**3GPP TSG-RAN WG4 Meeting # 116 R4-2509065**

**[Bengaluru](https://www.3gpp.org/Specification-Groups/" \t "_blank), India, 25 August – 29 August, 2025**

**Agenda item:** 7.24.1

**Source:** Moderator (vivo)

**Title:** Topic summary for [116][222] NR\_LPWUS

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

This document provides the summary of RRM part for NR\_LPWUS.

Based on the latest approved WI in [RP-240135] and updated WI in [RP-241824], the objectives of the WI are duplicated as below:

The objectives of the work item are the following:

* To specify an LP-WUS design commonly applicable to both IDLE/INACTIVE and CONNECTED modes (RAN1, RAN4)
  + Specify OOK (OOK-1 and/or OOK-4) based LP-WUS with overlaid OFDM sequence(s) over OOK symbol
    - The LP-WUS design shall ensure that for IDLE/INACTIVE operation, the same information is delivered irrespective of LP-WUR type. The OFDM sequence can carry information.
  + At least duty-cycled monitoring of LP-WUS is supported
* For IDLE/INACTIVE modes
  + Specify procedure and configuration of LP-WUS indicating paging monitoring triggered by LP-WUS, including at least configuration, sub-grouping and entry/exit condition for LP-WUS monitoring (RAN2, RAN1, RAN3, RAN4)
  + Specify LP-SS with periodicity with Yms for LP-WUR, for synchronization and/or RRM for serving cell. (RAN1, RAN4)
    - LP-SS is based on OOK-1 and/or OOK-4 waveform with or without overlaid OFDM sequences. Further down selection between with and without overlaid OFDM sequences is to be done within WI.
    - Note: For LP-WUR that can receive existing PSS/SSS, existing PSS/SSS can be used for synchronization and RRM instead of LP-SS.
    - Y will be decided within WI. 320ms is the start point.
  + Specify further RRM relaxation of UE MR for both serving and neighbor cell measurements, and UE serving cell RRM measurement offloaded from MR to LP-WUR, including the necessary conditions (RAN4, RAN2)
* For CONNECTED mode, specify procedures to allow UE MR PDCCH monitoring triggered by LP-WUS including activation and deactivation procedure of LP-WUS monitoring (RAN2, RAN1)
  + Check in RAN#105 for potential TU adjustment in RAN2
  + Note: In CONNECTED mode, UE MR ultra-deep sleep is not considered, and UE RRM/RLM/BFD/CSI measurements are performed by MR
* Note: The target coverage of LP-WUS and LP-SS shall be the coverage of PUSCH for message3.
* Note: The optimization of LP-WUS signal design for idle/inactive mode is prioritized over the optimization for connected mode.
* Specify the necessary RAN4 core requirement(s) to support the feature (RAN4).
  + Specifying UE low-power wake-up receiver requirements, at least REFSENS, ACS and ASCS requirements with consideration of possible new methodology
    - Define guard RBs for ACS and ASCS cases
    - Study testability of above requirements
    - Consider impacts of different architecture and impairments
  + Study and specify, if necessary, any BS requirements, e.g., increase upper limit for LP-WUS/LP-SS beyond current dynamic range
  + Specify necessary RRM requirements

Recommendation topic to be discussed online in order of priority identified by the moderator.

**Issue 1-2-1-1: Detail on LR accuracy and side conditions requirements**

**Issue 1-2-4-2-3: On how to define LR evaluation requirements**

**Issue 1-1-14: LP-WUR operation with eDRX**

**Issue 1-1-15 LP-WUR operation with RedCap**

**Issue 1-1-16: LP-WUR operation with EMR**

**Issue 1-2-11: RRM requirements for FR2**

**Issue 1-1-17: LP-WUR operation with SDT**

**Issue 1-5-3: MR wake up delay after exiting case 1 due to offloading conditions cannot be met**

**Issue 2-1-7: On interference in simulation**

**Issue 1-2-12: UE behaviro when both Rel-16 relaxation and Rel-19 LP-WUR offloading/relaxation are safisfied; or when when both Rel-17 relaxation for Redcap and Rel-19 LP-WUR offloading/relaxation are satisfied**

**Issue 1-2-9: LP-WUR status at legacy case (not at LP-WUS monitoring case/fully offloading(case 1) case/RRM relaxation (case 3) case)**

**Issue 1-2-13: Transition period**

**Issue 3-2-3: Test case design for entry/exit conditions for case 1/case 3**

**Issue 3-2-2: Test case for OOK based LR and OFDB based LR**

# Topic #1: RRM core requirements for LP-WUS/WUR

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| T-doc number | Company | Proposals / Observations |
| [**R4-2509500**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509500.zip) | Apple | ***Proposal 1: LR measurement can be used to check the criteria for neighbor cell measurement triggering/relaxation (in case #1).***  ***Proposal 2: No LP-WUR measurement and evaluation requirement applies at legacy case (not at LP-WUS monitoring case/fully offloading(case 1) case/RRM relaxation (case 3) case).***  ***Proposal 3: FR2 LP-WUR based RRM requirement can be deprioritized in R19.***  ***Proposal 4: Use 2.5 dB as the RF impairment margin for LP-RSRP accuracy requirements.***  ***Proposal 5: No need to define upper bound for SSB-based LP-WUR measurement periodicity.***  ***Proposal 6: The evaluation requirement (x1/y1) can be decided after RAN4 has simulation alignment for measurement requirement (x/y). Consider using x1=2\*x and y1=2\*y for the evaluation requirement.***  ***Proposal 7: For a UE which supports idleInactiveNR-MeasReport-r16 or idleInactiveEUTRA-MeasReport-r16, and serving cell configures carriers for idle mode CA/DC measurement reporting with T331 running, UE shall keep the MR ON for EMR measurement regardless of the MR offloading condition is met or not.***  ***Proposal 8: RAN4 to discuss followings LP-SS based RRM issue in IDLE/Inactive mode:***   * ***how to enter and exit offloading status if eDRX is configured with PTW.***   ***Proposal 9: in core maintenance phase, RAN4 to discuss the case when*** ***low mobility criteria is configured for UE power saving but not met in the LP-WUR based RRM case#1 and case#3.*** |
| [**R4-2509677**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509677.zip) | OPPO | **Proposal 1: No LR measurement and evaluation requirements apply at the legacy state.**  **Proposal 2: Prioritize defining RRM requirements for FR1 in this WI.**  **Proposal 3: The requirements for normal UE should be completed in high priority in Rel-19. After that, RAN4 can further discuss whether to apply for Redcap UE considering the RRM workload, RAN2 signaling support and UE RF impact.**  **Proposal 4: No need to define upper bound for SSB based LP-WUR measurement requirements.**  **Proposal 5: Use x1=2\*x and y1=2\*y for the LR evaluation requirement where x = y = 2 samples.**  **Proposal 6: Define requirements based on [±6] dB accuracy and reflect the margin into entry/exit condition.**  **Proposal 7: When case 3 (relaxed measurement) criterion is fulfilled, the configured IDLE mode CA/DC measurements can be relaxed only when T331 is not running.**  **Proposal 8: When case 1 (serving cell measurement offloading) criterion is fulfilled, UE is expected to perform relaxed high priority layers measurement without NW indication. And when T331 is running, the carriers configured for IDLE mode CA/DC measurements can also be included.**  **Proposal 9: When UE exits the serving cell offloading case, the following approaches can be considered for UE behavior:**   * **Option 1: UE follow relaxed measurement and meet the corresponding requirements.** * **Option 2: UE follow legacy measurement and meet the corresponding requirements.** * **Option 3: Up to UE implementation and no requirements apply.**   **Proposal 10: RAN4 to discuss whether to update the time for cell selection initiation for LP-WUS UE.**  **Proposal 11: Use the following structure as baseline for drafting CR.**   |  | | --- | | 4.x IDLE mode measurement for UE with LP-WUR4.x.1 Introduction4.x.2 Requirements4.x.2.1 UE measurement capability4.x.2.2 LP-WUR serving cell measurement and evaluation requirements 4.x.2.2.1 LP-WUR measurement and evaluation requirements for PSS/SSS  4.x.2.2.2 LP-WUR measurement and evaluation requirements for LP-SS  4.X.2.3 MR Measurement and evaluation of serving cell  4.X.2.4 MR measurements of intra-frequency NR cells 4.X.2.5 MR Measurements of inter-frequency NR cells[4.X.2.5.2 Measurements for UE with LP-WUR fulfilling [case3/relaxed MR measurement] criterion][4.X.2.5.3 Measurements for UE with LP-WUR fulfilling [MR fully offloading] criterion]4.X.2.6     MR Measurements of inter-RAT E-UTRAN cells[4.X.2.6.2 Measurements for UE fulfilling relaxed measurement criteria][4.X.2.6.3 Measurements for UE fulfilling serving cell measurement offloading entry criteria] 4.X.2.7 Maximum interruption in paging reception  4.X.2.8 MR measurements of high priority layers | |
| [**R4-2509775**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509775.zip) | Xiaomi | **Proposal 1: RAN4 to confirm that, for case 1, MR is expected to perform relaxed higher priority frequency layer measurement with K2\*Thigher\_priority\_search and K2 = 60.**  **Proposal 2: RAN4 to clarify for case 3:**  **When Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ,**   * **MR is expected to perform relaxed higher priority frequency layer measurement with K2\*Thigher\_priority\_search and K2 = 60, if configured;** * **MR is expected to perform relaxed serving cell measurement with scaling factor 16.**   **when the condition of Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ is NOT met:**   * **The same relaxed requirements for higher priority, equal priority and lower priority carriers are applied, i.e. 16 times of Tdetect,NR\_Inter, Tmeasure,NR\_Inter and Tevaluate,NR\_Inter;** * **The relaxed requirement for serving cell is applied, i.e. 16 times of Nserv.**   **Proposal 3: RAN4 not to define upper bound for the measurement delay requirements for LP-WUR when LP-SS is not configured.**  **Proposal 4: No LR measurement and evaluation requirements apply at the legacy state, i.e., for the following cases: from legacy case to LP-WUR monitoring, from legacy case to RRM measurement fully offloading (case 1), and from legacy case to RRM measurement relaxation (case 3).**  **Proposal 5: RAN4 to define LP-WUR related requirements for RedCap UE.**  **Proposal 6: RAN4 to assume the 3.5 dB RF impairment margin for LR.** |
| [**R4-2510030**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510030.zip) | CMCC | ***Proposal 1: The LR evaluation requirements will be applied when LR is ‘ON’ at legacy state.***  ***Proposal 2: Don’t introduce FR2 RRM requirements for LP-WUS WI.***  ***Proposal 3: Use 2.5dB for LR RF impairment margin.***  ***Proposal 4: No upper bound is needed on top of LO periodicity.***  ***Proposal 5: Don’t define requirements for the combination of eDRX and LP-WUS feature.*** |
| [**R4-2510093**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510093.zip) | China Telecom | **Proposal 1: No LP-WUR measurement and evaluation requirements apply when LR is “on” at the legacy state.**  **Proposal 2: Prioritize defining RRM requirements for FR1 in this WI.**  **Proposal 3: No need to define upper bound for SSB-based LP-WUR measurement periodicity.** |
| [**R4-2510194**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510194.zip) | vivo | **Observation 1: Regarding FR2 RRM requirements, there is not any concrete technical proposal on FR2 RRM requirements till RAN4 115 meeting**   1. **Specify serving cell and neighbor cell measurement for offloading and RRM relaxation for Redcap UE with 1 Rx and 2 Rx. Existing agreements for offloading and RRM relaxation will be used for Redcap UE.** 2. **For the number of SSB for wake up delay for 1 Rx Redcap, the same number of SSB, i.e., { 3 5 5} SSBs for {10ms, 400ms, 800ms} ramping up time, can be reused initially.** 3. **When both Rel-16 EMR and Rel-19 LP-WUR are configured, for case 1 (offloading) and case 3 (RRM relaxation) defined in Rel-19 LP-WUR:**  * **when T331 is running, all carriers (carriers configured/not configured for CA/DC idle state measurement) follow (Rel-15) legacy measurements; when T331 is not running, all carriers follow RRM requirements defined in Rel-19 LP-WUR, i.e., relaxed with scaling factor 16 when case 3 (RRM relaxation criteria) are satisfied or serving cell offloading when case 1 criteria are satisfied;**  1. **When both Rel-18 EMR and Rel-19 LP-WUR are configured, consider the following options:**   **Option 1: When Rel-18 EMR is configured, all carriers follow (Rel-15) legacy measurement requirement.**  **Option 2: Rel-18 EMR and Rel-19 LP-WUR cannot be configured at the same time (need send LS to RAN2)**   1. **No RAN4 RRM requirements for LP-WUR operation with eDRX or at least for eDRX with PTW window in Rel-19.** 2. **At legacy state, when LP-WUR measurement is “ON” for evaluating LR threshold, LR evaluation related requirements will not apply is preferred.** 3. **Suggest RAN4 to consider to drop FR2 RRM requirement in Rel-19 if there is no consensus or still no concrete technical proposals for FR2 RRM requirements in RAN4 116 meeting.** 4. **When both Rel-16 relaxation and Rel-19 LP-WUR relaxation are satisfied; or when both Rel-17 relaxation for Redcap and R19 LP-WUR relaxation are satisfied, UE is allowed to follow the most relaxation requirements.** 5. **When a UE leaves fully offloading state due to serving cell quality, the MR will consecutive measure a few (5) SSBs or consecutively measures SSBs within a transition period (100ms), then the MR will follow either relaxed measurement requirement or legacy measurement requirement.** 6. **Use 2.5 dB as the RF impairment margin for LP-RSRP and [SS-RSRP] accuracy requirements.** 7. **Using x1=2\*x and y1=2\*y for the evaluation requirement. The value x1 for LP-SS based LR evaluation requirement could be 4 or [6] under the condition when x = 2 or [3]. The value y1 for SSB based LR evaluation requirement could be 4 under the condition when y = 2.** 8. **MR and LR operate at different time, there is no need define interruption requirements on WUS monitoring by LR at connected state.** |
| [**R4-2510657**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510657.zip) | Huawei, HiSilicon | **Proposal 1:** **RAN4 not to define LR measurement requirements before entering or after exiting LP-WUS monitoring or LR measurement offloading.**  **Proposal 2:** **RAN4 to define LP-WUR related requirements for RedCap UE.**  **Proposal 3:** **Take [2.5]dB as the RF impairment margin for LR.**  **Proposal 4: Measurement periodicity for SSB is the LO periodicity, i.e. no upper limit is defined.**  **Proposal 5: Define LR measurement requirement as the minimum duration where one LR measurement shall be executed.**  **Proposal 6: RAN4 to confirm LR requirements are applicable when UE is in RRM relaxation mode or RRM offloading mode.**  **Proposal 7: Define LR evaluation requirement based on x1 = y1 = [4].**  **Proposal 8: RAN4 to confirm MR evaluation requirements are applicable when UE is in RRM relaxation mode or legacy mode.**  **Proposal 9: RAN4 to define requirements on MR wake-up delay for cases where UE determines LR exit condition is met. The wake-up delay for cases where UE detects LP-WUS is re-used.**  **Proposal 10: Legacy MR accuracy requirements in RRC\_IDLE or RRC\_INACTIVE are re-used for MR measurement with relaxation,** **for both serving and neighbour cell.**  **Proposal 11:** **RAN4 to wait for RAN1 further agreements to discuss possible RRM impacts of LP-WUS monitoring in CONNECTED mode.**  **Proposal 12:** **Clarify that UE should meet the existing EMR measurement requirements when in RRM relaxation or offloading mode when TR331 is running.**  **Proposal 13:** **RAN4 to de-prioritize defining LR related requirements with eDRX.** |
| [**R4-2510909**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510909.zip) | Ericsson | ***Proposal 1: The LR measurement and evaluation requirement is applied when the LP-WUR is in ON state.***  ***Proposal 2: In LP-WUS Case 3, when Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, but Srxlev < SIntraSearchP or Squal < SIntraSearchQ, UE follows RRM relaxation measurement requirement for intra-frequency with scaling factor 16.***  ***Proposal 3: RAN4 to focus on LP-WUS FR1 RRM requirement in Rel-19.***  ***Proposal 4: RAN4 to use 2.5dB RF impairment margin for LR accuracy requirements.***  ***Proposal 5: RAN4 to discuss transition requirement among normal measurement(Rel-15, Rel-16 measurement) and Rel-19 MR RRM measurement relaxation, offloading.***  ***Proposal 6: RAN4 to discuss the UE behaviour when UE detects to meet Rel-16 low mobility criteria and Rel-19 RRM relaxation criteira.***  ***Proposal 7: No RAN4 RRM requirement related to LP-WUS is idenfitied in RRC\_CONNECTED mode.***  ***Proposal 8: For a UE which supports Rel-16 EMR,***   * ***If UE fulfils MR RRM relaxation condition and Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, UE shall at least search for carriers configured for EMR (and the serving cell) based on higher priority layer search requirement Thigher\_priority\_search;*** * ***If UE fulfils MR RRM relaxation condition and Srxlev <= SnonIntraSearchP or Squal <= SnonIntraSearchQ, the RRM measurement relaxation is NOT applied to the carriers configured for EMR measurement;*** * ***If UE fulfils MR RRM offloading condition(UE also fulfils Rel-15 neighour cell measurement stopping criteira), UE shall at least search for carriers configured for EMR (and the serving cell) based on higher priority layer search requirement Thigher\_priority\_search.***   ***Proposal 9: For a UE which supports Rel-18 EMR, FFS UE’s measurement behaviour for the carriers configured for EMR when UE filfils RRM relaxation/offloading thresholds.***  ***Proposal 10: RedCap UE shall meet LP-WUS related requirement based on UE’s LP-WUS capability.*** |
| [**R4-2511026**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511026.zip) | ZTECorporation,Sanechips | **Observation 1: The channel condition shall be guaranteed if LR is ON and performs serving cell measurement.**  **Observation 2: If LR performs serving cell measurement at legacy case, how to guarantee the channel condition in legacy case and how to ensure the measurement accuracy by LR constitute the main concern.**  **Proposal 1: RAN4 shall not define the RRM requirements if LR is ON at legacy case.**  **Observation 3: If the communication quality can not be guaranteed, the power saving gain would not be considered, and we do not think if the upper bound is settled, the power consumption will be largely increased.**  **Proposal 2: The upper bound is needed on SSB-based LP-WUR measurement periodicity if LP-SS is not configured.**  **Proposal 3: We are open to consider RRM requirements on FR2.**  **Observation 4: RF session has already defined the IM margin as 2.5dB.**  **Observation 5: If the RF margin is large, the MAPL will be decreased and the communication coverage will be decreased. If the same coverage is ensured under different RF margin, the power consumption will be increased, which is not good to power saving neither for network nor UE.**  **Proposal 4: Use 2.5 dB as the RF impairment margin for LP-RSRP accuracy requirements.**  **Proposal 5: The maximum interruption in paging reception requirements shall be reused in LP-WUS.**  **Proposal 6: RAN4 shall cosnsider RedCap UEs with MR/LR, there are six cases shall be considered, the following table shall be considered:**   |  |  | | --- | --- | | **Cases** | **Requirements to define** | | **2Rx RedCap UE with MR** | 1. **Reused legacy 2Rx RedCap UE RRM requirements;** 2. **Reused wake up delay requirements (the number of SSB)** | | **1Rx RedCap UE with MR** | 1. **the requirements for 1Rx RedCap UE with MR is the same as 1Rx RedCap UE in legacy with specific side conditions.** 2. **Reused wake up delay requirements (the number of SSB)** 3. **RAN4 shall define the specific side conditions** | | **1Rx RedCap UE with LR** | **The requirements for normal UE with LR could be reused for 1Rx RedCap UE with LR.** | | **HD-FDD RedCap UE with MR** | **The legacy maximum interruption in paging reception requirements shall be reused for HD-FDD RedCap UE with MR** | | **HD-FDD RedCap UE with LR** | **The same legacy availability rule shall be reused, then the legacy requirements on maximum interruption in paging reception can be the same.** |   **Observation 6: For normal UE with LP-WUS, RAN1 is discussing the UE capability.**  **Observation 7: For RedCap UE capability with LP-WUS, the UE capability among R17 RedCap, R18 RedCap and R19 LP-WUS are independently. The discussion on RedCap UE with LP-WUS capability is not observed in RAN1.**  **Proposal 7: For UE with LP-WUS, RAN4 shall wait for RAN1’s discussion on UE capability. The new UE capability shall not be introduced.**  **Proposal 8: The feature for RedCap UE with LP-WUS only applies for R19 UEs not for R17/R18 UEs.** |
| [**R4-2511242**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511242.zip) | Nokia | [**Observation 1:** How to filter is up to UE for LP-SS, but evaluation needs to be at least two samples.](#_Toc206169780)  [Proposal 1: Capture in the specification that the UE shall filter the LP-RSRP and LP-RSRQ measurements of the serving cell using at least 2 measurement samples.](#_Toc206169781)  [Proposal 2: Evaluation period is 2 \* (number of measurements to reach target accuracy). I.e., x = y = 2 and x1 = y1 =4.](#_Toc206169782)  [**Observation 2:** Currently it’s not clear in which scenarios the UE should not check LR before entering case 1 / 3](#_Toc206169783)  [**Observation 3:** MR and LR accuracy are different, meaning that not performing any measurements with LR in legacy state may cause ping-pongs.](#_Toc206169784)  [Proposal 3: At legacy state, when both MR and LR entry thresholds are configured, the UE shall evaluate both MR and LR thresholds at least once before entering relaxation / offloading. When only MR threshold is configured the UE is required to only perform MR evaluation when entering relaxation / offloading.](#_Toc206169785)  [Proposal 4: Add requirements support for RedCap without impact to connected mode requirements, and no FR2 impact, at least for LP-SS.](#_Toc206169786)  [Proposal 5: If 1 Rx is to be supported, no differentiation for 1 Rx redcap on number of samples](#_Toc206169787)  [Proposal 6: SDT requirements apply also for UE supporting LP-WUS](#_Toc206169788)  [Proposal 7: The UE supporting LP-WUS uses LR-RSRP measurements for condition evaluation when the evaluation is started while the UE is in MR offloading.](#_Toc206169789)  [Proposal 8: Prioritize defining RRM requirements for FR1 in this WI](#_Toc206169790)  [**Observation 4:** Total accuracy margin is measurement accuracy (3.5dB) + RF impairment margin.](#_Toc206169791)  [**Observation 5:** The larger the accuracy margin, the smaller the MR relaxation / offloading operation area is reduced.](#_Toc206169792)  [Proposal 9: Use 2 dB as the RF impairment margin for LP-RSRP accuracy requirements](#_Toc206169793)  [Proposal 10: No need to define upper bound for SSB-based LP-WUR measurement periodicity](#_Toc206169794)  [**Observation 6:** UE may be configured with EMR by a different cell than when UE left](#_Toc206169795)  [Proposal 1: Discuss about two alternatives to handle the situation](#_Toc206169796)  [a. When T331 running UE shall keep the MR ON for EMR measurement regardless of the MR offloading condition is met or not.](#_Toc206169797)  [b. UE shall not enter relaxation / offloading if configured simultaneously with EMR.](#_Toc206169798)  [Proposal 2: UE may report measurements from MR relaxation with rel-18 EMR reporting](#_Toc206169799)  [**Observation 7:** PTW window is used for PO monitoring and network guarantees that the LP-WUS is transmitted early enough before the next PO when UE is expected to wake up.](#_Toc206169800)  [Proposal 3: Discuss if MR based RRM measurement/evaluation shall be contained in one PTW window or it can extend outside of the PTW.](#_Toc206169801)  [Proposal 4: After MR wake up, MR follows SSB periodicity for serving and neighbouring cell evaluation.](#_Toc206169802) |
| [**R4-2511607**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511607.zip) | MediaTek inc. | **Proposal 1: On EMR for LPWUS and when T331 is running, MR is expected to perform measurements on NR inter-frequency carriers configured for idle mode CA/DC measurements without relaxation for both Case#1 (RRM offloading) and Case#3 (RRM relaxation).**  **Proposal 2: On EMR for LPWUS and when T331 is not running in Case#1 (RRM offloading):**   * **RAN4 assumed in this case Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ is always met. Therefore, the UE shall search for inter-frequency layers configured for idle mode CA/DC measurements by following the relaxed higher priority frequency measurement requirements for Case#1 (i.e., every 1 hr).**   **Proposal 3: On EMR for LPWUS and when T331 is not running in Case#3 (RRM relaxation):**   * **If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ**   + **the UE shall search for inter-frequency layers configured for idle mode CA/DC measurements by following the relaxed higher priority frequency measurement requirements for Case#3 (i.e., every 1 hr)** * **if Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ**   + **the UE shall search for inter-frequency layers configured for idle mode CA/DC measurements by following the relaxed higher priority frequency measurement requirements for Case#3 (i.e., 16 times)**   **Proposal 4: The agreed requirements for LP-WUS cannot be reused directly for RedCap. Due to the short time RAN4 to deprioritize LP-WUS requirements for RedCap.**  **Proposal 5: Discuss how to avoid the ping pong behaviour when transitioning between different cases based on RRM measurements.**  **Proposal 6: RAN4 to study switching between Case#3 and Case#1 based on a timer. Since UE need to be confident enough to enter Case#1 before deactivating MR, it is better for the UE to enter Case#3 first for a period of time (confidence period) before UE can enter Case#1.**  **Proposal 7: No LR measurement and evaluation requirements apply at the legacy state.**  **Proposal 8: RAN4 to consider using x1=2\*x and y1=2\*y for the evaluation requirement, where x and y are decided based on simulation results.**  **Proposal 9: On the applicability of MR and LR evaluation:**   * **MR evaluation applies to the entry to case#1 and case#3** * **LR evaluation applies to exiting from case#1 and case#3 to legacy case; and (optional) switching between case3# to case#1**   **Proposal 10: Consider 3.5 dB RF impairment margin for LR.**  **Proposal 11: No need to define upper bound for SSB-based LP-WUR measurement periodicity.**  **Proposal 12: Prioritize FR1 requirements for R19 LPWUS and deprioritize FR2.** |
| [**R4-2511632**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511632.zip) | Qualcomm Incorporated | **Proposal 1**: **Specify LP-WUR measurement and evaluation requirements in FR2 by scaling the FR1 requirements using a beam sweeping factor N1.**  **Proposal 2**: **For SSB-based measurements, assume N1 is equal to the number of Rx beams used by the MR.**  **Proposal 3**: **For OOK-based measurements, assume N1 = 8**.  **Proposal 4: The target measurement accuracy requirements for FR2 is 1.5 dB worse than FR1, to account for the additional RF inaccuracy.**  **Proposal 5**: **For MR-based relaxed serving and neighbor cell measurements in FR2, reuse the measurement relaxation factor of 16 as agreed for FR1**.  **Proposal 6: RAN4 to specify RRM requirements for LP-WUR operation only for eDRX without PTW (i.e.,** **eDRX cycles <=10.24s).**  **Proposal 7: RAN4 requirements on LP-WUR are applicable only when LP-WUS/LP-SS is transmitted within the initial DL BWP of the UE.** |
| [**R4-2509285**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509285.zip) | CATT | draftCR |
| [**R4-2509286**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509286.zip) | CATT | draftCR |
| [**R4-2509678**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509678.zip) | OPPO | draftCR |
| [**R4-2509739**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509739.zip) | LG Electronics Inc. | draftCR |
| [**R4-2509776**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509776.zip) | Xiaomi | draftCR |
| [**R4-2510031**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510031.zip) | CMCC | draftCR |
| [**R4-2510658**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510658.zip) | Huawei, HiSilicon, vivo | draftCR |
| [**R4-2510911**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510911.zip) | Ericsson | draftCR |
| R4-2511048 | ZTECorporation,Sanechips | draftCR |
| R4-2511049 | ZTECorporation,Sanechips | draftCR |
| [**R4-2511112**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511112.zip) | ZTECorporation,Sanechips | draftCR |
| [**R4-2511113**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511113.zip) | ZTECorporation,Sanechips | draftCR |
| [**R4-2511243**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511243.zip) | Nokia | draftCR |
| [**R4-2511634**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511634.zip) | Qualcomm Incorporated | draftCR |
| [**R4-2510197**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510197.zip) | vivo | draftCR |
|  |  |  |

## Open issues summary

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

### Sub-topic 1-1 General aspects

**Issue 1-1-2: Threshold for switch between different cases**

* Proposals
  + P1: LR measurement can be used to check the criteria for neighbor cell measurement triggering/relaxation (in case #1). (Apple)
  + P2: Discuss how to avoid the ping pong behaviour when transitioning between different cases based on RRM measurements; Study switching between Case#3 and Case#1 based on a timer. Since UE need to be confident enough to enter Case#1 before deactivating MR, it is better for the UE to enter Case#3 first for a period of time (confidence period) before UE can enter Case#1. (MTK)

*Recommendations:*

*It is up to RAN2’s decision.*

**Issue 1-1-9: LP-WUR status at legacy case (not at LP-WUS monitoring case/fully offloading(case 1) case/RRM relaxation (case 3) case)**

*Move to section 2*

**Issue 1-1-10: Considerations on higher priority frequency layer**

*Move to section 2*

**Issue 1-1-11: RRM requirements for FR2**

*Move to section 2*

**Issue 1-1-13: Spec impact**

* Proposals
  + P1: Use the structure as baseline for drafting CR. (oppo)

|  |
| --- |
| 4.x IDLE mode measurement for UE with LP-WUR4.x.1 Introduction4.x.2 Requirements4.x.2.1 UE measurement capability4.x.2.2 LP-WUR serving cell measurement and evaluation requirements 4.x.2.2.1 LP-WUR measurement and evaluation requirements for PSS/SSS  4.x.2.2.2 LP-WUR measurement and evaluation requirements for LP-SS  4.X.2.3 MR Measurement and evaluation of serving cell  4.X.2.4 MR measurements of intra-frequency NR cells 4.X.2.5 MR Measurements of inter-frequency NR cells[4.X.2.5.2 Measurements for UE with LP-WUR fulfilling [case3/relaxed MR measurement] criterion][4.X.2.5.3 Measurements for UE with LP-WUR fulfilling [MR fully offloading] criterion]4.X.2.6     MR Measurements of inter-RAT E-UTRAN cells[4.X.2.6.2 Measurements for UE fulfilling relaxed measurement criteria][4.X.2.6.3 Measurements for UE fulfilling serving cell measurement offloading entry criteria] 4.X.2.7 Maximum interruption in paging reception  4.X.2.8 MR measurements of high priority layers |

*Recommendations: Discuss in the CR*

**Issue 1-1-14: LP-WUR operation with eDRX**

* Proposals
  + P1: RAN4 to discuss followings LP-SS based RRM issue in IDLE/Inactive mode: how to enter and exit offloading status if eDRX is configured with PTW. (Apple)
  + P2: No requirements for the combination of eDRX and LP-WUS feature (CMCC vivo Huawei)
  + P2-1: No RAN4 RRM requirements for LP-WUR operation with eDRX with PTW window in Rel-19. (vivo QC)
  + P3: If LP-WUS operation is configured together with eDRX, the UE is required to monitor LP-WUS signal only during PTW. Discuss if MR based RRM measurement/evaluation shall be contained in one PTW window or it can extend outside of the PTW. (Nokia)
  + P4: RAN4 to specify RRM requirements for LP-WUR operation only for eDRX without PTW (i.e., eDRX cycles <=10.24s). (QC)

*Recommendations:*

No RAN4 RRM requirements for LP-WUR operation with eDRX with PTW window in Rel-19.

For LP-WUR operation with eDRX without PTW (i.e., eDRX cycles <=10.24s)

Option 1: no RAN4 RRM requirements

Option 2: Specify RRM requirements

**Issue 1-1-15 LP-WUR operation with RedCap**

* Proposals
  + P1: Specify LP-WUR related idle/inactive requirements including requirement on serving cell offloading, RRM relaxation and higher priority frequency layer search for Redcap UE. (Xiaomi vivo Huawei ZTE Ericsson Nokia)
    - P1-1:Existing agreements for offloading and RRM relaxation will be used for Redcap UE (vivo)
    - P1-2: RedCap UE shall meet LP-WUS related requirement based on UE’s LP-WUS capability (Ericsson)
    - P1-3: Requirements support for RedCap without impact to connected mode requirements, and no FR2 impact, at least for LP-SS. (Nokia)
    - P1-4: The feature for RedCap UE with LP-WUS only applies for R19 UEs not for R17/R18 UEs (ZTE)
    - P1-5: For HD-FDD RedCap UE with LR, the same legacy availability rule shall be reused, then the legacy requirements on maximum interruption in paging reception can be the same.(ZTE)
  + P2: The requirements for normal UE should be completed in high priority in Rel-19. After that, RAN4 can further discuss whether to apply for Redcap UE considering the RRM workload, RAN2 signaling support and UE RF impact (oppo)
  + P3: The agreed requirements for LP-WUS cannot be reused directly for RedCap. Due to the short time RAN4 to deprioritize LP-WUS requirements for RedCap (MTK)
  + P4: For the number of SSB for wake up delay for 1 Rx Redcap, the same number of SSB, i.e., { 3 5 5} SSBs for {10ms, 400ms, 800ms} ramping up time, can be reused initially. (vivo Nokia)

*Recommendations:*

Specify LP-WUR related idle/inactive requirements including requirement on serving cell offloading, RRM relaxation and higher priority frequency layer search for Redcap UE.

* Existing requirements for MR offloading, RRM relaxation and higher priority frequency layer search will be reused for Redcap UE
* FFS on whether define LP-WUR related requirement on FR2 Redcap UE

Discuss on P4

**Issue 1-1-16: LP-WUR operation with EMR**

* Proposals
  + P1: When both Rel-16 EMR and Rel-19 LP-WUR are configured (vivo):
    - when T331 is running, all carriers (carriers configured/not configured for CA/DC idle state measurement) follow legacy measurements;
    - when T331 is not running, all carriers follow RRM requirements defined in Rel-19 LP-WUR, i.e., relaxed with scaling factor 16 when RRM relaxation criteria are satisfied or serving cell offloading when offloading criteria are satisfied;
  + P1-1: For a UE which supports idleInactiveNR-MeasReport-r16 or idleInactiveEUTRA-MeasReport-r16, and serving cell configures carriers for idle mode CA/DC measurement reporting with T331 running, UE shall keep the MR ON for EMR measurement regardless of the MR offloading condition is met or not. (Apple)
  + P1-2: When case 3 (relaxed measurement) criterion is fulfilled, the configured IDLE mode CA/DC measurements can be relaxed only when T331 is not running, when case 1 (serving cell measurement offloading) criterion is fulfilled, UE is expected to perform relaxed high priority layers measurement without NW indication. And when T331 is running, the carriers configured for IDLE mode CA/DC measurements can also be included (oppo)
  + P1-3: UE should meet the existing EMR measurement requirements when in RRM relaxation or offloading mode when TR331 is running. (Huawei)
  + P1-4: If UE fulfils MR RRM relaxation condition and Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, UE shall at least search for carriers configured for EMR (and the serving cell) based on higher priority layer search requirement Thigher\_priority\_search; If UE fulfils MR RRM relaxation condition and Srxlev <= SnonIntraSearchP or Squal <= SnonIntraSearchQ, the RRM measurement relaxation is NOT applied to the carriers configured for EMR measurement; If UE fulfils MR RRM offloading condition(UE also fulfils Rel-15 neighour cell measurement stopping criteira), UE shall at least search for carriers configured for EMR (and the serving cell) based on higher priority layer search requirement Thigher\_priority\_search. (Ericsson)
  + P1-5: option 1, When T331 running UE shall keep the MR ON for EMR measurement regardless of the MR offloading condition is met or not. Option 2, UE shall not enter relaxation / offloading if configured simultaneously with EMR. (Nokia)
  + P1-6: (MTK)
  + On EMR for LPWUS and when T331 is running, MR is expected to perform measurements on NR inter-frequency carriers configured for idle mode CA/DC measurements without relaxation for both Case#1 (RRM offloading) and Case#3 (RRM relaxation).
  + On EMR for LPWUS and when T331 is not running in Case#1 (RRM offloading):
    - The UE shall search for inter-frequency layers configured for idle mode CA/DC measurements by following the relaxed higher priority frequency measurement requirements for Case#1 (i.e., every 1 hr).
  + On EMR for LPWUS and when T331 is not running in Case#3 (RRM relaxation):
    - If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ
      * the UE shall search for inter-frequency layers configured for idle mode CA/DC measurements by following the relaxed higher priority frequency measurement requirements for Case#3 (i.e., every 1 hr)
    - if Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ
      * the UE shall search for inter-frequency layers configured for idle mode CA/DC measurements by following the relaxed higher priority frequency measurement requirements for Case#3 (i.e., 16 times)
* For Rel-18 EMR:
  + P1: When both Rel-18 EMR and Rel-19 LP-WUR are configured: (vivo)
    - Option 1: When Rel-18 EMR is configured, all carriers follow legacy measurement requirement.
    - Option 2: Rel-18 EMR and Rel-19 LP-WUR cannot be configured at the same time (need send LS to RAN2)
  + P2: For a UE which supports Rel-18 EMR, FFS UE’s measurement behaviour for the carriers configured for EMR when UE filfils RRM relaxation/offloading thresholds. (Ericsson)

*Recommendations:*

When both Rel-16 EMR and Rel-19 LP-WUR are configured:

When T331 is running

* + all NR inter-frequency carriers (including NR inter-frequency carriers configure and not configured for idle mode CA/DC measurements) follow legacy measurements, regardless the offloading and RRM relaxation condition are met or not;
  + serving cell and intra-frequency measurement follow legacy measurement, regardless the offloading and RRM relaxation condition are met or not;

when T331 is not running,

* + When Case#1 (RRM offloading) conditions are met:
    - The UE shall search for NR inter-frequency layers configured for idle mode CA/DC measurements by following the relaxed higher priority frequency measurement requirements for Case#1 (i.e., every 1 hr).
    - Note: serving cell, intra-frequency and NR inter-frequency layers not configured for idle mode CA/DC measurements follow corresponding agreed requirements defined in case 1.
  + When Case#3 (RRM relaxation) conditions are met:
    - If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ
      * the UE shall search for NR inter-frequency layers configured for idle mode CA/DC measurements by following the relaxed higher priority frequency layer measurement requirements (i.e., every 1 hr)
    - if Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ
      * the UE shall search for NR inter-frequency layers configured for idle mode CA/DC measurements by following the relaxed measurement requirements for Case#3 (i.e., with relaxation factor 16)
    - Note: serving cell, intra-frequency and NR inter-frequency layers not configured for idle mode CA/DC measurements follow corresponding agreed requirement defined in case 3.

When both Rel-18 EMR and Rel-19 LP-WUR are configured:

* all NR inter-frequency carriers (including NR inter-frequency carriers configure and not configured for idle mode CA/DC measurements) follow legacy measurements, regardless the offloading and RRM relaxation condition are met or not;
* serving cell and intra-frequency measurement follow legacy measurement regardless the offloading and RRM relaxation condition are met or not;

**Issue 1-1-17: LP-WUR operation with SDT**

* Proposals
  + P1: SDT requirements apply also for UE supporting LP-WUS.
  + P1-1: The UE supporting LP-WUS uses LR-RSRP measurements for condition evaluation when the evaluation is started while the UE is in MR offloading. (Nokia)

*Recommendations:*

*Discuss the proposal P1-1*

**Issue 1-1-18 UE capability**

* Proposals
  + P1: For UE with LP-WUS, RAN4 shall wait for RAN1’s discussion on UE capability. The new UE capability shall not be introduced. (ZTE)

*Recommendations:*

*No more discussion is needed*

### Sub-topic 1-2 Detail LP-WUR requirements at RRC\_IDLE/INACTIVE state

**Issue 1-2-1-1: Detail on LR accuracy and side conditions requirements**

* Proposals
  + P1: Use 2.5 dB as the RF impairment margin for LP-RSRP accuracy requirements. (Apple oppo CMCC vivo Huawei Ericsson ZTE)
  + P2: Consider 3.5 dB RF impairment margin for LR (xiaomi MTK)
  + P3: Use 2 dB as the RF impairment margin for LP-RSRP accuracy requirements (Nokia)

*Background:*

**Agreements in** [**R4-2504908**](ftp://10.10.10.10/ftp/tsg_ran/WG4_Radio/TSGR4_114bis/Inbox/R4-2504908.zip)

**Issue 1-2-1-1: Detail on LR accuracy and side conditions requirements**

Agreement:

For FR1:

* + - [±3.5] dB can be used for core requirements for LP-RSRQ accuracy and [±5.5 or ±6] dB can be used for core requirements for LP-RSRP accuracy, under the side conditions Ês/Iot [x, x = -3] dB
    - [±3.5] dB can be used for core requirements of SSB based RSRQ accuracy and [±5.5 or ±6] dB can be used for core requirements for SSB based RSRP accuracy, under the side conditions Ês/Iot [y, y = -3] dB
    - Note: [2 or 2.5] dB RF impairment margin is assumed

**Agreements in R4-2503028**

**Issue 2-1-1: SNR, NF and IM value for FR1 LP-WUR**

**Agreement:**

* For the FR1 requirements targeting at bands <2.5GHz
  + The IM+NF values are
    - Set 1: 18dB
    - Set 2: 13.5dB
* Send an LS to RAN1 with RAN4 decision of two sets of : NF (assume IM is 2.5dB)

*Recommendations:*

*Agree P1 based on majority view.*

*Based on P1 remove [] of the agreements in RAN4 114bis as*

For FR1:

* + - ±3.5 dB is used for core requirements for LP-RSRQ accuracy and ±6 dB is used for core requirements for LP-RSRP accuracy, under the side conditions Ês/Iot -3 dB
    - ±3.5 dB is used for core requirements of SSB based RSRQ accuracy and ±6 dB is used for core requirements for SSB based RSRP accuracy, under the side conditions Ês/Iot -3 dB

**Issue 1-2-2: Periodicity for LP-WUR RRM requirements**

**Issue 1-2-2-2: Upper bound on SSB-based LP-WUR measurement periodicity**

* Proposals
  + P1: No need to define upper bound for SSB-based LP-WUR measurement periodicity. (Apple oppo xiaomi CMCC China Telecom Huawei Nokia MTK)
  + P2: The upper bound is needed on SSB-based LP-WUR measurement periodicity if LP-SS is not configured. (ZTE)

*Recommendations:*

Agree P1

**Issue 1-2-4: On LR measurement/evaluation requirements**

**Issue 1-2-4-0: On LR measurement requirement**

* Proposals
  + P1: Define LR measurement requirement as the minimum duration where one LR measurement shall be executed. (Huawei)

*Background:*

*Recommendations:*

Suggest to agree P1

**Issue 1-2-4-2: On LR requirements for entry/exit threshold evaluation for WUS paging monitoring/Fully Offloading (Case 1)/MR RRM relaxation (Case 3)**

**Issue 1-2-4-2-1: On applicability LR evaluation requirements**

* Proposals
  + P1: RAN4 to confirm LR requirements are applicable when UE is in RRM relaxation mode or RRM offloading mode. (Huawei)

*Background:*

*Recommendations:*

* Confirm P1 or discuss in the CR directly

**Issue 1-2-4-2-3: On how to define LR evaluation requirements**

* Proposals
* P1: Using x1=2\*x and y1=2\*y for the evaluation requirement. (Apple oppo vivo Huawei Ericsson Nokia MTK)
* P2: x = 2 and y = 2 samples (vivo oppo Huawei Ericsson Nokia)
* P3: x = 3 (xiaomi vivo LG MTK)

*Background:*

*RAN4 114 agreement:*

*Define a single LR evaluation requirement for both LR entry and exit threshold evaluation for LP-WUS monitoring, case 1 and case 3, i.e., LR evaluation requirement is not differentiated on entry or exit; or on different cases.*

*Note: RAN2’s discussion on timer will not impact on RAN4’s evaluation requirement.*

*LR evaluation duration is [x1 samples]\*LP-SS (for OOK LR) or [y1 samples] \*LO (for SSB LR), assuming x or y samples are used to satisfy accuracy requirement and x1 > x and y1>y.*

*Number x and y are defined as measurement requirement as [x samples]\*LP-SS (for OOK LR) or [y samples] \*LO (for SSB LR)*

*Recommendations:*

*Agree P1;*

*Agree y = 2;*

*For x, down-select between 2 and 3;*

**Issue 1-2-5: On requirements for MR for entry/exit threshold evaluation for WUS paging monitoring/Fully Offloading (Case 1)/MR RRM relaxation (Case 3)**

**Issue 1-2-5-1: On applicability MR evaluation requirements**

* Proposals
  + P1: RAN4 to confirm MR evaluation requirements are applicable when UE is in RRM relaxation mode or legacy mode (Huawei)

*Background:*

|  |  |  |
| --- | --- | --- |
| **Case** | **Entry conditions** | **Exit conditions** |
| LP-WUS monitoring | MR threshold and optional LR threshold | LR threshold |
| RRM measurement fully offloading (Case 1) | MR threshold and optional LR threshold | LR threshold |
| RRM measurement relaxation (Case 3) | MR threshold and optional LR threshold | MR threshold and optional LR threshold |

*Recommendations:*

*Based on the latest RAN2 agreement, P1 is ok; or discuss directly in the CR*

**Issue 1-2-8-1: Accuracy for normal or relaxed MR serving cell measurement**

* Proposals
  + P1: For normal or relaxed MR serving cell measurement, the legacy accuracy requirements for MR is reused (Huawei)

*Recommendations:*

*Confirm P1 or discuss directly in the CR*

*Close this issue*

**Issue 1-2-8-2: Accuracy for relaxed MR neighbour cell measurement**

* Proposals
  + P1: For relaxed MR neighbour measurement, the legacy accuracy requirements for MR are re-used. (Huawei)

*Recommendations:*

*Confirm P1 or discuss directly in the CR*

*Close this issue*

**Issue 1-2-9: LP-WUR status at legacy case (not at LP-WUS monitoring case/fully offloading(case 1) case/RRM relaxation (case 3) case)**

* Proposals
  + P1: No LR measurement and evaluation requirements apply at the legacy state, i.e., for the following cases: from legacy case to LP-WUR monitoring, from legacy case to RRM measurement fully offloading (case 1), and from legacy case to RRM measurement relaxation (case 3). (Apple oppo xiaomi China Telecom vivo Huawei ZTE MTK)
  + P2: The LR evaluation requirements will be applied when LR is ‘ON’ at legacy state. (CMCC Ericsson)
  + P2-1: At legacy state, when both MR and LR entry thresholds are configured, the UE shall evaluate both MR and LR thresholds at least once before entering relaxation / offloading (Nokia)

*Background:*

* *Summary of entry/exit conditions based on existing RAN2’s agreements*

|  |  |  |
| --- | --- | --- |
| **Case** | **Entry conditions** | **Exit conditions** |
| LP-WUS monitoring | MR threshold and optional LR threshold | LR threshold |
| RRM measurement fully offloading (Case 1) | MR threshold and optional LR threshold | LR threshold |
| RRM measurement relaxation (Case 3) | MR threshold and optional LR threshold | MR threshold and optional LR threshold |

Agreement at RAN4 114bis:

* At legacy state, when and how to turn on LR for serving cell measurement is up to UE implementation.

*Recommendations:*

*Agree P1 based on majority view.*

**Issue 1-2-10: Higher priority frequency layer measurement requirements**

* Proposals

P1: RAN4 to confirm that, for case 1, MR is expected to perform relaxed higher priority frequency layer measurement with K2\*Thigher\_priority\_search and K2 = 60. (xiaomi)

For case 3:

When Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ,

* MR is expected to perform relaxed higher priority frequency layer measurement with K2\*Thigher\_priority\_search and K2 = 60, if configured;
* MR is expected to perform relaxed serving cell measurement with scaling factor 16.

when the condition of Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ is NOT met:

* The same relaxed requirements for higher priority, equal priority and lower priority carriers are applied, i.e. 16 times of Tdetect,NR\_Inter, Tmeasure,NR\_Inter and Tevaluate,NR\_Inter;
* The relaxed requirement for serving cell is applied, i.e. 16 times of Nserv.

P2: In LP-WUS Case 3, when Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, but Srxlev < SIntraSearchP or Squal < SIntraSearchQ, UE follows RRM relaxation measurement requirement for intra-frequency with scaling factor 16. (Ericsson)

*Background:*

|  |
| --- |
| Agreement at RAN4 115:  For case 1:   * + MR is expected to perform relaxed higher priority frequency layer measurement with K2\*Thigher\_priority\_search and K2 = 60     - Note: RAN4 assumes Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ is always met for case 1.   For case 3:   * + When Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, MR is expected to perform relaxed higher priority frequency layer measurement with K2\*Thigher\_priority\_search and K2 = 60   + When the condition of Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ is NOT met, the same requirement for higher priority, equal priority and lower priority carriers:     - 16 times of Tdetect,NR\_Inter, Tmeasure,NR\_Inter and Tevaluate,NR\_Inter are applied |

*Recommendations:*

*To moderator’s understanding, for P1, agreements for higher priority frequency layer search have bene achieved at RAN4 115 and no further confirmation is needed. For P2, it is right however it is not related to higher priority frequency layer measurement or not.*

**Issue 1-2-11: RRM requirements for FR2**

* Proposals
  + P1-1: Prioritize defining RRM requirements for FR1 in this WI; FR2 LP-WUR based RRM requirement can be deprioritized in R19 (Apple oppo China Telecom Ericsson Nokia MTK)
  + P1-2: Don’t introduce FR2 RRM requirements for LP-WUS WI (CMCC)
  + P1-3: Suggest to consider to drop FR2 RRM requirement in Rel-19 if there is no consensus or still no concrete technical proposals for FR2 RRM requirements in RAN4 116 meeting. (vivo)
  + P2: Specify LP-WUR measurement and evaluation requirements in FR2 by scaling the FR1 requirements using beam sweeping factor N1. (QC)
    - For SSB-based measurements, assume N1 is equal to the number of Rx beams used by the MR
    - For OOK-based measurements, assume N1 = 8.
  + P3: The target measurement accuracy requirements for FR2 is 1.5 dB worse than FR1, to account for the additional RF inaccuracy. For MR-based relaxed serving and neighbor cell measurements in FR2, reuse the measurement relaxation factor of 16 as agreed for FR1 (QC)

*Recommendations:*

*Discuss the issue*

**Issue 1-2-12: UE behaviro when both Rel-16 relaxation and Rel-19 LP-WUR offloading/relaxation are safisfied; or when when both Rel-17 relaxation for Redcap and Rel-19 LP-WUR offloading/relaxation are satisfied**

* Proposals
  + P1: UE is allowed to follow the most relaxation requirements. (vivo)
  + P2: RAN4 to discuss the UE behaviour when UE detects to meet Rel-16 low mobility criteria and Rel-19 RRM relaxation criteria.(Ericsson)

*Recommendations:*

*Discuss UE behaviour when meeting Rel-16 low mobility criteria.*

**Issue 1-2-13: Transition period**

* Proposals
  + *P1: RAN4 to discuss transition requirement among normal measurement (Rel-15, Rel-16 measurement) and Rel-19 MR RRM measurement relaxation, offloading. (Ericsson)*

*Recommendations:*

*Discuss P1.*

*.*

**Issue 1-2-14: Others**

* Proposals
  + P1: T in serving cell requirement : RAN4 to discuss whether to update the time for cell selection initiation for LP-WUS UE. (oppo)
  + P2: The maximum interruption in paging reception requirements shall be reused in LP-WUS. (ZTE)
  + P3: Capture in the specification that the UE shall filter the LP-RSRP and LP-RSRQ measurements of the serving cell using at least 2 measurement samples (Nokia)
  + P4: RAN4 requirements on LP-WUR are applicable only when LP-WUS/LP-SS is transmitted within the initial DL BWP of the UE.(QC)

*Recommendations:*

*For P1, discuss in the CR; for P2, the section 4.2.2.6 can be referred; for P3, it can be captured in CR.*

### Sub-topic 1-3 MR RRM relaxation

### Sub-topic 1-4 LP-WUR CONNECTED mode

**Issue 1-4-1: LP-WUR at CONNECTED mode**

* Proposals
  + P1: No RRM impact for connected mode in this WI. (oppo ZTE Ericsson)
  + P2: MR and LR operate at different time, there is no need define interruption requirements on WUS monitoring by LR at connected state (vivo)
  + P3: RAN4 to wait for RAN1 further agreements to discuss possible RRM impacts of LP-WUS monitoring in CONNECTED mode if RAN1 agrees LP-WUS monitoring is prioritized over those MR measurements. (Huawei)

*Recommendations:*

Use “no RRM impact for connected mode in LP-WUS WI” as working assumption.

### Sub-topic 1-5 Others

**Issue 1-5-1: LR based RRM with EMR in IDLE/inactive mode**

Move to issue 1-1-16

**Issue 1-5-2: eDRX related**

Move to issue 1-1-14

**Issue 1-5-3: MR wake up delay after exiting case 1 due to offloading conditions cannot be met**

* Proposals:
  + P1: When UE exits the serving cell offloading case, the following approaches can be considered for UE behavior: (oppo)
    - Option 1: UE follow relaxed measurement and meet the corresponding requirements.
    - Option 2: UE follow legacy measurement and meet the corresponding requirements.
    - Option 3: Up to UE implementation and no requirements apply.
  + P2-1: When a UE leaves fully offloading state due to serving cell quality, the MR will consecutive measure a few (5) SSBs or consecutively measures SSBs within a transition period (100ms), then the MR will follow either relaxed measurement requirement or legacy measurement requirement (vivo)
  + P2-2: RAN4 to define requirements on MR wake-up delay for cases where UE determines LR exit condition is met. The wake-up delay for cases where UE detects LP-WUS is re-used (Huawei)
  + P2-3: After MR wake up, MR follows SSB periodicity for serving and neighbouring cell evaluation.(Nokia)

*Recommendations:*

Suggest: Within the wake up delay after exiting case 1 due to offloading conditions cannot be met, MR follows SSB periodicity for serving cell measurement, the wake-up delay and corresponding number of SSBs can reuse the wake up delay for the case when UE detects LP-WUS.

**Issue 1-5-4: LR based RRM when stationary or low-mobility criteria is configured for power saving feature**

* Proposals
  + P1: In core maintenance phase, RAN4 to discuss the case when low mobility criteria is configured for UE power saving but not met in the LP-WUR based RRM case#1 and case#3. (Apple)
  + P2: RAN4 to discuss the UE behaviour when UE detects to meet Rel-16 low mobility criteria and Rel-19 RRM relaxation criteria.(Ericsson)

*Recommendations:*

*As suggested, discuss this issue at maintenance phase.*

# Topic #2: Simulation assumptions and results

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| T-doc number | Company | Proposals / Observations |
| [**R4-2509574**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509574.zip) | Apple | Observation 1: LP-SS candidate binary sequences are down-selected to 1) M=1, L= {6, 8}, 2) M=2, L= {12, 16}, and 3) M=4, L= {16, 32}. The number of occupied OFDM symbols by LP-SS has been narrowed down to 6 symbols and 8 symbols.  Observation 2: For each value of M in existing LP-SS candidate sequences UE supports both L values and no UE capability. There is no consensus in RAN1 that an SNR of -3dB can be fulfilled with the smaller value of L for each M. RAN1 states that definition of the proper requirements for different values of L is up to RAN4.  Proposal 1: RAN4 to continue simulation results campaign and alignment until at least RAN4#116bis. Companies to report all 5th, 50th and 95th percentiles of RSRP/RSRQ distributions, and discuss over RAN1 coverage concerns.  Proposal 2: Determine accuracy and delay requirements no earlier than RAN4#116bis to allow simulation results to converge and being fully understood.  Observation 3: Companies have raised concerns about the deployment scenario where LP-SS signals are scheduled on the same frequency resources across co-channel cells, suggesting precluding such operation as a way forward.  Observation 4: RSRP/RSRQ accuracy results might be dependent on the binary patterns of desired LP-SS vs the binary patterns of the interfering LP-SS, i.e. the “opposite sequence” problem.  Proposal 3: RAN4 to discuss if RSRP/RSRQ accuracy requirements should be based on the worst case scenario of colliding LP-SS binary patterns between serving cell and interfering cell.  Observation 5: Current Es/Iot > -6dB condition seems to be reused from legacy NR intra-frequency measurements conditions seems overly pessimistic since LP-SS operation is not expected to occur at legacy NR cell edge.  Proposal 4: As an alternative to mandate LP-SS across cells to operate in different time/frequency resources, RAN4 to discuss if the condition of interfering cell vs serving cell power is -6dB is overly pessimistic and whether to relax it to 1) a lower value (<-6dB), or 2) simply remove the interfering cell from the test setup.  Observation 6: Some companies have observed a bias in the RSRP estimation for the case when LP-SS is interfered by another LP-SS. This bias is not present when the interfering signals is OFDM.  Observation 7: RSRP estimation bias might be explained by the almost perfect correlation between the on-durations of the colliding LP-SS signals, at least in AWGN channel. The bias might be almost perfectly cancelled if serving cell and interfering cell are configured with orthogonal OFDM overlaid sequences, which is what should be deployed in practice.  Observation 8: Network could statically assign a single root index *q* across cells and use *j=1..4* different cyclic shifts associated with root index *q* for each cell. Alternatively, could assign multiple root indexes *q\_i* across cells with I*=1..#Cell* where *#Cell* is determined bit specification or by static variable, in order to reduce the bias observed.  Proposal 5: RAN4 to take a closer look at the decision that same requirement shall be applied for OOK-based LP-WUR serving cell measurement based on LP-SS regardless of whether overlaid OFDM sequence is configured or not, or alternatively, propose a way to deal with the observed estimation bias.  Observation 9: There is an obvious tradeoff between RSRP/RSRQ estimation accuracy and the number of samples considered for L1 filtering, but beyond 3 samples we observe diminishing returns.  Observation 10: RSRP accuracy is defined as Actual RSRP vs Ideal RSRP, while RSRQ accuracy is defined by Actual RSRQ vs Ideal RSRQ. Ideal RSRQ is defined as Ideal RSRP vs Actual RSSI.  Proposal 6: RAN4 to consider an RF margin of 2.5 dB for both RSRP and RSRQ accuracy requirements.  Proposal 7: RAN4 to consider relaxing the accuracy requirement to 4dB if considering 2 samples for L1 filtering. Alternatively, RAN4 to relax the delay requirement to 3 samples to achieve a 3.5dB accuracy. |
| [**R4-2509575**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509575.zip) | Apple | Simulation results |
| [**R4-2509676**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509676.zip) | OPPO | Simulation results |
| [**R4-2509737**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509737.zip) | LG Electronics Inc. | Simulation results |
| [**R4-2509738**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509738.zip) | LG Electronics Inc. | *Observation 1*: In AWGN channel propagation, 1 sample is enough to meet the accuracy requirements at any scenarios. However in TDL-C channel propagation scenario, it is hard to meet the target accuracy 3.5 dB in 3 samples. If the bias is removed, then can meet the target accuracy 3.5 dB in 3 samples |
| [**R4-2509774**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509774.zip) | Xiaomi | Observation 1: To achieve 3.5 dB absolute baseband accuracy, measurement with 2 LP-SS samples is needed at SNR = -3dB in TDL-C channel.  Observation 2: To achieve 2.5 dB absolute baseband accuracy, measurement with 5 LP-SS samples is needed at SNR = -3dB in TDL-C channel.  Proposal 1: RAN4 to use 3 samples for LR measurement requirements with the target accuracy of ±3.5 dB. |
| [**R4-2510192**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510192.zip) | vivo | Proposal 1: For the case {M, L}={1,6} when fully opposite sequence is used for serving and neighbour cell, no need to have any particular consideration for this case.  Proposal 2: No need to align simulation parameter for the overlaid OFDM sequence for LP-SS since there is no separate simulation for LP-SS overlaid OFDM.  Proposal 3: The number of LP-SS samples for achieving ±3.5 dB accuracy for LP-SS RSRP and LP-SS RSRQ at -3 dB SINR is [2 or 3]; the number of SSBs for achieving ±3.5 dB accuracy for RSRP and RSRQ at -3 dB SINR is 2. |
| [**R4-2510193**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510193.zip) | vivo | 1. For LP-RSRP, under all alternatives and combinations including different LP-SS sequence, different interference power setting, different synchronous conditions and different channel conditions (AWGN or TDL-C):  * The target RSRP measurement accuracy can be achieved by 1 and 2 LP-SS sample at SINR = -3dB based on 320ms periodicity of LP-SS for AWGN and TDL-C channel. * If the adjacent cell LP-SS sequence is opposite, the RSRP measurement accuracy will become worse, but the number of measurement samples will not change.   For LP-RSRQ, under all alternatives and combinations including different LP-SS sequence, different interference power setting, different synchronous conditions and different channel conditions (AWGN or TDL-C):   * The target RSRP measurement accuracy can be achieved by 1 and 3 samples for AWGN and TDL-C channel at SINR = -3dB based on 320ms periodicity of LP-SS. * If the LP-SS sequence of the neighboring cell is opposite, the RSRQ measurement accuracy will become worse, but the number of measurement samples will not change.  1. For SSB based, LR can satisfy RSRP/RSRQ measurement accuracy based on 1 sample at SINR = -3dB under AWGN channel and 1 sample at SINR = -3dB under TDL-C channel. |
| [**R4-2510656**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510656.zip) | Huawei, HiSilicon | Proposal 1: For defining ideal RSRQ, the ideal RSSI is the actual total received power at the specific time/frequency resources with channel fading.  Proposal 2: LP-SS measurement requirements are not applicable to cases where serving cell and neighbour cell are using opposite binary sequences.  Proposal 3: RAN4 to confirm to define same requirement for OOK based LR with and without overlaid sequence configured.  Proposal 4: RAN4 to take samples for LP-SS measurement X as [2].  Proposal 5: RAN4 to take samples for LP-SS measurement Y as [2]. |
| [**R4-2510910**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510910.zip) | Ericsson | Observation 1: Based on our simulation, 2 samples are enough to achieve the LP-SS RSRP accuracy ±3.5dB.  Observation 2: Based on our simulation, 2 samples are enough to achieve the LP-SS RSRQ accuracy ±3.5dB. |
| [**R4-2511240**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511240.zip) | Nokia | [Observation 1: Number of samples does not significantly impact the accuracy of the LP-SS measurements across different scenarios](#_Toc206165931)  [Proposal 1: The number of LP-SS samples for achieving ±3.5 dB accuracy for LP-SS RSRQ for AWGN and TDL-C channel at -3 dB SINR is 2](#_Toc206165932)  [Proposal 2: For the case when fully opposite sequence is used for serving and neighbour cell, no need to have any particular consideration for this case. If consideration is needed, RAN4 can have a time-offset for the interfering signal.](#_Toc206165933) |
| [**R4-2511241**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511241.zip) | Nokia | Simulation results |
| |  |  | | --- | --- | | [**R4-2511606**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511606.zip) | Simulation assumptions for R19 LP-WUS | | MediaTek inc. | Proposal 3: For OOK-based LP-WUR, use 3 samples for RSRP measurements. |
|  |  |  |
|  |  |  |

## Open issues summary

### Sub-topic 2-1 On simulation assumptions and parameters

**Issue 2-1-1: SINR setting**

**Issue 2-1-2: Measurement metrics**

**Issue 2-1-3: Time/frequency error**

**Issue 2-1-4: On LP-SS sequence for simulation purpose**

**Issue 2-1-5: On ideal RSRP/RSRQ in simulation**

* Proposals
  + P1: Proposal 1: For defining ideal RSRQ, the ideal RSSI is the actual total received power at the specific time/frequency resources with channel fading. (Huawei)

*Recommendations:*

**Issue 2-1-6: On SCS in simulation**

**Issue 2-1-7: On interference in simulation**

* Proposals
  + P1: RAN4 to discuss if RSRP/RSRQ accuracy requirements should be based on the worst case scenario of colliding LP-SS binary patterns between serving cell and interfering cell (Apple)
  + P2: As an alternative to mandate LP-SS across cells to operate in different time/frequency resources, RAN4 to discuss if the condition of interfering cell vs serving cell power is -6dB is overly pessimistic and whether to relax it to 1) a lower value (<-6dB), or 2) simply remove the interfering cell from the simulation setup. (Apple)
  + P3: For the case {M, L}={1,6} when fully opposite sequence is used for serving and neighbour cell, no need to have any particular consideration for this case (vivo Nokia)
  + P4: LP-SS measurement requirements are not applicable to cases where serving cell and neighbour cell are using opposite binary sequences. (Huawei)

*Background:*

* Set of binary sequences for LP-SS:
* For M=1, L=6, the set of LP-SS sequence is:

[1 0 1 0 1 0]

[0 1 0 1 0 1]

[1 0 0 1 0 1]

[1 0 1 0 0 1]

* For M=1, L=8, the set of LP-SS sequence is:

[1 0 1 0 0 1 0 1]

[1 0 1 0 1 0 0 1]

[1 0 0 1 0 1 0 1]

[0 1 0 1 0 1 0 1]

* For M=2, L=12, the set of LP-SS sequence is:

[1 0 0 1 1 0 0 1 1 0 0 1]

[0 1 1 0 1 0 0 1 1 0 0 1]

[0 1 1 0 0 1 1 0 1 0 0 1]

[0 1 1 0 0 1 0 1 1 0 0 1]

* For M=2, L=16, the set of LP-SS sequence is:

[1 0 0 1 0 1 0 1 1 0 0 1 1 0 0 1]

[1 0 0 1 1 0 0 1 0 1 1 0 0 1 0 1]

[1 0 0 1 1 0 1 0 0 1 0 1 1 0 0 1]

[1 0 1 0 0 1 1 0 0 1 1 0 0 1 0 1]

* For M=4, L=16, the set of LP-SS sequence is:

[0 1 1 0 1 0 0 1 1 0 1 0 1 0 1 0]

[0 1 1 0 1 0 1 0 1 0 0 1 1 0 1 0]

[1 0 1 0 0 1 1 0 1 0 1 0 1 0 0 1]

[1 0 1 0 1 0 0 1 1 0 1 0 0 1 1 0]

* For M=4, L=32, the set of LP-SS sequence is:

[0 1 0 1 1 0 1 0 1 0 1 0 1 0 0 1 1 0 1 0 0 1 1 0 0 1 1 0 0 1 0 1]

[0 1 1 0 0 1 0 1 0 1 1 0 0 1 0 1 1 0 0 1 1 0 1 0 1 0 1 0 0 1 0 1]

[0 1 0 1 0 1 0 1 1 0 1 0 1 0 0 1 1 0 1 0 1 0 0 1 1 0 1 0 0 1 1 0]

[0 1 0 1 0 1 1 0 0 1 0 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 0 0 1 0 1]

For M=1, L=6, the following set is the only case with fully opposite sequence:

[1 0 1 0 1 0]

[0 1 0 1 0 1]

*Recommendations:*

*Discuss the issue*

**Issue 2-1-8: On LP-SS with overlaid OFDM sequences**

* Proposals
  + P1: No need to align simulation parameter for the overlaid OFDM sequence for LP-SS since there is no separate simulation for LP-SS overlaid OFDM (vivo)
  + P2: RAN4 to take a closer look at the decision that same requirement shall be applied for OOK-based LP-WUR serving cell measurement based on LP-SS regardless of whether overlaid OFDM sequence is configured or not, or alternatively, propose a way to deal with the observed estimation bias. (Apple)
  + P3: RAN4 to confirm to define same requirement for OOK based LR with and without overlaid sequence configured.(Huawei)

*Background:*

*To moderator’s understanding based on the following agreements, no extra simulation is needed for the case when OFDM based LR detects LP-SS.*

RAN4 114 Agreement:

* Define the requirements for OFDM-based LP-WUR serving cell measurement based only on LP-SS
  + Reuse the same requirement for LP-SS OOK based

RAN1 118bis meeting agreement:

Support overlaid OFDM sequence(s) for LP-SS:

* From RAN1 perspective, it is not intended to introduce new RAN4 requirements specific to overlaid sequences

*Recommendations:*

RAN4 114 agreement is not changed

**Issue 2-1-9: On LP-SS preamble and LP-SS periodicity**

**Issue 2-1-10: General aspects on simulation procedure**

* Proposals
  + P1: (Apple)
    - RAN4 to continue simulation results campaign and alignment until at least RAN4#116bis. Companies to report all 5th, 50th and 95th percentiles of RSRP/RSRQ distributions, and discuss over RAN1 coverage concerns. Determine accuracy and delay requirements no earlier than RAN4#116bis to allow simulation results to converge and being fully understood.

*Recommendations:*

*Suggest to finish the simulation campaign in RAN4 116 meeting.*

**Issue 2-1-11: On I and Q branches in simulation**

**Issue 2-1-12: Others on simulation assumptions and campaign**

* Proposals
  + P1: RAN4 to consider an RF margin of 2.5 dB for both RSRP and RSRQ accuracy requirements. RAN4 to consider relaxing the accuracy requirement to 4dB if considering 2 samples for L1 filtering. Alternatively, RAN4 to relax the delay requirement to 3 samples to achieve a 3.5dB accuracy. (Apple)

### Sub-topic 2-2 Simulation results alignment and summary

**Issue 2-2-1: Summary on number of samples for OOK based LR and OFDB based LR based on simulation results**

*OOK based LR-RSRP and LR-RSRQ*

|  |  |
| --- | --- |
| *Results on* ***maximum*** *number of LP-SS samples for achieving* ±*3.5 dB accuracy for LR-SS RSRP and LR-RSRQ for AWGN and TDL-C channel at -3 dB SINR, for information purpose* | |
| *CMCC* |  |
| *oppo* | *3* |
| *ZTE* |  |
| *LG* | *3* |
| *vivo* | *3* |
| *xiaomi* | *2* |
| *Apple* | *3* |
| *Ericsson* | *2* |
| *Huawei* | *2* |
| *Nokia* | *2* |
| *MTK* | *3* |

*Recommendations:*

*Discuss the final value in topic 1*

*OFDM based LR*

|  |  |
| --- | --- |
| *Initial results on* ***maximum*** *number samples for achieving* ±*3.5 dB accuracy for SSB based RSRP and RSRQ for AWGN and TDL-C channel at -3 dB SINR, for information purpose* | |
| *CMCC* |  |
| *oppo* | *2* |
| *ZTE* |  |
| *LG* |  |
| *vivo* | *1* |
| *Ericsson* |  |
| *Huawei* | *2* |
| *Nokia* |  |
| *MTK* |  |

*Recommendations:*

*Discuss the final value in topic 1*

# Topic #3: LR-WUR performance

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| T-doc number | Company | Proposals / Observations |
| [**R4-2509287**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509287.zip) | CATT | **Proposal 1: For the frenquency range, at least FR1 based LP-WUS test cases will be introduced, which depends on the consensus in core part.**  **Proposal 2: For the test categories, the following three aspects need to be tested:**   * **Test cases for LP-WUS monitoring** * **Test cases for RRM offloading** * **Test cases for RRM relaxation**   **Proposal 3: For LP-WUS monitoring, RAN4 to define one test case to verify the MR wake up delay when UE receives LP-WUS.**  **Proposal 4: For RRM offloading, RAN4 to discuss whether to introduce a new test methodology to verify MR RRM offloading scenario.**  **Proposal 5: For RRM relaxation, the test cases defined in Rel-16 UE power saving WI can be as a baseline to verify the cell reselection when a UE meets the relaxed measurement criterion.**  **Proposal 6: For RRM relaxation, the following tests can be considered for Case 3:**   * **Measurements of intra-frequency NR cells for UE fulfilling relaxed measurement criterion** * **Measurements of inter-frequency NR cells for UE fulfilling relaxed measurement criterion** * **Measurements of inter-RAT E-UTRAN cells UE fulfilling relaxed measurement criterion** |
| [**R4-2509576**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509576.zip) | Apple | **Observation 1: Testing should verify timing and delay performance of the UE while operating in LP-WUR related modes. It is to be discussed the verification coverage in terms of which exit and entry conditions to test.**  **Observation 2: Verifying LP-WUR behavior is not unreliable or impractical without a test mode.**  **Observation 3: On the other hand, a test mode is quite invasive in terms of UE hardware/firmware implementation**  **Observation 4: Test cases need to be separated based on whether the UE supports PSS/SSS- or LP-SS-based LP-WUR due to differing measurement mechanisms.**  **Observation 5: RAN4 should discuss the test coverage and if and how to include various cell reselection scenarios across intra-frequency, inter-frequency, and inter-RAT cases.**  **Proposal 1: RAN4 to focus on time and delay behavior of RRM offloading, RRM relaxation and LP-WUR monitoring modes.**  **Proposal 2: Do not define a test mode for LP-WUS/WUR performance part.**  **Proposal 3: RAN4 to consider only define test cases for exit conditions.**  **Proposal 4: RAN4 to consider defining separate test cases based on PSS/SSS vs LP-SS.**  **Proposal 5: RAN4 to define a test case for higher priority cell reselection in Case 1.**  **Proposal 6: RAN4 to only introduce RRM performance requirements for FR1.** |
| [**R4-2509679**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2509679.zip) | OPPO | **Proposal 1: Define the following test cases for UE with LP-WUR in IDLE mode:**   * **Test case for the evaluation requirements of entry/exit conditions for:**    + **Scenario 1: UE enter Case 1 from legacy and exit to legacy**   + **Scenario 2: UE enter Case 3 from legacy and exit to legacy**   + **Scenario 3: UE enter Case 1 from Case 3** * **Test case for cell reselection when UE in case 3 for:**    + **Intra-frequency NR cells**   + **Inter-frequency NR cells**   + **Inter-RAT E-UTRAN cells** * **Test case for cell reselection when UE in case 1 and high priority layers are configured** * **Test case for OOK based LP-WUR serving cell measurement based on LP-SS** * **Test case for OFDM based LP-WUR serving cell measurement based on PSS/SSS**   **Proposal 2: For cell reselection related test cases, the legacy test configurations can be used as baseline.**  **Proposal 3: Define test mode for LP-WUR serving cell measurement tests.** |
| [**R4-2510032**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510032.zip) | CMCC | ***Proposal 1: No test for entry criteria evaluation of both MR and LR.***  ***Proposal 2: Define following tests for exit criteria evaluation:***   * ***LR exit criteria evaluation test when exit from LP-WUS monitoring*** * ***LR exit criteria evaluation test when exit from Case 1*** * ***FFS exit criteria evaluation test when exit from Case 3, wait the RAN2’s conclusion of exit condition***   ***Proposal 3: Introduce separate testing for OOK-based LR and OFDM based LR. Use LP-SS as the measurement reference signal for OOK-based LR testing, use SSB as the measurement reference signal for OFDM-based LR testing.***  ***Proposal 4: For RRM measurement offloading, not to introduce test case for higher priority carrier frequency measurement.***  ***Proposal 5: For RRM measurement relaxation, at least introduce following tests to guarantee the test coverage***   * ***intra-frequency cell re-selection*** * ***inter-frequency cell re-selection including lower and equal priority re-selection and higher priority re-selection*** * ***inter-RAT cell re-selection***   ***Proposal 6: With the sprite of ensuring test coverage with minimize test effort, we propose the test list as following***  ***1. Cell reselection to FR1 intra-frequency NR case for OOK/OFDM-based LR capable UE***   * ***LR exit criteria evaluation test when exit from Case 1 is embedded*** * ***LR exit criteria evaluation test when exit from Case 3 is embedded*** * ***MR wake up delay requirement is embedded*** * ***MR RRM relaxation measurement requirement is embedded***   ***2. Cell reselection to FR1 inter-frequency NR case for OOK/OFDM-based LR capable UE fulfilling [case3/relaxed MR measurement] criterion***   * ***Including lower and equal priority re-selection and higher priority re-selection***   ***3. Cell reselection to FR1 lower priority E-UTRAN cell for OOK/OFDM-based LR capable UE fulfilling [case3/relaxed MR measurement] criterion***  ***4. LP-WUS monitoring exit for LR capable UE***   * ***LR exit criteria evaluation test when exit from LP-WUS monitoring is embedded*** * ***MR wake up delay requirement is embedded***   ***Proposal 7: For the test of Cell reselection to FR1 intra-frequency NR case for OOK/OFDM-based LR capable UE, cell 1 and cell 2 shall be configured. Set 3 Time durations, including:***   * ***T1 (UE camp on Cell1, stay in Case#1):*** * ***T2 (UE transit from Case#1 to Case#3, cell re-selection to Cell 2):*** * ***T3 (UE transit from Case#3 to legacy Case, cell re-selection to Cell 1):***   ***Proposal 8: For the test of Cell re-selection to FR1 inter-frequency NR case for OOK/OFDM-based LR capable UE fulfilling [case3/relaxed MR measurement] criterion, refer to the legacy cell re-selection to FR1 inter-frequency NR case testing defined in A.6.1.1.2, with the update of:***   * ***serving cell quality to guarantee UE stay in Case#3*** * ***time duration T1 &T3 and the test requirement according to relaxed cell detection and higher priority layer searching requirement.***   ***Proposal 9: For theDuring T1, The LP-WUS entry condition is me. During T2, the LP-WUS exit condition is met, network send paging to UE. UE shall starts to send preambles on the PRACH within the duration LR exit criteria evaluation delay + PO delay + PRACH resource delay.***  ***Proposal 10: Due to the large scaling factor for MR relaxation requirement, DRX 320ms or 640ms shall be configured as test setup to minimize the testing time effort.*** |
| [**R4-2510094**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510094.zip) | China Telecom | **Proposal 1: It’s proposed to design test cases for LP-WUR monitoring, RRM offloading and RRM relaxation.**  **Proposal 2: Introduce separate sets of test cases for UE supporting PSS/SSS based LP-WUR and UE supporting LP-SS based LP-WUR.**  **Proposal 3: It’s proposed to design test cases in FR1.** |
| [**R4-2510195**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510195.zip) | vivo | Proposal 1: Define test cases for offloading and RRM relaxation, for offloading and RRM relaxation, only the exit from one state to another state needs be verified. And at the beginning of a test case, the UE will already in the offloading or RRM relaxation or LP-WUR monitoring mode  Proposal 2: Whether and how to verify MR wake up need further study, except for it, no need for test cases for LP-WUR monitoring like miss detection/false alarm.  Proposal 3: Define separate test cases for LP-SS based LR and SSB based LR. In the test case for LP-SS based LR, only LP-SS will be sent and the SSB will not be sent.  Proposal 4: Suggest to introduce the following test cases for RRM relaxation:   * + intra-frequency cell re-selection (for LP-SS based LR and/or SSB based LR)   + inter-frequency cell re-selection for lower and equal priority re-selection (for LP-SS based LR and/or SSB based LR)   + inter-RAT cell re-selection (for LP-SS based LR and/or SSB based LR)   Proposal 5: whether to introduce all the former 3 test cases for each LR type, i.e., the LP-SS based LR or the SSB based LR, could be further discussed.  Proposal 6: A joint procedures can be considered to verify the exit from offloading to legacy state. For example, a cell reselection procedure can be triggered immediately or after some time after the UE exit from the offloading state.  Proposal 7: Suggest do not define test case for higher priority frequency layer cell reselection. |
| [**R4-2510659**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510659.zip) | Huawei, HiSilicon | Proposal 1: Do not define dedicated test cases for evaluation of entry conditions.  Proposal 2: Define test cases for evaluation of exit conditions for the following cases.   * Case 1: UE exist Case 1 to legacy * Case 2: UE exist Case 3 to legacy   Proposal 3: Separate test cases for evaluation of exit conditions into LP-SS based and SSB based.  Proposal 4: Define one test case to verify the MR wake up delay when UE receives LP-WUS.  Proposal 5: Define 3 test cases for intra-frequency, inter-frequency and inter-RAT cell reselection when UE is in Case 3. Define 1 test case for higher priority cell reselection in Case 1. |
| [**R4-2510912**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2510912.zip) | Ericsson | *Proposal 1: RAN4 to define the test cases to verify both MR RRM relaxation and MR RRM offloading scenarios.*  *Proposal 2: RAN4 to introduce the RRM relaxation test cases similar as Rel-16 cell reselection.*  *Proposal 3: RAN4 to discuss the test methodology about how to verify MR RRM offloading scenario, such as whether to introduce a new test mode.*  *Proposal 4: RAN4 to introduce a single test for both LP-SS and SSB based LP-WUR UE.*  *Proposal 5: RAN4 to discuss whether to introduce an applicability to the LP-WUR UE which supports both LP-SS and SSB.*  *Proposal 6: RAN4 to only introduce FR1 based LP-WUS test case.*  *Proposal 7: RAN4 to introduce new LP-SS configuration for LP-WUS test case.* |
| [**R4-2511027**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511027.zip) | ZTECorporation,Sanechips |  |
| [**R4-2511244**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511244.zip) | Nokia | [**Observation 1:** LR entry measurements are untestable without verifying that UE has entered LP-WUS mode (monitoring, relaxation / offloading)](#_Toc206166361)  [Proposal 2: Use test mode / procedure for LR entry measurements](#_Toc206166362)  [Proposal 3: Define separate set of test cases for PSS/SSS and LP-SS based reference signals](#_Toc206166363)  [Proposal 4: Discuss how to define a test case / configuration for OFDM capable UE (FG-62-1a) which is only configured with LP-RSRP & LP-RSRQ (no SS-RSRP, SS-RSRQ configuration).](#_Toc206166364)  [Proposal 5: Introduce test case only for LP-WUS monitoring to test the delay between network transmitted LP-WUS to UE responding to paging message. Both, OFDM and OOK based receiver types are tested but UE can select a test case based on which receiver type it supports. LP-WUS monitoring margin can be used to set thresholds.](#_Toc206166365)  [Proposal 6: Introduce reselection test case(s) for PSS/SSS and LP-SS considering intra-frequency, inter-frequency and both, MR relaxation / offloading cases.](#_Toc206166366)  [Proposal 7: Discuss how to initialise the test case such that UE is in MR relaxation / MR offloading before performing cell reselection](#_Toc206166367)  [Proposal 8: Discuss how to select the reselection thresholds in relation to LP-WUS entry / exit thresholds.](#_Toc206166368) |
| [**R4-2511608**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511608.zip) | MediaTek inc. | **Proposal 1: Not to define test cases for the evaluation requirements for Entry/Exit between different cases (Case#1 and Case#3).**  **Proposal 2: RAN4 not to define test cases for RRM measurements requirements in Case#1.**  **Proposal 3: RAN4 to discuss whether Rel-16 test cases for RRM relaxation based on cell reselection can be applied for Case#3.**  **Proposal 4: Defining TCs for LPWUS cannot verify whether UE meet the new RRM relaxation requirements in R19 LPWUS or the legacy requirements without RRM relaxation (in both cases UE will pass the test). The TCs are redundant.** |
| [**R4-2511633**](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_116/Docs/R4-2511633.zip) | Qualcomm Incorporated | **Observation 1: The main thing network cares about for LP-WUR is that the UE shouldn’t miss any paging message.**  **Observation 2: UE may miss paging message either due to LP-WUS missed detections or longer MR wake-up delay.**  **Observation 3: There are no RRM test-cases defined for PEI, which the LP-WUS is designed to replace.**  **Observation 4: The missed-detection performance of LP-WUS is being discussed in RF/Demod room.**  **Proposal 1: No need to discuss LP-WUS missed detection or false-alarm rate performance for RRM.**  **Proposal 2: Discuss whether to introduce a test-case to verify the MR wake-up delay after receiving the LP-WUS.**  **Observation 5: The evaluations of entry conditions of LP-WUR are not testable because the UE cannot be forced to turn on the WUR at any point of time**  **Proposal 3: Introduce the following test cases where the exit conditions can be tested:**   * **UE meets the cell reselection requirements with initial conditions being WUR operating in the full offloading mode** * **UE meets the cell resection requirements with initial conditions being WUR operating in the relaxed measurement mode.** |
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|  |  |  |

## Open issues summary

### Sub-topic 3-1 General aspects

**Issue 3-1-2 General aspects**

* Proposals
  + P1: RAN4 to focus on time and delay behavior of RRM offloading, RRM relaxation and LP-WUR monitoring modes. (Apple vivo)
  + P2: Do not define a test mode for LP-WUS/WUR performance part. (Apple)
  + P3:Define test mode for LP-WUR serving cell measurement tests (oppo Nokia)
  + P4: Defining TCs for LPWUS cannot verify whether UE meet the new RRM relaxation requirements in R19 LPWUS or the legacy requirements without RRM relaxation (in both cases UE will pass the test). The TCs are redundant. (MTK)

*Recommendations:*

### Sub-topic 3-2 LP-WUR test case design

**Issue 3-2-1: Test case scenarios**

* Proposals
  + P1: Consider test case for the following scenarios: 1: LP-WUR monitoring related test case; 2: RRM offloading related test case; 3: RRM relaxation related test case (CATT China telecom vivo)
  + P2: RAN4 to define the test cases to verify both MR RRM relaxation and MR RRM offloading scenarios.(Ericsson Nokia)

*Recommendations:*

**Issue 3-2-2: Test case for OOK based LR and OFDB based LR**

* Proposals
  + P1: RAN4 to consider defining separate test cases for PSS/SSS based LR and LP-SS based LR. (Apple oppo CMCC China telecom vivo Huawei Nokia)
  + P2: RAN4 to introduce a single test for both LP-SS and SSB based LP-WUR UE (Ericsson)
  + P3: RAN4 to discuss whether to introduce an applicability to the LP-WUR UE which supports both LP-SS and SSB.(Ericsson)
  + P4: Discuss how to define a test case / configuration for OFDM capable UE (FG-62-1a) which is only configured with LP-RSRP & LP-RSRQ (no SS-RSRP, SS-RSRQ configuration). (Nokia)

*Recommendations:*

*Suggest to agree:*

PSS/SSS based LR and LP-SS based LR should be verified separately in some scenarios.

**Issue 3-2-3: Test case design for entry/exit conditions for case 1/case 3**

* Proposals
* Entry/exit condition evaluation verification
  + Option 1: RAN4 to consider only define test cases for exit conditions, do not define dedicated test cases for evaluation of entry conditions (Apple CMCC vivo Huawei QC)
  + Option 2: Define test case for entry scenario (oppo Nokia)
    - Option 2-1 (oppo)
      * Scenario 1: UE enter Case 1 from legacy and exit to legacy
      * Scenario 2: UE enter Case 3 from legacy and exit to legacy
      * Scenario 3: UE enter Case 1 from Case 3
    - Option 2-2: Use test mode / procedure for LR entry measurements (Nokia)
  + Option 3: Not to define test cases for the evaluation requirements for Entry/Exit between different cases (Case#1 and Case#3).(MTK)
* Detail on exit condition evaluation verification:
  + P1: Define following tests for exit criteria evaluation (CMCC)
    - LR exit criteria evaluation test when exit from LP-WUS monitoring
    - LR exit criteria evaluation test when exit from Case 1
    - FFS exit criteria evaluation test when exit from Case 3, wait the RAN2’s conclusion of exit condition
  + P2: Define test cases for evaluation of exit conditions for the following cases. (Huawei)
    - Case 1: UE exist Case 1 to legacy
    - Case 2: UE exist Case 3 to legacy
  + P3: Introduce the following test cases where the exit conditions can be tested (QC)
    - UE meets the cell reselection requirements with initial conditions being WUR operating in the full offloading mode
    - UE meets the cell resection requirements with initial conditions being WUR operating in the relaxed measurement mode.

*Recommendations:*

Suggest to agree the following based on majority view:

only define test cases for exit conditions, do not define dedicated test cases for evaluation of entry conditions

**Issue 3-2-4: Test case design for RRM relaxation**

* Proposals
  + P1: For RRM relaxation, the following tests can be considered: (CATT oppo CMCC vivo Huawei Ericsson)
    - intra-frequency cell re-selection
    - inter-frequency cell re-selection including lower and equal priority re-selection and higher priority re-selection
    - inter-RAT cell re-selection
  + P1-1: whether to introduce all the former 3 test cases for each LR type, i.e., the LP-SS based LR or the SSB based LR, could be further discussed. (vivo)
  + P2: In case 3, the test cases for cell reselection shall be considered and the specific number of test cases could be discussed in this meeting (ZTE)
  + P3: Introduce reselection test case(s) for PSS/SSS and LP-SS considering intra-frequency, inter-frequency and both, MR relaxation / offloading cases.
  + P4: RAN4 to discuss whether Rel-16 test cases for RRM relaxation based on cell reselection can be applied for Case#3. (MTK)

*Recommendations:*

**Issue 3-2-5: Test case design for offloading case**

* Proposals
  + P1: RAN4 to discuss whether to introduce a new test methodology to verify MR RRM offloading scenario. (CATT)
  + P2: A joint procedures can be considered to verify the exit from offloading to legacy state. For example, a cell reselection procedure can be triggered immediately or after some time after the UE exit from the offloading state. (vivo)
  + P3: RAN4 to discuss the test methodology about how to verify MR RRM offloading scenario, such as whether to introduce a new test mode. (Ericsson)
  + P4: RAN4 not to define test cases for RRM measurements requirements in Case#1. (MTK)

*Recommendations:*

**Issue 3-2-6: Test case design for higher priority frequency layer search**

* Proposals
  + Option 1: Introduce test case for high priority frequency search in case 1. (Apple oppo Huawei ZTE)
  + Option 2: ***For RRM measurement offloading, not to introduce test case for higher priority carrier frequency measurement. (CMCC vivo)***

*Recommendations:*

**Issue 3-2-6: Test case design for LP-WUS monitoring**

* Proposals
  + P1: RAN4 to define one test case to verify the MR wake up delay when UE receives LP-WUS (CATT Huawei Nokia)
    - P1-1: Both, OFDM and OOK based receiver types are tested but UE can select a test case based on which receiver type it supports. LP-WUS monitoring margin can be used to set thresholds. (Nokia)
  + P2: Whether and how to verify MR wake up need further study (vivo QC)
  + P3: No need for test cases for LP-WUR monitoring like miss detection/false alarm. (vivo QC)

*Recommendations:*

**Issue 3-2-7: On test case configuration**

* Proposals
  + P1: For the test of Cell reselection to FR1 intra-frequency NR case for OOK/OFDM-based LR capable UE, cell 1 and cell 2 shall be configured. Set 3 Time durations, including (CMCC)
  + T1 (UE camp on Cell1, stay in Case#1):
  + T2 (UE transit from Case#1 to Case#3, cell re-selection to Cell 2):
  + T3 (UE transit from Case#3 to legacy Case, cell re-selection to Cell 1):
  + P2: For the test of Cell re-selection to FR1 inter-frequency NR case for OOK/OFDM-based LR capable UE fulfilling [case3/relaxed MR measurement] criterion, refer to the legacy cell re-selection to FR1 inter-frequency NR case testing defined in A.6.1.1.2, with the update of (CMCC)
  + serving cell quality to guarantee UE stay in Case#3
  + time duration T1 &T3 and the test requirement according to relaxed cell detection and higher priority layer searching requirement.
  + P3: For theDuring T1, The LP-WUS entry condition is me. During T2, the LP-WUS exit condition is met, network send paging to UE. UE shall starts to send preambles on the PRACH within the duration LR exit criteria evaluation delay + PO delay + PRACH resource delay. (CMCC)
  + P4: Due to the large scaling factor for MR relaxation requirement, DRX 320ms or 640ms shall be configured as test setup to minimize the testing time effort. (CMCC)
  + P5: RAN4 to introduce new LP-SS configuration for LP-WUS test case (Ericsson)
  + P6: At the beginning of a test case, the UE will already in the offloading or RRM relaxation or LP-WUR monitoring mode for exit condition evaluation verification (vivo)
  + P7: In the test case for LP-SS based LR, only LP-SS will be sent and the SSB will not be sent.(vivo)
  + P8: Discuss how to initialise the test case such that UE is in MR relaxation / MR offloading before performing cell reselection. Discuss how to select the reselection thresholds in relation to LP-WUS entry / exit thresholds (Nokia)

*Recommendations:*

**Issue 3-2-8: On FR1/FR2 for test case**

* Proposals
  + P1: RAN4 to only introduce FR1 based LP-WUS test case. (Apple China Telecom Ericsson)

*Recommendations:*

### Sub-topic 3-3 Test case list

**Issue 3-3-1: Test case list**

* Proposals
* P1: (CMCC)
  + 1. Cell reselection to FR1 intra-frequency NR case for OOK/OFDM-based LR capable UE
    - LR exit criteria evaluation test when exit from Case 1 is embedded
    - LR exit criteria evaluation test when exit from Case 3 is embedded
    - MR wake up delay requirement is embedded
    - MR RRM relaxation measurement requirement is embedded
  + 2. Cell reselection to FR1 inter-frequency NR case for OOK/OFDM-based LR capable UE fulfilling [case3/relaxed MR measurement] criterion
    - Including lower and equal priority re-selection and higher priority re-selection
  + 3. Cell reselection to FR1 lower priority E-UTRAN cell for OOK/OFDM-based LR capable UE fulfilling [case3/relaxed MR measurement] criterion
  + 4. LP-WUS monitoring exit for LR capable UE
    - LR exit criteria evaluation test when exit from LP-WUS monitoring is embedded
    - MR wake up delay requirement is embedded

*Recommendations:*

# Appendix 1 Simulation parameter update based on RAN4 112bis [[R4-2416861](ftp://10.10.10.10/ftp/tsg_ran/WG4_Radio/TSGR4_112bis/Inbox/R4-2416861.zip)] and RAN4 114 [[R4-2502600](ftp://10.10.10.10/ftp/tsg_ran/WG4_Radio/TSGR4_114/Inbox/R4-2502600.zip)] agreements

Table 1: General parameters

|  |  |
| --- | --- |
| **Simulation parameters** | **Comments/values** |
| Carrier frequency for Cell 1 and Cell 2 | Agreement: 2.6 GHz initially |
| Prior knowledge of Cell 1 / Cell 2 by the UE | Interfering cell (Cell 2) is not known to UE |
| DRX | No applicable for LP-WUR |
| BS transmit antennas for LP-SS blocks | 1 Tx |
| UE receive antennas | 1 Rx |
| Data and control channel subcarrier spacing | [Data, SSB and LP-SS have the same SCS] |
| Subcarrier spacing | 30KHz [15 KHz up to company report] |
| Measurement period (in number of measurement samples) | [4, 5, other number could be studied upon a need] |
| LP-SS/SSB measurement interval | LP-SS: 320 ms  SSB: 320 ms |
| LP-SS BW | 132 subcarriers for SCS=30kHz for LP-SS initially  TBD for 15KHz SCS |
| SSS | 30KHz for SSS, TBD for 15KHz |
| Actual LP-SS transmissions | always transmitted |
| Guard band | 1 RB on each side of LP-SS/LP-WUS signal |

Table 2: Cell-specific parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Cell 1 | Cell 2 |
| RF Channel number | - | Channel 1 | Channel 1 |
| NR-PSS, NR-SSS (OFDM based LP-WUR) | - | To be indicated by companies | To be indicated by companies |
| LP-SS |  | Refer to conclusion of the Issue 2-1-4 in [[R4-2502600](ftp://10.10.10.10/ftp/tsg_ran/WG4_Radio/TSGR4_114/Inbox/R4-2502600.zip)] | Refer to conclusion of the Issue 2-1-4 in [[R4-2502600](ftp://10.10.10.10/ftp/tsg_ran/WG4_Radio/TSGR4_114/Inbox/R4-2502600.zip)] |
| PBCH and DMRS power offset with respect to NR-PSS, NR-SSS and LP-SS | dB | 0 | 0 |
| Data and control PSD relative to NR-PSS,NR-SSS and LP-SS | dB | 0 | 0 |
| RB Utilization | % | 100 | 100 |
| Data Modulation | - | QPSK | QPSK |
| Slot length | - | 14 symbols | 14 symbols |
| CP Length | - | Normal | Normal |
| Frequency offset relative to UE frequency reference | Hz | OFDM based receiver [5] ppm  OOK based receiver [5 10] ppm | N/A |
| Timing error |  | Residual timing error  + timing drift (frequency offset\* 320ms (reference signal periodicity)  Residual timing error:   * + *T= 5us for OOK-1*   + *T= 2us for OOK-4 with M=2*   + *T= 1us for OOK-4 with M=4* |  |
| 1)Relative Delay of 1st Path (synchronous) | µs | 0 | CP/2 |
| 2) Relative Delay of 1st Path (asynchronous): Fixed delay | ms | 0 | 3 ms |
| SNR | dB | SNR setting for serving and interference cell are derived based on agreement of Issue 2-1-1-1 | |
| When Ês/Iot = -3 dB   * When SNR of cell 2 is 9 dB lower compared with cell 2;   SNR = [-2.7]   * When SNR of cell 2 is 6 dB lower compared with cell 2   SNR = [-2.4] | When Ês/Iot = -3 dB   * When SNR of cell 2 is 9 dB lower compared with cell 2;   SNR = [-11.7]   * When SNR of cell 2 is 6 dB lower compared with cell 2;   SNR = [-8.4] |
| When Ês/Iot = -0.5 dB (low priority case)    Note: Determine the SNR based on based on agreement of Issue 2-1-1-1 | When Ês/Iot = -0.5 dB (low priority case)    Note: Determine the SNR based on based on agreement of Issue 2-1-1-1 |
| When Ês/Iot = 2 dB (low priority case)  Note: Determine the SNR based on based on agreement of Issue 2-1-1-1 | When Ês/Iot = 2 dB (low priority case)  Note: Determine the SNR based on based on agreement of Issue 2-1-1-1 |
| When Ês/Iot = -6 dB (low priority case) | When Ês/Iot = -6 dB (low priority case) |
| Ês/Iot | dB | -3; -0.5dB; 2dB | N/A |
| Propagation conditions | - | FR1:  AWGN  TDL-C 300ns | |
| UE speed |  | 3 km/h | |
|  | | | |

Table 3: UE-specific parameters

|  |  |
| --- | --- |
| [Receiver Filter] | [3th/5th Order Butterworth with 3.96MHz bandwidth] |
| [Receiver ADC bit width] | [4 or 8-bitADC] |
| [Receiver Sampling Rate for LP-SS only] | [3.84 or 7.68MHz] |

# Appendix 2 Collection of simulation results

