-2109885 | Discussion on HO with PSCell | MediaTek inc. | Noted |  |
| R4-2109891 | Discussion on PSCell HO | NEC | Noted |  |
| R4-2110062 | RRM requirements for HO with PSCell | OPPO | Noted |  |
| R4-2110147 | Views on HO with PSCell | NTT DOCOMO, INC. | Noted |  |
| R4-2110344 | Discussion on requirements for HO with PSCell | Huawei, HiSilicon | Noted |  |
| R4-2110971 | On handover with PSCell | Ericsson | Noted |  |
| R4-2111042 | discussion on HO with PSCell | Nokia, Nokia Shanghai Bell | Noted |  |
| R4-2111265 | Discussion on RRM requirements for HO with PSCell | vivo | Noted |  |

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** |
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Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents