**3GPP TSG-RAN WG4 Meeting # 111 R4-2408026**

[Fukuoka City,](https://www.3gpp.org/Specification-Groups/) Japan, 20 May – 24 May, 2024

**Agenda item:** 10.14.5

**Source:** Moderator (vivo)

**Title:** Topic summary for [111][229] 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 topic [111][229] NR\_LPWUS.

Based on the latest approved WI in [RP-240135], 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 1-1-2: Cases/states to be considered for RRM relaxation**

**Issue 1-1-3: Core requirements to be specified for MR RRM relaxation**

**Issue 1-1-7: Criteria (entry/exit conditions) for LP-WUS monitoring**

**Issue 1-4-2: LP-SS periodicity for evaluation**

**Issue 1-4-3: PSS/SSS periodicity for evaluation**

**Issue 1-1-4: On requirements for entry/exit criteria evaluation for WUS paging monitoring/LP-WUR measurement/MR RRM relaxation**

**Issue 1-4-5: Simulation assumptions**

**Issue 1-3-1: MR RRM relaxation for serving cell/neighbour cell**

# 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

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2407311**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407311.zip) | Apple | ***Proposal 1: RAN4 specifies MR relaxation requirements at idle/inactive mode for UE supporting LP-WUR.******Proposal 2: the criteria design for RRM relaxation of UE MR for both serving and neighbor cell measurements can be left to RAN2 to decide, but RAN4 can*** ***investigate the mobility performance to quantify the relaxation, e.g., scaling factor for measurement period.******Proposal 3: If both LP-WUR and MR are ON, RAN4 to discuss whether UE uses LP-WUR measurement to decide MR relaxation or UE uses both LP-WUR and MR measurement to decide MR relaxation.******Proposal 4: RAN2 shall be the main group for criteria (entry/exit conditions) design******Proposal 5: RAN4 can work on the RRM measurement relaxations (e.g., Scaling factor) and offloading mechanisms based on the criteria defined by RAN2.******Proposal 6: two states can be considered after offloading from MR to LR(LP-WUR), i.e.,**** ***State 1: MR is still ON with RRM measurement relaxation on serving cell and neighbour cell (if any) and LP-WUR is ON for serving cell measurement.***
* ***State 2: MR is OFF or deep-sleep without reception/transmission and LP-WUR is ON for serving cell measurement.***

***Proposal 7: before entering offloading or after exiting offloading, the state of UE also needs to be clarified:*** * ***Alt 1: MR is ON with RRM measurement on serving cell and neighbour cell (if any) and LP-WUR is ON for serving cell measurement***
* ***Alt 2: MR is ON with RRM measurement on serving cell and neighbour cell (if any) and LP-WUR is ON without RRM measurement***
* ***Alt 3: MR is ON with RRM measurement on serving cell and neighbour cell (if any) and LP-WUR is OFF without RRM measurement.***

***We slightly prefer alt 2 or 3.******Proposal 8: this issue 2-1-6 can be discussed after when the whole mechanism of offloading, LP-SS/LP-WUS design and measurement metrics are concluded.******Proposal 9: RAN4 to decide the Es/Iot side condition for LP-WUR based RRM requirement when we have RAN1 conclusion on target SINR for coverage and RAN4 RF conclusion on noise figure.******Proposal 10:*** ***For LR based PSS/SSS synchronization/measurement, the simulation assumption of legacy SSB based intra-frequency measurement can be reused, and only need to revisit the candidate SINRs and candidate sample numbers.******For LR based LP-SS synchronization/measurement, RAN4 to discuss simulation assumption after RAN1 concluded on the LP-SS design.******Proposal 11:*** ***For RAN4 requirement of LR based RRM measurement in Idle/inactive states, no dedicated accuracy requirement is defined in the performance section, and reflect the accuracy performance as a margin in the core requirement.******Proposal 12:*** ***Single Rx is assumed for LR based RRM measurement.******Proposal 13:*** ***LP-SS measurement in IDLE/Inactive mode shall only follow LP-SS periodicity.******Proposal 14:*** ***RAN4 to wait conclusions from RAN1 on timing error and frequency error.******Proposal 15:*** ***RAN4 started RRM requirement for LP-WUR at idle/inactive state after RAN4 has sufficient information on LP-SS design and LP-SS based measurement metric from RAN1.******Proposal 16: regarding RRM relaxation of UE MR for both serving and neighbor cell measurements, RAN4 to discuss:**** ***whether serving and neighbor cell measurements can share the same criteria for triggering relaxation or not and,***
* ***whether serving and neighbor cell measurements can share the same relaxation requirement (e.g., scaling factor) or not.***

***Proposal 17: RAN4’s involvement on entry/exit conditions for LP-WUS monitoring can be triggered by other groups if necessary.******Proposal 18: no RRM objectives is needed for connected mode in this LP-WUR/LP-WUS WI.******Proposal 19: 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.***
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| [**R4-2407330**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407330.zip) | Samsung | **Proposal 1: RAN4 shall focus on following two cases for LP-WUR RRM measurement requirements during idle/inactive mode** * **Case 1: LP-SS for OOK based LP-WUR**
* **Case 2: Existing PSS/SSS for OFDM based on LP-WUR**

**Other requirements pending on further decision from RAN1****Proposal 2: RAN4 shall start the evaluation work on LP-WUR RRM measurement** * **Evaluation work on existing PSS/SSS based RRM measurement for LP-WUR can be started first**

**Proposal 3: For initial simulation calibration purpose, following assumption can be considered:*** **Target SNR/SINR: [-10~6] dB with 2dB step size**
* **LP-SS with periodicity: 320 ms**
* **Measurement metric: RSRP, RSRQ**

**MR measurement relaxtion****Proposal 4: RAN4 needs to further evaluate serving cell measurement relaxation, and further neighboring cell measurement relaxation by MR** **Proposal 5: RAN4 shall lead the discussion regarding criterion or scenario (entry/exit condition) for LP-WUR measurement and MR RRM measurement relaxation with the involvement of RAN1 and RAN2****Proposal 6: RAN4 shall further discuss the applicable side condition /scenario with corresponding assumption on MR serving cell measurement, MR neighboring cell measurement and LP-WUR measurement as a package*** **It’s not precluded multiple states can be introduced with different assumption on side condition**

**Proposal 7: For Entry/exit condition for LP-WUS monitoring, the performance of miss detection rate on LP-WUS can be considered as side condition in addition to RSRP and RSRQ****Proposal 8: Calibration between MR measurement and LR measurement maybe required which also pending on the progress of UE RF session.****Proposal 9: FFS whether new requirements need to be specified for the processing/interruption time between LP-WUS received paging indication to MR ready for Paging monitoring.****Others****Proposal 10: FFS whether need to introduce LP-WUS monitoring activation and deactivation delay requirements pending on RAN2/RAN1 progress.** **Proposal 11: eDRX can be discussed after further input from RAN1****Proposal 12: Paging reception requirement impact can be discussed after further input from RAN2 and RAN1.****Proposal 13: Consider following table for the expected impact to RRM core requirements for Rel-19 LP-WUS/WUR WI**

|  |  |
| --- | --- |
| **RRM core requirements** | **Expected impact** |
| 4: RRC\_Idle state mobility5: RRC\_INACTIVE state mobility | 4.1/4.2/5.1: Serving cell/intra-inter-frequency measurement by MR can be relaxed* Serving cell measurement relaxation by MR
* Intra/inter-freq. and inter-RAT measurement relaxation by MR
* Maximum interruption time in paging reception (FFS pending on RAN2/RAN1 progress)
* Serving cell measurement requirement for LP-SS and PSS/SSS by LP-WUR
* eDRX (FFS pending on RAN1)
 |
| 6: RRC\_CONNECTED state mobility | NO |
| 7: Timing | No |
| 8. Signalling characteristics | FFS on new requirements for LP-WUS monitoring during idle and inactive stateFFS on new requirements for LP-WUS monitoring activation and deactivation delay under connected mode |
| 9. Measurement | NO |

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| [**R4-2407377**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407377.zip) | NTT DOCOMO, INC. | **Proposal 1: The interruption requirements for MR measurement during entry/exit transition periods should be defined. For LP-WUR, the necessity of interruption requirements needs further discussion.****Proposal 2: For CONNECTED state, no additional RRM requirements are needed unless other functionality is defined by other WGs.** |
| [**R4-2407487**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407487.zip) | CATT | **Observation 1: It is very important to confirm the understanding of UE serving cell RRM measurement offloaded from MR to LP-WUR firstly, it is also related to the criteria and requirements for MR RRM relaxation.****Proposal 1: The states of UE serving cell RRM measurement offloaded from MR to LP-WUR need to be determined firstly in RAN4.****Proposal 2: The following states of UE serving cell RRM measurement offloaded from MR to LP-WUR can be considered:*** **State 1: UE serving cell RRM measurement via MR is stopped, i.e. no UE serving cell RRM measurement via MR, and LP-WUR performs serving cell measurement.**
* **State 2: UE serving cell RRM measurement via MR is relaxed, i.e. UE serving cell RRM measurement via MR is performed with longer cycle, and LP-WUR performs serving cell measurement.**

**Proposal 3: At least State 1 should be supported for UE serving cell RRM measurement offloaded from MR.** * **FFS for State 2.**

**Observation 2: The criteria of entry/exit conditions for LP-WUS monitoring has already been discussed in RAN1/RAN2.****Proposal 4: RAN4 to firstly discuss the differences between entry/exit conditions for LP-WUS monitoring defined in RAN1/RAN2 and conditions for LP-WUR measurement.****Proposal 5: RAN4 should at least consider LP-SS and PSS/SSS when discussing the entry/exit conditions for LP-WUR measurement.****Proposal 6: RAN4 to wait for RAN1/RAN2, if the entry/exit conditions for LP-WUS monitoring are introduced by RAN1/RAN2, the thresholds on serving cell measurement result can be further discussed in RAN4.****Proposal 7: Before discussing the entry/exit conditions for MR RRM measurement relaxation, RAN4 should firstly discuss the meaning of MR RRM measurement relaxation.*** **Which phases and what purposes are included for RRM relaxation in the entire procedure, i.e. for cell selection/reselection or handover, for serving cell measurement or neighbor cell measurement, etc.**

**Proposal 8: The MR RRM relaxation of UE MR for both serving and neighbor cell measurements should be further discussed.*** **What is the difference between MR RRM measurement relaxation and legacy RRM measurement relaxation (e.g., not-at-cell edge or low mobility in R16/R17)?**
* **Whether the legacy criteria for RRM relaxation can be reused for relaxing serving and neighbor cell measurements for UE MR?**

**Proposal 9: Whether RRM measurement of MR is used for neighbor cell measurement when the UE is operating with LP-WUR can be discussed after further input from RAN2.****Proposal 10: After determining the meaning and the criteria (entry/exit conditions) for MR RRM measurement relaxation in RAN2/RAN4, the method and requirements for MR RRM relaxation will be further discussed in RAN4.****Observation 3: The LP-WUR RRM measurement results of serving cell may be used in the entry/exit conditions, so the measurement accuracy is very important to guarantee the network performance.****Proposal 11: RAN4 to use the legacy measurement accuracy for CONNECTED mode in Clause 10.1.2 TS 38.133 as baseline.****Proposal 12: Regarding how to define the accuracy requirements (reflecting in the core requirements or dedicated section), it can be discussed after the simulation by taking the results into account.** |
| [**R4-2407844**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407844.zip) | Xiaomi | **Proposal 1: RAN4 to determine the measurement accuracy** **in RRC\_IDLE/INACTIVE state for simulation purpose, and NO need to define dedicated accuracy requirement in the performance section.****Proposal 2: RAN4 to consider a common target accuracy when defining LP-SS based and PSS/SSS based RRM delay requirements for LP-WUR.****Proposal 3: The entry/exit conditions for LP-WUR measurement should be consistent with the entry/exit conditions LP-WUS monitoring.****Proposal 4: Threshold on serving cell measurement result could be introduced to control the entry/exit of LP-WUR operation.****Proposal 5: RAN4 to define the relaxed RRM measurement requirements for MR after RAN2 making progress on the relaxation criteria.****Proposal 6: RAN4 should consider the requirements for UE MR to guarantee the paging reception and RRM measurements.** |
| [**R4-2407886**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407886.zip) | OPPO | **Proposal 1: Specify MR relaxation requirements for both serving cell and neighbor cell measurements in RRC idle/inactive mode.****Proposal 2: The criteria (entry/exit conditions) for LP-WUR measurement or MR RRM relaxation should be determined by RAN2/RAN1.****Proposal 3: Not consider adjustment on the target SNR from RAN1 due to the noise figure of LP-WUR since it has already been considered in RAN1 assumption.****Proposal 4: Follow RAN1 agreement that at least LP-RSRP/LP-RSRQ for OOK-based LP-WUR should be considered.****Proposal 5: Discuss the Rx beam sweeping factor to define delay requirements in case of multiple-beam.****Proposal 6: No impact on the existing RRM/RLM/BFD/L1-RSRP measurement requirements in RRC connected mode.**  |
| [**R4-2407939**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407939.zip) | CMCC | ***Proposal 1: Study the following measurement requirements in the first phase.**** ***Measurement requirements for OOK-based LP-WUR serving cell measurement based on LP-SS at Idle/Inactive state***
* ***Measurement requirements for OFDM-based LP-WUR serving cell measurement based on existing PSS/SSS at Idle/Inactive state***

***Proposal 2: Suspend the discussion of OFDM-based LP-WUR serving cell measurement requirement based on LP-SS at Idle/Inactive state, until RAN1 achieve the consensus about whether it can be target for sync and RRM measurement.******Proposal 3: Following three states can be further considered when defining the requirement and criteria (entry/exit conditions):**** ***State 1: Measurement only based on MR (legacy)***
* ***State 2: Measurement based on both MR with RRM relaxation and LP-WUR***
	+ ***State 2-1: MR measure both serving and neighbour with relaxation***
	+ ***State 2-2: MR measure only neighbour with relaxation***
* ***State 3: Measurement only based on LP-WUR***

***Proposal 4: Both serving cell quality and UE mobility should be considered for the criteria(entry/exit conditions) for MR RRM measurement relaxation&LP-WUR measurement (State2) and only LP-WUR measurement (State 3).******Proposal 5: Whether network configure the high priority frequency carrier measurement or not should also be considered when defining the criteria (entry/exit conditions).******Proposal 6: When UE enters the State 3, The serving cell quality should at least be Srxlev > SIntraSearchP and Squal > SIntraSearchQ.******Proposal 7: For target SNR and NF value, wait for more progress of RAN1 and RAN4 UE RF.******Proposal 8: Take the legacy measurement accuracy for Connected Mode (TS 38.133 Clause 10.1.2.1.1) as baseline for LP-SS measurement simulation assumption.******Proposal 9: Postpone the discussion of whether and how to define the dedicated accuracy requirement in the spec. Options can be kept.******Proposal 10: Consider LP-RSRP and LP-RSRQ as the metric for RRM serving cell measurement performed by OOK-based receiver based on LP-SS.******Proposal 11: For the definition of LP-RSSI, suggest to use the linear average of total received power in all LP-SS OOK symbols.******Proposal 12: For the simulation assumption of LP-SS periodicity, use 320ms as the starting point, and further update is not precluded based on RAN1’s output.******Proposal 13: For the measurement based on both MR with RRM relaxation (X time relaxation) and LP-WUR, X should be larger than or equal to 8.******Proposal 14: In order to guarantee the power saving gain, the entry/exit condition for LP-WUS monitoring and the entry/exit condition for LP-WUR measurement should be considered jointly.*** |
| [**R4-2407966**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407966.zip) | LG Electronics Inc. | * ***Proposal 1***: RAN4 needs to wait for conclusion of LP-SS design from RAN1 and noise figure/other RF impairements for LP-WUR from RF session to evaluation measurement requirements for LP-WUR.
* ***Proposal 2***: Further MR based RRM measurement relaxation for serving cell and/or neighbour cells should be applied for UE supporting LP-WUR.
* ***Proposal 3***: Study other conditions for the entry/exit condition for LP-WUS monitoring other than the measurement based condition from the RAN4 pespective
* ***Proposal 4***: RAN4 to discuss and provide input to RAN2 such as possible serving/neighbour measurement relaxzation conditions or which receiver (i.e., MR or LP-WUR) to base it on for MR based RRM measurement relaxation
* ***Proposal 5***: RAN4 needs to wait further conclusion of LP-SS design from RAN1
* ***Proposal 6***: Do not define measurement accuracy requirements for LP-WUR in Idle/Inactive state in performance section
* ***Proposal 7***: If there are other conditions that should be considered such as UE mobility besides serving cell RRM measurement for measurement offloading from MR to LP-WUR, RAN4 needs to provide input to RAN2.
* ***Proposal 8***: Focus on RRM core requirements only for IDLE/INACTIVE mode in Rel-19
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| [**R4-2408040**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408040.zip) | Qualcomm Incorporated | **Proposal 1: RAN4 specifies the following for entry/exit criteria evaluation for WUS paging monitoring:**1. **The number of measurement samples needed for filtering.**
2. **The number of consecutive times the UE needs to meet the entry/exit criteria.**

**Proposal 2: RAN4 to specify RRM core requirements for serving cell measurement offloading to the WUR only for the case when WUR and MR are operating on the same carrier frequency.**  |
| [**R4-2408316**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408316.zip) | China Telecom | **Proposal 1: RAN4 specifies MR relaxation requirements at idle/inactive mode for UE supporting LP-WUR.****Proposal 2: RAN4 to define requirements on entry/exit criteria for LP-WUR measurement based on RAN1 and RAN2 design.****Proposal 3: RAN4 to define requirements on entry/exit criteria for MR RRM measurement relaxation based on RAN1 and RAN2 design.****Proposal 4: For the methodology on specifying LP-WUR RRM requirements at Idle/Inactive mode:*** **First determine the measurement accuracy based on the legacy RAN4 requirement and target SNR/SINR based on RAN1 Rel-19 study.**
* **Determine required measurement samples based on RAN4 simulations.**
* **Determine measurement delay based on sampling number and reference signal periodicity.**

**Proposal 5: RAN4 to define the dedicated accuracy requirement in the performance section.** **Proposal 6: RAN4 to decide whether the legacy EMR Idle mode accuracy requirement and Connected mode** **accuracy requirement can be reused for LP-WUR measurements later based on the simulation results.****Proposal 7: It’s proposed to start RRM requirement for LP-WUR at idle/inactive state after RAN4 has sufficient information on LP-SS design and LP-SS based measurement metric from other sources.****Proposal 8: It’s proposed to discuss relaxation factors within the range from 8 to 16 as the starting point for the relaxation factor for the MR RRM relaxation.****Proposal 9: There is no RRM objective for connected mode in LP-WUR/LP-WUS WI.** |
| [**R4-2408329**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408329.zip) | Ericsson | ***Proposal 1: No dedicated accuracy requirement in the performance section and reflect the accuracy performance as a margin in the core requirement.******Proposal 2: RAN4 to wait other WGs’ progress to clarify the MR RRM relaxation scenario before discussing the relaxation requirement.******Proposal 3: RAN4 to discuss the requirement about exit the LR by serving cell evaluation based on the LP-RSRP/LP-RSRQ simulation results.******Proposal 4: RAN4 to discuss the requirement about entry the LR by serving cell evaluation based on the SSB.******Proposal 5: RAN4 to follow RAN1’s LP-RSRP definition to evaluate the LP-SS performance and wait RAN1’s further progress on LP-RSRQ.******Proposal 6: RAN4 to use LP-SS with 320ms periodicity to evaluate the performance.******Proposal 7: RAN4 to evaluate the PSS/SSS based LP-WUR exiting condition with the same periodicity as LP-SS.******Proposal 8: RAN4 to discuss the following simulation assumption to evaluate the LP-SS related measurement metrics.******Proposal 9: RAN4 to discuss the simulation assumption to evaluate the LP-SS measurement.******Proposal 10: CONNECTED mode requirements for LP-WUS is postoponed until more progress is achieved in other WGs.*** |
| [**R4-2408624**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408624.zip) | vivo | **Observation 1: For RRM measurement purpose, UE can satisfy RSRP measurement accuracy based on 2 LP-SS samples and satisfy RSRQ measurement accuracy based on 3 LP-SS samples at SNR = -3dB under TDL-C channel based on 320ms periodicity of LP-SS.** 1. **For the agreement “Measurement requirements for LP-WUR serving cell measurement based on LP-SS at Idle/Inactive state”, RAN4 should start study on requirements for LP-SS capable receiver and wait for more RAN1 progress on the option where LP-SS with overlaid OFDM sequences.**
2. **For the UE serving cell RRM measurement offloaded from MR to LP-WUR, besides the case where MR has RRM relaxation on serving cell and neighbour cell measurement and LP-WUR performs serving cell measurement, the following cases should be supported in “UE serving cell RRM measurement offloaded from MR to LP-WUR”**

**Case 1: Fully offloading case - MR stops perform any RRM measurement and LP-WUR performs serving cell measurement.** **Case 2: Relaxed case - MR has RRM relaxation on serving cell measurement (no neighbour cell measurement is needed) and LP-WUR performs serving cell measurement.** 1. **RAN2 is be the main group on designing the “necessary conditions” including criteria and corresponding threshold in the objective “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”**
2. **Same criteria and same/different entry/exit conditions can be used for LP-WUS monitoring and serving cell RRM measurement offloading.**
3. **Update the wording of previous agreement as “The outcome of RAN1’s study in Rel-19 WI on SINR target is used as the starting point for RAN4 LP-WUR requirement study”.**
4. **RAN4 could consider LP-RSRP initially and uses 320ms as the LP-SS periodicity for requirement study.**
5. **The entry/exit conditions for LP-WUS monitoring in RAN4’s initial simulation could be based on RAN1 116bis’s working assumption, i.e., the entry conditions will be based on measurement results from MR and the exit conditions will be based on measurement results from LP-WUR.**
6. **The accuracy requirement defined for Redcap with 1Rx can be used as the base when defining requirements for LP-WUR serving cell measurement.**
7. **Further relaxation on the accuracy target based on reference accuracy maybe needed. The amount of relaxation could be based on RAN4’s simulation outcome.**
8. **Consider relaxation factors within the range from 8 to 16 as the starting point for the relaxation factor for the MR RRM relaxation.**
9. **RAN4 should consider relaxation on higher priority frequency layer search requirements based on “conditions” defined by RAN2.**
10. **No RAN4 RRM involvement is required for CONNECTED mode at the early stage.**
11. **Suggest to consider the following initial simulation assumptions for LP-WUR RRM measurement requirements. Companies are encouraged to propose simulation assumptions for alignment in future meeting.**
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| [**R4-2408673**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408673.zip) | Nokia | Observation 1: For LP-WUR that is capable of receiving PSS/SSS, RAN1 is discussing on absolute and relative measurement quantities based on SSB. The metrics should be defined so that they are applicable for time and frequency domain processing.Proposal 1: RAN4 to perform evaluations on PSS/SSS based LP-WUR measurements.Observation 4: After RAN1#116 at least the following aspects are still FFS is RAN1:I. FFS how OOK-1 and OOK-4 are specified.II. RRM measurement metric is still FFS in RAN1.III. FFS Whether or not to specify overlaid OFDM sequences(s)IV. FFS on SNR to achieve the coverage of PUSCH for message3.Proposal 2: RAN4 to identify common requirements for PSS/SSS and LP-SS based LR and prioritise those while RAN1 is working on LP-SS design.Proposal 3: RAN4 to prioritise PSS/SSS based LP-WUR requirements while RAN1 is working on LP-SS design.Proposal 4: RAN4 to study the need for RRM requirements for different architecture types and define requirements separately for supported architecture types, as needed.Proposal 5: RAN4 to discuss what is the impact of different architecture options on LP-WUR requirements.Proposal 6: For both PSS/SSS and LP-SS based LP-WUR, support scenario where MR RRM measurements are partially relaxed.Proposal 7: For both PSS/SSS and LP-SS based LP-WUR, MR stops perform any RRM measurement and LP-WUR performs serving cell measurement.Observation 5: Performing the evaluation of MR relaxation/offloading based on MR measurements in connected mode provide more accurate representation of radio conditions than LP-WUR measurements in the idle-mode.Proposal 8: RAN4 to discuss the starting point of MR relaxation/offloading when UE is being released to idle-mode.Proposal 9: Further discuss in which conditions the relaxation factors are applied.Proposal 10: RAN4 to discuss serving cell evaluation for entry / exit conditions for PSS/SSS and LP-SS based LR.Proposal 11: PSS/SSS based entry/exit evaluation can be prioritised.Observation 6: RAN1 is interested to find the SNR to achieve the coverage of PUSCH for message3.Proposal 12: RAN4 to wait for the RAN1 conclusions on the target SNR before agreeing on the coverage of PUSCH message3. |
| [**R4-2409295**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409295.zip) | Huawei, HiSilicon | **Proposal 1: For LP-WUR measurement, define accuracy requirements and reflect it as a margin in the core requirement. The exact accuracy values are FFS for both OOK and OFDM based receiver.** **Proposal 2: RAN4 to discuss time and frequency error when agreeing on the simulation assumption for evaluating LP-WUR measurement performance.****Proposal 3: For LP-WUR measurement, further discuss the assumptions on the measurement interval for defining the requirements, e.g. LP-SS periodicity or DRX/eDRX cycle.****Proposal 4: RAN4 to specify relaxed MR measurement requirements at least for neighbor cells, FFS for serving cell.****Proposal 5: For relaxed MR measurement, define accuracy requirements and reflect it as a margin in the core requirement. FFS whether the existing margins for cell reselection can be re-used.****Proposal 6: For MR measurement with relaxation, the legacy SINR condition and accuracy are re-used, and the relaxation factor should be >= 16.****Proposal 7: RAN4 to define requirements on UE paging monitoring to make sure that UE does not miss paging when entry/exit condition for LP-WUS monitoring is met.****Proposal 8: RAN4 to confirm that same entry/exit condition for LP-WUS monitoring applies for serving cell RRM measurement offloading (from MR to LP-WUR).** |
| [**R4-2409687**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409687.zip) | ZTECorporation,Sanechips | **Observation 1:** **The downlink channel quality of the serving cell can be monitored and compared with the “threshold” to decide whether to enter the LP-WUS coverage or not.*** **Entry condition: the serving cell measurement performed by the MR is above entry threshold, if configured by the gNB.**
* **Exit condition: the serving cell measurement performed by the LR is below exit threshold, if configured by the gNB.**

**Proposal 1: For the entry/exit conditions for LP-WUS monitoring, the threshold for the serving cell measurement performed by MR or LR shall be decided by RAN4.****Observation 2: It is up to RAN4 to make decision on whether/how to define the RRM measurement requirements for OFDM-based LP-WUR using the overlaid sequence of LP-SS.****Proposal 2: The feasibility of OFDM-based LP-SS measurement shall be discussed.****Observation 3: Although the LR is different from MR and the measurement requirements may be different, the legacy measurement procedure/method are similar and the existing measurement requirements for using SSS can be the baseline.****Proposal 3: It is not necessary for RAN4 to define measurement requirements for OFDM-based LP-SS RRM measurement at least in this stage.****Proposal 4: RAN4 could send the LS to RAN1 and convey our ideas whether we agree with defining OFDM-based LP-SS measurement requirements or not.****Observation 4: Y will be decided within WI and 320ms is the start point.****Proposal 5: RAN4 shall wait for the RAN1’s agreements and then decide the concrete values for LP-SS periodicity.****Observation 5: In the legacy L3 measurement, the UE shall measure the SS-RSRP and SS-RSRQ level of the serving cell and evaluate the cell selection criterion S defined in TS 38.304 for the serving cell.****Observation 6: The definition of LP-RSRP and LP-RSRQ are similar to the legacy SS-RSRP and SS-RSRQ, but the measured quantity value range may be different and the details shall be waited for RAN1.****Proposal 6: The legacy measurement criteria for serving cell can be reused for the OOK-based LP-SS measurement for serving cell, that is, *the UE shall measure the LP-RSRP and LP-RSRQ level of the serving cell and evaluate the cell selection criterion S defined in TS 38.304 for the serving cell***.**Proposal 7: It is hard to perform the cell reselection when considering the LR and define the related measurement requirements used by LP-SS.****Observation 7: The legacy methodology to obtain SNR could not be used since the legacy method for SNR is obtained by the downlink information.****Observation 8: RAN1 will report the SNR target to achieve the coverage of PUSCH for message 3 and several assumptions shall be considered.****Proposal 8: RAN4 shall wait for the RAN1’s discussion on SNR target in order to study the requirements of LP-WUR.****Proposal 9: When considering the target SNR, the LR noise figure is the key factor shall be considered.****Observation 9:** **To my understanding, there are three scenarios for RRM measurements:*** **Scenario 1: Legacy. Only MR performs the RRM measurements (3times)**
* **Scenario 2: Partially offload. MR RRM relaxation and LR performs the RRM measurements.**
* **Scenario 3: Fully offload. MR stops any RRM measurement and LR performs the RRM measurements.**

**Observation 10:** * **For scenario 1, we find that no power saving gain if no MR RRM relaxed.**
* **For scenario 3, we can infer that the propagation condition is the best and the MR will stop any RRM measurement and the power saving gain is the best.**
* **For scenario 2, there are 3 cases can be seen, the different relaxation factors have the different power saving gain and the larger relaxation factors the larger power saving gain.**

**Observation 11: If the factor is less than 8 times the power saving gain is average 4%. However, if the relaxation factor is equal or larger than 8, the power saving gain has a sharp increase.****Proposal 10: Relaxation factors within the range from 8 to 16 as the starting point for the relaxation factor for the MR RRM relaxation.****Proposal 11: RAN4 shall not define the measurement requirements at CONNECTED state.** |
| [**R4-2409729**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409729.zip) | MediaTek inc. | **Proposal 1: Given any outcome from RAN1 discussion on the target SNR, RAN4 still need to consider other RF impairments to determine the final value for the target SNR.****Proposal 2: RAN4 to evaluate the RRM performance for LP-SS using the existing side condition of the Idle mode performance requirements (i.e., -4dB for Idle mode in FR1).****Proposal 3: RAN4 to discuss different accuracies for LP-SS based LP-WUR RRM measurement and PSS/SSS based LP-WUR RRM measurement.****Proposal 4: No dedicated accuracy requirement in the performance section, and reflect the accuracy performance as a margin in the core requirement.****Proposal 5: RAN4 to specify MR RRM relaxation requirements for serving cell measurements in Idle/Inactive mode when*** **LP-SS based LP-WUR RRM measurement is activated, or**
* **PSS/SSS based LP-WUR RRM measurement is activated**

**Proposal 6: Not to consider RRM relaxation based on the hybrid measurements of both (LP-SS and SSS).****Proposal 7: RAN4 to discuss RRM related requirements for entry/exit conditions for LP-WUS monitoring taking into consideration RAN1/RAN2 design.** |

## 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 1-1-1: Core requirements to be specified for LP-WUR measurement**

* Proposals
	+ P1: RAN4 shall focus on following cases (Samsung CMCC vivo ZTE):
		- Case 1: LP-SS for OOK based LP-WUR;
		- Case 2: Existing PSS/SSS for OFDM based on LP-WUR;
	+ P1-1: Suspend the discussion of OFDM-based LP-WUR serving cell measurement requirement based on LP-SS at Idle/Inactive state, until RAN1 achieve the consensus about whether it can be target for sync and RRM measurement. (Samsung CMCC)
	+ P1-2: It is not necessary for RAN4 to define measurement requirements for OFDM-based LP-SS RRM measurement at least in this stage. (ZTE)
	+ P2: New requirements may need be specified for the interruption time between LP-WUS received paging indication to MR ready for Paging monitoring (Samsung xiaomi Docomo)
	+ P2-1: RAN4 to define requirements on UE paging monitoring to make sure that UE does not miss paging when entry/exit condition for LP-WUS monitoring is met (HW)
	+ P3: RAN4 to discuss what is the impact of different architecture options on LP-WUR requirement and study the need to define requirements separately for supported architecture types (Nokia)
	+ P4: The feasibility of OFDM-based LP-SS measurement shall be discussed, a LS could be sent to RAN1 on RAN’4 conclusion. (ZTE)

Background: RAN4 110bis agreement

* + At Rel-19 LP-WUR WI, for LP-WUR measurement, RAN4 specifies measurement requirements for the following:
		- Measurement requirements for LP-WUR serving cell measurement based on LP-SS at Idle/Inactive state
		- Measurement requirements for LP-WUR serving cell measurement based on existing PSS/SSS at Idle/Inactive state
	+ Other related requirements are FFS

*Recommendations:*

* Update the first bullet of RAN4 110bis’s agreement on issue 2-2-1 as
	+ - Measurement requirements for OOK based LP-WUR serving cell measurement based on LP-SS at Idle/Inactive state
* Suspend the discussion of OFDM-based LP-WUR serving cell measurement requirement based on LP-SS at Idle/Inactive state until more RAN1 progress is available

**Issue 1-1-2: Cases/states to be considered for RRM relaxation**

* Proposals
* P1:
	+ Case 1: Fully offloading case - MR stops perform any RRM measurement and LP-WUR performs serving cell measurement. (Apple Samsung CATT CMCC vivo Nokia HW ZTE)
	+ Case 2: Relaxed case - MR has RRM relaxation on serving cell measurement (no neighbour cell measurement is needed) and LP-WUR performs serving cell measurement. (Apple Samsung vivo Nokia ZTE)
		- FFS on Case 2; (CATT HW)
	+ Case 3: Relaxed case - MR has RRM relaxation on serving cell and neighbour cell measurement and LP-WUR performs serving cell measurement. (Apple Samsung CMCC vivo Nokia HW ZTE)
		- FFS on Case 3; (CATT)
	+ Case 4: Relaxed case - MR has RRM relaxation on neighbour cell measurement and LP-WUR performs serving cell measurement. (CMCC)
	+ Case 5: Legacy case- Exit from LP-WUR RRM measurement and MR follows normal RRM measurement (Samsung)

*Recommendations:*

 Discuss the following cases:

|  |  |  |  |
| --- | --- | --- | --- |
| **RRM measurement case index** | **MR serving cell measurement** | **MR neighboring cell measurement** | **LR measurement** |
| #1 Fully offloading case | Off  | Off | ON  |
| #2 Relaxed case  | On with relaxation measurement | Off  | ONFFS on OFF |
| #2 Relaxed case  | On with relaxation measurement | On with relaxation measurement | ON FFS on OFF |
| #4 Relaxed case  | Off  | On with relaxation measurement | ON |
| #5 Legacy case  | On | On | FFS |

**Issue 1-1-3: Core requirements to be specified for MR RRM relaxation**

* Proposals
	+ P1: RAN4 specifies MR relaxation requirements for both serving cell and neighbor cell measurements at idle/inactive mode for UE supporting LP-WUR. (Apple xiaomi oppo LG CT ZTE)
		- RAN4 can investigate the mobility performance to quantify the relaxation, e.g., scaling factor for measurement period. If both LP-WUR and MR are ON, RAN4 to discuss whether UE uses LP-WUR measurement to decide MR relaxation or UE uses both LP-WUR and MR measurement to decide MR relaxation (Apple)
	+ P1-1: RAN4 to specify MR RRM relaxation requirements for serving cell measurements in Idle/Inactive mode when (MTK)
		- LP-SS based LP-WUR RRM measurement is activated, or
		- PSS/SSS based LP-WUR RRM measurement is activated

 Not to consider RRM relaxation based on the hybrid measurements of both (LP-SS and SSS).

*Recommendations:*

**Issue 1-1-4: On requirements for entry/exit criteria evaluation for WUS paging monitoring/LP-WUR measurement/MR RRM relaxation**

* Proposals
	+ P1-1: RAN4 specifies the following for entry/exit criteria evaluation for WUS paging monitoring: (Qualcomm)
		- The number of measurement samples needed for filtering.
		- The number of consecutive times the UE needs to meet the entry/exit criteria
	+ P1-2: Define requirements on entry/exit criteria for LP-WUR measurement/ MR RRM measurement relaxation based on RAN1 and RAN2 design (CT)
	+ P1-3: RAN4 to discuss the requirement about exit the LR by serving cell evaluation based on the LP-RSRP/LP-RSRQ simulation result and the requirement about entry the LR by serving cell evaluation based on the SSB RSRP/RSRQ. (Ericsson)

*Recommendations:*

**Issue 1-1-5: Criteria (entry/exit conditions) for LP-WUR measurement**

* Proposals
	+ P1: RAN2 is be the main group for criteria (entry/exit conditions) design (Apple oppo vivo)
	+ P2: RAN4 shall lead the discussion regarding criterion or scenario (entry/exit condition) for LP-WUR measurement and MR RRM measurement relaxation with the involvement of RAN1 and RAN2 (Samsung)
		- RAN4 shall further discuss the applicable side condition /scenario with corresponding assumption on MR serving cell measurement, MR neighbouring cell measurement and LP-WUR measurement as a package
			* It’s not precluded multiple states can be introduced with different assumption on side condition
	+ P3: RAN4 to firstly discuss the differences between entry/exit conditions for LP-WUS monitoring defined in RAN1/RAN2 and conditions for LP-WUR measurement. RAN4 should at least consider LP-SS and PSS/SSS when discussing the entry/exit conditions for LP-WUR measurement. RAN4 to wait for RAN1/RAN2, if the entry/exit conditions for LP-WUS monitoring are introduced by RAN1/RAN2, the thresholds on serving cell measurement result can be further discussed in RAN4. (CATT)
	+ P4: Both serving cell quality and UE mobility should be considered for the criteria(entry/exit conditions) for MR RRM measurement relaxation &LP-WUR measurement (State2) and only LP-WUR measurement (State 3). Whether network configure the high priority frequency carrier measurement or not should also be considered when defining the criteria (entry/exit conditions). (CMCC)
	+ P5: When UE enters the State 3 (Measurement only based on LP-WUR), The serving cell quality should at least be Srxlev > SIntraSearchP and Squal > SIntraSearchQ (CMCC)
	+ P6: Study other conditions for the entry/exit condition for LP-WUS monitoring other than the measurement based condition from the RAN4 pespective (LG)
	+ P7: RAN4 to discuss serving cell evaluation for entry/exit conditions for PSS/SSS and LP-SS based LR. PSS/SSS based entry/exit evaluation can be prioritised. (Nokia)

*Recommendations:*

**Issue 1-1-6: Criteria (entry/exit conditions) for MR RRM measurement relaxation**

* Proposals
	+ P1: RAN2 is be the main group for criteria (entry/exit conditions) design (oppo vivo Apple)
		- RAN4 can work on the RRM measurement relaxations (e.g., Scaling factor) and offloading mechanisms based on the criteria defined by RAN2. (Apple)
	+ P2: RAN4 should firstly discuss the meaning of MR RRM measurement relaxation on which phases and what purposes are included for RRM relaxation in the entire procedure, i.e. for cell selection/reselection or handover, for serving cell measurement or neighbor cell measurement, etc. (CATT)
	+ P3: RAN4 to discuss and provide input to RAN2 such as possible serving/neighbour measurement relaxzation conditions or which receiver (i.e., MR or LP-WUR) to base it on for MR based RRM measurement relaxation (LG)
	+ P3a: RAN4 shall lead the discussion regarding criterion or scenario (entry/exit condition) for LP-WUR measurement and MR RRM measurement relaxation with the involvement of RAN1 and RAN2 (Samsung)
		- RAN4 shall further discuss the applicable side condition /scenario with corresponding assumption on MR serving cell measurement, MR neighbouring cell measurement and LP-WUR measurement as a package
			* It’s not precluded multiple states can be introduced with different assumption on side condition

*Recommendations:*

**Issue 1-1-7: Criteria (entry/exit conditions) for LP-WUS monitoring**

* Proposals
	+ P1: RAN4’s involvement on entry/exit conditions for LP-WUS monitoring can be triggered by other groups if necessary (Apple)
	+ P2: For Entry/exit condition for LP-WUS monitoring, the performance of miss detection rate on LP-WUS can be considered as side condition in addition to RSRP and RSRQ (Samsung)
	+ P3-1: The entry/exit conditions for LP-WUR measurement should be consistent with the entry/exit conditions LP-WUS monitoring (xiaomi)
	+ P3-2: The entry/exit condition for LP-WUS monitoring and the entry/exit condition for LP-WUR measurement should be considered jointly.(CMCC)
	+ P3-3: Same criteria and same/different entry/exit conditions can be used for LP-WUS monitoring and LP-WUR RRM measurement. (vivo)
	+ P3-4: RAN4 to confirm that same entry/exit condition for LP-WUS monitoring applies for serving cell RRM measurement offloading (from MR to LP-WUR). (HW)

Notes: MR measurements results shall be larger than the threshold and satisfy the related MR relaxation conditions. (ZTE)

* + P4: If there are other conditions that should be considered such as UE mobility besides serving cell RRM measurement for measurement offloading from MR to LP-WUR, RAN4 needs to provide input to RAN2 (LG)
	+ P5: For the entry/exit conditions for LP-WUS monitoring, the threshold for the serving cell measurement performed by MR or LR shall be decided by RAN4 (ZTE)

*Recommendations:*

*Suggest to check whether the following top level description:*

*LP-WUR monitoring is triggered no later than one of cases identified in issue 1-1-2*

**Issue 1-1-8: LP-WUR status before entering offloading or after exiting offloading**

* Proposals
	+ P1: (Apple)
		- Alt 1: MR is ON with RRM measurement on serving cell and neighbour cell (if any) and LP-WUR is ON for serving cell measurement
		- Alt 2: MR is ON with RRM measurement on serving cell and neighbour cell (if any) and LP-WUR is ON without RRM measurement (Apple)
		- Alt 3: MR is ON with RRM measurement on serving cell and neighbour cell (if any) and LP-WUR is OFF without RRM measurement. (Apple)

*Recommendations:*

**Issue 1-1-9: Impact on specification**

* Proposals
	+ P1: Can be discussed after when the whole mechanism of offloading, LP-SS/LP-WUS design and measurement metrics are concluded. (Apple)
	+ P2: Consider following table for the expected impact to RRM core requirements for Rel-19 LP-WUS/WUR WI (Samsung)

|  |  |
| --- | --- |
| **RRM core requirements** | **Expected impact** |
| 4: RRC\_Idle state mobility5: RRC\_INACTIVE state mobility | 4.1/4.2/5.1: Serving cell/intra-inter-frequency measurement by MR can be relaxed* Serving cell measurement relaxation by MR
* Intra/inter-freq. and inter-RAT measurement relaxation by MR
* Maximum interruption time in paging reception (FFS pending on RAN2/RAN1 progress)
* Serving cell measurement requirement for LP-SS and PSS/SSS by LP-WUR
* eDRX (FFS pending on RAN1)
 |
| 6: RRC\_CONNECTED state mobility | NO |
| 7: Timing | No |
| 8. Signalling characteristics | FFS on new requirements for LP-WUS monitoring during idle and inactive stateFFS on new requirements for LP-WUS monitoring activation and deactivation delay under connected mode |
| 9. Measurement | NO |

*Recommendations:*

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

**Issue 1-2-1: Methodology on specifying LP-WUR RRM requirements at Idle/Inactive mode**

* Proposals
	+ P1: RAN4 to decide the Es/Iot side condition for LP-WUR based RRM requirement when we have RAN1 conclusion on target SINR for coverage and RAN4 RF conclusion on noise figure (Apple CMCC)
	+ P2: Update the wording of previous agreement as “The outcome of RAN1’s study in Rel-19 WI on SINR target is used as the starting point for RAN4 LP-WUR requirement study”. (vivo)
	+ P3:RAN4 to wait for the RAN1 conclusions on the target SNR (Nokia ZTE)
		- P3-1: RAN4 shall study the target SNR as baseline since RAN1 has agreed the target SNR shall be reported. (ZTE)
	+ P4: Given any outcome from RAN1 discussion on the target SNR, RAN4 still need to consider other RF impairments to determine the final value for the target SNR. RAN4 to evaluate the RRM performance for LP-SS using the existing side condition of the Idle mode performance requirements (i.e., -4dB for Idle mode in FR1). (MTK)

*Recommendations:*

**Issue 1-2-2: Noise figure and others impact(RF impairment) on SNR target X**

* Proposals
	+ P1: Not consider adjustment on the target SNR from RAN1 due to the noise figure of LP-WUR since it has already been considered in RAN1 assumption. (oppo)

*Recommendations:*

**Issue 1-2-3: Accuracy for LP-WUR measurement**

* Proposals
	+ P1: No dedicated accuracy requirement is defined in the performance section for LR-WUR based RRM measurement in Idle/inactive states, and reflect the accuracy performance as a margin in the core requirement. (Apple xiaomi LG Ericsson Huawei MTK ZTE)
	+ P2: RAN4 to use the legacy measurement accuracy for CONNECTED mode in Clause 10.1.2 TS 38.133 as baseline. FFS on whether or how to define dedicated accuracy requirements. (CATT CMCC)
	+ P3: RAN4 to consider a common target accuracy when defining LP-SS based and PSS/SSS based RRM delay requirements for LP-WUR. (xiaomi)
	+ P4: First determine the measurement accuracy based on the legacy RAN4 requirement and target SNR/SINR based on RAN1 Rel-19 study. Determine required measurement samples based on RAN4 simulations. Determine measurement delay based on sampling number and reference signal periodicity. RAN4 to decide whether the legacy EMR Idle mode accuracy requirement and Connected mode accuracy requirement can be reused for LP-WUR measurements later based on the simulation results (CT)
	+ P5: RAN4 to define the dedicated accuracy requirement in the performance section (CT)
	+ P6: The accuracy requirement defined for Redcap with 1Rx can be used as the base when defining requirements for LP-WUR serving cell measurement. (vivo)
		- P6-1: Further relaxation on the accuracy target based on reference accuracy maybe needed. The amount of relaxation could be based on RAN4’s simulation outcome. (vivo)

*Recommendations:*

**Issue 1-2-4: Measurement metrics**

* Proposals
	+ P1: Follow RAN1 agreement that LP-RSRP for OOK-based LP-WUR should be used, wait RAN1’s further progress on LP-RSRQ. (oppo CMCC Ericsson ZTE)
	+ P2: For the definition of LP-RSSI, suggest to use the linear average of total received power in all LP-SS OOK symbols. (CMCC)

*Recommendations:*

**Issue 1-2-5: Time/frequency sync**

* Proposals
	+ P1: RAN4 to wait conclusions from RAN1 on timing error and frequency error. (Apple vivo)
	+ P2: RAN4 to discuss time and frequency error when agreeing on the simulation assumption for evaluating LP-WUR measurement performance. (Huawei)

*Recommendations:*

**Issue 1-2-6: Timeline on RRM requirement evaluation work**

* Proposals
	+ P1: RAN4 start RRM requirement for LP-WUR at idle/inactive state after RAN4 has sufficient information on LP-SS design and LP-SS based measurement metric from other sources. (Apple CT)

*Recommendations:*

**Issue 1-2-7: Other considerations**

* Proposals
	+ P1: Calibration between MR measurement and LR measurement maybe required which also pending on the progress of UE RF session. (Samsung)
	+ P2: RAN4 to specify RRM core requirements for serving cell measurement offloading to the WUR only for the case when WUR and MR are operating on the same carrier frequency (Qualcomm)
	+ P3: RAN4 to discuss the starting point of MR relaxation/offloading when UE is being released to idle-mode. (Nokia)
	+ P4: The legacy measurement criteria for serving cell can be reused for the OOK-based LP-SS measurement for serving cell, that is, the UE shall measure the LP-RSRP and LP-RSRQ level of the serving cell and evaluate the cell selection criterion S defined in TS 38.304 for the serving cell. (ZTE)

*Recommendations:*

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

**Issue 1-3-1: MR RRM relaxation for serving cell/neighbour cell**

* Proposals
	+ P1: Regarding RRM relaxation of UE MR for both serving and neighbor cell measurements, RAN4 to discuss (Apple)
		- whether serving and neighbor cell measurements can share the same criteria for triggering relaxation or not and,
		- whether serving and neighbor cell measurements can share the same relaxation requirement (e.g., scaling factor) or not.
	+ P2: RAN4 needs to further study serving cell measurement relaxation, and further neighboring cell measurement relaxation by MR (Samsung CATT Nokia)
		- P2-1 (CATT): What is the difference between MR RRM measurement relaxation and legacy RRM measurement relaxation (e.g., not-at-cell edge or low mobility in R16/R17)? Whether the legacy criteria for RRM relaxation can be reused for relaxing serving and neighbor cell measurements for UE MR ?  Whether RRM measurement of MR is used for neighbor cell measurement when the UE is operating with LP-WUR can be discussed after further input from RAN2. After determining the meaning and the criteria (entry/exit conditions) for MR RRM measurement relaxation in RAN2/RAN4, the method and requirements for MR RRM relaxation will be further discussed in RAN4.
	+ P3: Relaxation factors within the range from 8 to 16 as the starting point for the relaxation factor for the MR RRM relaxation (CT vivo ZTE)
		- P2-1: Equal or larger than 8 (CMCC)
		- P2-2: >=16 (Huawei)
	+ P4: RAN4 to wait other WGs’ progress to clarify the MR RRM relaxation scenario before discussing the relaxation requirement. (Ericsson)
	+ P5: The legacy SINR condition and accuracy are re-used(HW)

*Recommendations:*

**Issue 1-3-2: Accuracy for relaxed MR measurement**

* Proposals
	+ P1: For relaxed MR measurement, define accuracy requirements and reflect it as a margin in the core requirement. The legacy accuracy are re-used. (HW)

*Recommendations:*

### Sub-topic 1-4 Simulation work and assumptions

**Issue 1-4-1: General aspects on evaluation work**

* Proposals
	+ P1: Evaluation work on existing PSS/SSS based RRM measurement for LP-WUR can be started first (Samsung Nokia)
	+ P2: Discuss the Rx beam sweeping factor to define delay requirements in case of multiple-beam (oppo)
	+ P3: RAN4 to discuss the following simulation assumption to evaluate the LP-SS related measurement metrics.(Ericsson)
		- Whether interference cell is needed
		- Which interference signals need to be modeled, SSB, LP-SS or both

*Recommendations:*

**Issue 1-4-2: LP-SS periodicity for evaluation**

* Proposals
	+ P1: LP-SS measurement in IDLE/Inactive mode shall only follow LP-SS periodicity. (Apple)
	+ P2: RAN4 uses 320ms as the LP-SS periodicity for requirement study. (CMCC Ericsson Samsung vivo)
	+ P3: For LP-WUR measurement, further discuss the assumptions on the measurement interval for defining the requirements, e.g. LP-SS periodicity or DRX/eDRX cycle (Huawei)
	+ P4: RAN4 shall wait for the RAN1’s agreements and then decide the concrete values for LP-SS periodicity (ZTE)

*Recommendations:*

**Issue 1-4-3: PSS/SSS periodicity for evaluation**

* Proposals
	+ P1: RAN4 to discuss the PSS/SSS periodicity to evaluate the LP-WUR exiting condition in LR. (Ericsson)

*Recommendations:*

**Issue 1-4-4: Nubmer of Rx antenna**

* Proposals
	+ P1: Single Rx is assumed for LR based RRM measurement.(Apple vivo)

*Recommendations:*

**Issue 1-4-5: Simulation assumptions for LP-WUR measurement**

* Proposals
	+ P1: For LR based PSS/SSS synchronization/measurement, the simulation assumption of legacy SSB based intra-frequency measurement can be reused, and only need to revisit the candidate SINRs and candidate sample numbers. For LR based LP-SS synchronization/measurement, RAN4 to discuss simulation assumption after RAN1 concluded on the LP-SS design. (Apple)
	+ P2: For initial simulation calibration purpose, following assumption can be considered: Target SNR/SINR: [-10~6] dB with 2dB step size; LP-SS with periodicity: 320 ms; Measurement metric: RSRP, RSRQ. (Samsung)
	+ P3: Simulation assumptions as in tables in [R4-2408624](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408624.zip) (vivo)

*Recommendations:*

Align the framework for simulation assumption and companies are encouraged to provide simulation assumption or feedback on existing simulation assumptions.

Table 1: General parameters

|  |  |
| --- | --- |
| **Simulation parameters** | **Comments/values** |
| Carrier frequency for Cell 1 and Cell 2 | FR1: 2.6 GHz/700MHz |
| System bandwidth | 20/100 MHz; |
| Prior knowledge of Cell 1 / Cell 2 by the UE | No / Yes |
| DRX | No |
| BS transmit antennas for LP-SS blocks | 1 tx or single layer transmissions |
| UE receive antennas | 1 rx  |
| Data and control channel subcarrier spacing | OFDB based: The same as SS block subcarrier spacingOOK based: the same as one of the SCS(s) used for other NR transmissions in the same CP-OFDM symbol  |
| Measurement period (in number of measurement samples) |  OOK based: 5, other number of samples may also be studied upon a needOFDM based: 5  |
| [Receiver Filter] | [5th Order Butterworth with 4.32MHz bandwidth] |
| [Receiver ADC bit width] | [4/8-bitADC] |
| [Receiver Sampling Rate for LP-SS only] | [3.84/7.68MHz] |
| * Subcarrier spacing
 | 2.6GHz: 15 kHz and 30 kHz; 700MHz: 15kHz |
| * Number of LP-SS blocks per SS burst set, K
 | [1] |
| * LP-SS/SSB burst periodicity
 | [320 ms]OFDB based: [20 ms] |
| * Number of transmit antenna ports
 | 1 (the same port for NR-SSS, NR-PSS, NR-PBCH) |
| * LP-SS block BW
 | * 144 subcarriers for SCS=30kHz, 288 subcarriers for SCS=15kHz
 |
| * Actual LP-SS block transmissions
 | always transmitted |

Table 2: Cell-specific parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Cell 1 | Cell 2 |
| RF Channel number | - | Channel 1 | Channel 1 |
| NR-PSS,NR-SSS and LP-SS sequences | - | To be indicated by companies | To be indicated by companies |
| 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 |
| LP-SS |  | OOK-1;OOK-4 with M = 2,4; | OOK signal: [OOK-1 when Cell 1 is OOK-1;OOK-4 when Cell 1 is OOK-4]Or NR signal |
| LP-SS pattern |  | Company report | Company report |
| Data Modulation | - | [OOK based: OOK][OFDM based: QPSK] | [OOK based: QPSK/OOK][OFDM based: QPSK] |
| Slot length | - | 14 symbols | 14 symbols |
| CP Length | - | Normal | Normal |
| Frequency Offset relative to UE frequency reference | Hz | [TBD] | [TBD] |
| 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 | OFDM based: [TBD]OOK based: [TBD] | OFDM based: [TBD]OOK based: [TBD]  |
| Es/IoT (calculated from SNR) | dB | N/A | OFDM based: [TBD]OOK based: [TBD] |
| Propagation conditions | - | FR1:AWGNTDL-A 30nsTDL-B 100nsTDL-C 300ns |
| UE speed |  | FR1: 30 km/h |
| NOTE: the companies are encouraged to state channel model parameters together with the results, the parameters are to be further discussed and aligned |

Table 3: UE-specific parameters

|  |  |
| --- | --- |
| [Receiver Filter] | [5th Order Butterworth with 4.32MHz bandwidth] |
| [Receiver ADC bit width] | [4/8-bitADC] |
| [Receiver Sampling Rate for LP-SS only] | [3.84/7.68MHz] |

### Sub-topic 1-5 LP-WUR CONNECTED mode

**Issue 1-5-1: LP-WUR at CONNECTED mode**

* Proposals
	+ P1: No RRM objectives is for connected mode in this WI. (Apple Docomo oppo LG CT vivo ZTE)
	+ P2: Postponed until more progress (Ericsson)
	+ P3: FFS whether need to introduce LP-WUS monitoring activation and deactivation delay requirements pending on RAN2/RAN1 progress (Samsung)

*Recommendations:*

### Sub-topic 1-6 Others

**Issue 1-6-1: eDRX related**

* 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: eDRX can be discussed after further input from RAN1 (Samsung)

*Recommendations:*

Suggest eDRX related issue to be down prioritized at the early stage of this WI.