**3GPP TSG-RAN WG4 Meeting # 113** **R4-2420117**

**Orlando, USA, 18th - 22nd November, 2024**

**Agenda item:** 7.23.5

**Source:** Moderator (vivo)

**Title:** Ad-hoc minutes for NR\_LPWUS

**Document for:** Approval

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

* P1: Use fixed scaling factor between 8 to 16 for MR serving/neighbour cell relaxation as the starting point (xiaomi LG CMCC CT ZTE oppo Apple vivo Huawei Samsung MTK)
	+ P1-1: Relaxation factor =8 as the starting point (CMCC MTK)
	+ P1-2: Relaxation factor >=16 (Apple vivo Huawei MTK)
	+ P1-3: At least the scaling factor should be larger than that of legacy Rel-16 UE power saving WI (>3). (oppo vivo)
* P2: Use fixed scaling factor, for MR neighbor cell measurement relaxation, the existing relaxed requirements in 4.2.2 can be used as baseline. For MR serving cell measurement relaxation, a scaling factor can be introduced on existing serving cell measurement requirements in 4.2.2. (CATT)
* P3: RAN4 shall study the mobility performance to quantify the relaxation such as scaling factor for time period (ZTE)
* P4: Relaxation factors is configurable by NW
	+ P4.1 RAN4 to introduce NW controlled serving/neighbour cell measurement relaxation. The relaxation factor can be indicated by NW from one of the following values: 3, 8, 16 etc. (Ericsson)
	+ P4.2 Discuss the range of relaxation factor, once simulation work has progressed. (Nokia)

*Background:*

*During RAN4 112bis online meeting:*

***Aspect 1: Agree on relaxation/scaling factor(s) for MR serving/neighbour cell relaxation as the starting point***

* *Support: vivo, ZTE, MTK, Samsung, Apple, HW, China Telecom, QC*
* *Discuss the number later: Nokia, E///, OPPO, Xiaomi, LGE, CATT*

***Aspect 2: The same or different relaxation/scaling factors for MR serving and neighbour cell relaxation***

* *Same: MTK, vivo, QC, China Telecom, HW, OPPO, Xiaomi, CMCC, ZTE, Samsung, Apple*
* *Different: CATT, Nokia*

*FFS Smaller factor for serving cell or neighboring cell*

***Exact relaxation factor as the starting point***

* *Option 1: Only consider the scaling factor(s) larger than that of legacy Rel-16 UE power saving WI (i.e., 3) (QC, CMCC, LGE, ZTE, HW, China Telecom, Apple, vivo, MTK, Xiaomi, Samsung)*
* *Option 2: 3 is included as one of the factors (E///, Nokia)*

*For the scaling factor(s) larger than 3, which number can be used as starting point.*

* *8: CMCC, China Telecom, vivo, Samsung, Ericsson, MTK, QC, Nokia*
* *>=16: vivo, QC, HW, Apple, Samsung, MTK*

**For discussion:**

**Scaling factor(s) for MR RRM relaxation for serving cell/neighbour cell for case 3**

The range of relaxations factor, no matter scaling factor(s) is/are a fixed, or multiple fixed or by NW configuration

* Option 1: Only consider the scaling factor(s) larger than that of legacy Rel-16 UE power saving WI (i.e., 3) (QC, CMCC, LGE, ZTE, HW, China Telecom, Apple, vivo, MTK, Xiaomi, Samsung)
* Option 2: 3 is included as one of the factors (E///, Nokia, CATT)

Scaling factor(s) is/are larger than 3.

Nokia: Be careful about very large scaling factor

CATT: We can consider to compromise, prefer to list candidate values.

ZTE: ok with option 1

MTK: From RAN2 perspective, NW does not know when UE operates LP-WUR. Based on that, NW configuration may not necessary. We can consider larger than legacy for the scaling factor.

Samsung: In our view, from RAN2 perspective it is also similar to Rel-16 criteria based on threshold, when the threshold is satisfied, scaling factor will apply. If we use legacy scaling factor, the power consumption is even worse compared with the legacy case.

Ericsson: Firstly agree NW configuration.

Oppo: Whether the same or different scaling factor for serving and neighbour cell needs be considered.

Vivo: If 3 is considered here, we do not have any further RRM relaxation in the WI.

Samsung: At least equal or larger than 6

QC: The concern from NW side is for very large DRX cycle. Having a small scaling factor (larger than 3) can be used for large DRX cycle.

Nokia: Open to discuss the scaling factor. If UE go to out of service very often. It is not only for power saving issue. LP-WUR needs fit existing deployment.

QC: Address Nokia concern. The concern is from paging perspective however there is no paging issue here.

Apple: Same reply as QC. In addition, LP-WUR will also perform serving cell measurement as well.

MTK: If all scaling factor >=6, we can consider NW configuration.

Ericsson: From NW side, the concern is sometime the scaling factor is too large.

Vivo: it is already up to NW configuration.

MTK: If we have only one scaling factor.

Apple: for option 3 at the next section, need to address what is the lower bound of the scaling factor.

Agreement:

Scaling factor(s) is/are >= 4. Further down-select from

* Option 1: 1 fixed scaling factor
* Option 2: multiple values configured by NW
* Option 3: multiple values, scaling factor value depends on DRX cycle length (QC MTK apple xiaomi vivo)

|  |  |
| --- | --- |
| DRX cycle length [s] | Scaling factor |
| 0.32 | TBD  |
| 0.64 | TBD |
| 1.28 | TBD |
| 2.56 | TBD  |

*At RAN4 113 Online discussion*

Check further on scaling factor

* Option 1: fixed scaling factor(s)
	+ Option 1-1: 1 fixed scaling factor
	+ Option 1-2: multiplex scaling factor – how to use if multiple factors are defined
* Option 2: multiple values configured by NW
	+ Option 2-1: Set of scaling factors [8 16];
	+ Option 2-2: Set of scaling factors [ 6 8 16]
* Option 3: multiple values, scaling factor value depends on DRX cycle length

|  |  |
| --- | --- |
| DRX cycle length [s] | Scaling factor |
| 0.32 | TBD |
| 0.64 | TBD |
| 1.28 | TBD |
| 2.56 | TBD |

**Issue 1-3-2: On Neighbour cell and serving cell relaxation factor**

* Proposals
	+ P1: Wait for RAN2 progress on relaxation criteria to decide whether to use same scaling factor as neighbour cell measurement (CATT)
	+ P2: Neighbour measurements have the more relaxation than serving cell measurement. (Apple)
	+ P3: Same relaxation factor applies to serving and neighbor cell measurements (CT oppo Apple vivo Huawei MTK)
	+ P4: Relaxation factor is configurable per serving and neighbouring cell measurements. (Nokia)
		- RAN4 to further study the MR Relaxation scaling factor before fixing the relaxation factor first, and evaluate other aspects with simulations
		- FFS if if both neighbor cell measurement and serving cell measurement shall share the same relaxation criteria or relaxation factor

*Recommendations:*

Agreement:

Same relaxation factor(s) applies to serving and neighbour cell measurements in idle/inactivate state

**Issue 1-1-8: LP-WUR operating carrier frequency**

* Proposals
	+ P1: RAN4 only consider the case when MR and LR are operating on the same carrier frequency in Rel-19. (CATT, Ericsson)
	+ P2: Issue is pending until further conclusions from RAN1/2 are available (xiaomi)
	+ P3: Consider LR and MR work at different band (CMCC ZTE vodafone vivo)
		- P3-1: LP-SS and WUS are in the same band , LP-SS and MR measurement are in different bands. (ZTE)
			* For RRM measurement, LR and MR could work on different band. The accuracy threshold may be considered. For WUS monitoring, LP-WUS could wake up MR in different band to perform paging monitoring.
		- P3-2: Co-located scenario could be considered when LR and MR work at different band. (vivo)
		- P3-3: LR measurement requirements depends only on LR band. For LR measurement requirements, there is no extra specification work on RAN4 if LR and MR work at the different band. RAN4 has also identified impacts on requirements for both offloading and relaxation of RRM measurements, given that the measurements performed by LR in a different frequency than the MR might not be accurate (Vodafone vivo)
	+ P4: Consider LR-WUS reception and MR on the same carrier frequency as the baseline (oppo Apple Huawei)
	+ P5: FFS for the case of MR and LR working on different carrier frequencies if it is supported in RAN1/2. (Apple)
	+ P5: From Rel-19 RAN4 RRM requirement perspective, LR shall be operated as the same carrier frequency of serving cell for MR measurement offloading and relaxation; From LP-WUS monitoring perspective, LR and MR can be on different carriers/bands. And the delay for MR wake up will be increased with re-synchronization to operating carrier for MR required before MR is ready to monitor paging (Samsung)
	+ P6: The RAN1 LS should be handled in RF session. (Ericsson)

*Background:*

**R1-2407559/ R4-2414909**

|  |
| --- |
| In RAN1, the common understanding is that UE may not support LP-WUS reception on all the bands supported by the UE.RAN1 respectfully asks RAN2 and RAN4 to check if there is any issue and specification support needed for IDLE/INACTIVE UEs.**To RAN2 and RAN4:****ACTION:** RAN1 respectfully asks RAN2 and RAN4 to check if there is any issue and specification support needed for IDLE/INACTIVE UEs. |

*RAN4 112bis agreement:*

RF session (WF R4-2417112)

*Issue 1-1-2: Consideration on RAN1 LS R4-2414909*

*Agreements:*

* + *no specific RF work related to RAN1 LS.*

RRM session (WF R4-2417112)

*Issue 1-1-8: LP-WUR operating carrier frequency*

*Agreement:*

* *RAN4 will further discuss whether any technical issues regarding the LS from RAN1.*
* *From Rel-19 RAN4 RRM requirement of MR offloading and relaxation perspective, RAN4 assumed LR and MR are operating on the same carrier frequency as baseline. FFS for the case of MR and LR working on different carrier frequencies if it is supported in RAN1/2.*

*Issue for further discussion based on contribution driven:*

* *For WUS monitoring assumption, further discuss whether or not the same carrier frequency is assumed for LR and MR.*

**For discussion:**

Suggest to discuss the following items in the reply LS

Part 1. Based on RAN4 112bis RRM session’s agreement in the reply LS;

 “*From Rel-19 RAN4 RRM requirement of MR offloading and relaxation perspective, RAN4 assumed LR and MR are operating on the same carrier frequency as baseline*.”

Vod: fine to keep the wording.

Part 2. RAN4 112bis RF session’s agreement in the reply LS;

Part 3. RAN4 112bis issue for further discussion

Usage of LP-WUS monitoring will be restricted if only operation on the same band is supported.

Yes:

No: QC

Part 4. RAN4 action in future

RAN4 will further discuss requirements for the case of MR and LR working on different bands if it is supported by RAN1/2.

Which group to sent

To: RAN1

CC: RAN2

Vod: it is more efficient to send it to RAN plenary

Samsung: The topic is triggered by RAN1. To RAN1 and CC RAN2. There are several way to address this issue.

Vod: Another aspect is not send to RAN plenary however cc.

CC to RAN plenary

Yes:

No: MTK QC HW Apple Samsung CATT xiaomi LG

Agreement:

In the LS only the following part will be included:

RAN4 112bis RF session’s agreement in the reply LS;

 “*From Rel-19 RAN4 RRM requirement of MR offloading and relaxation perspective, RAN4 assumed LR and MR are operating on the same carrier frequency as baseline*.”

Regarding whether to include the “FFS for the case of MR and LR working on different carrier frequencies if it is supported in RAN1/2”

Yes: oppo, vivo

No: QC, Apple, MTK, HW

ZTE: FFS sentence included as a note in the LS

**Issue 1-2-3: On requirements for entry/exit criteria(threshold) evaluation for Case 1 and Case 3**

**Background:**

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



* For evaluation requirements for LP-WUR for LP-WUS monitoring/fully offloading (case 1), discuss the following options,
* Option 1: Define evaluation requirements used for corresponding **entry/exit** conditions evaluation using the corresponding **LP-WUR measurement period**.
* Option 2: Define evaluation requirements used for corresponding **entry/exit** conditions evaluation using a duration **longer** than corresponding LP-WUR measurement period, FFS on detail.
* Option 3: Define evaluation requirements used for corresponding **entry** conditions based on option 2, and **exit** conditions based on option 1.

**For discussion:**

**Issue x: Whether to differentiate requirements based on cases**

**Note:** For entry condition evaluation requirements, requirements from legacy state to case 1 or case 3 or LP-WUS monitoring will be discussed separately.

**Option 1: No**

For requirements on entry criteria(threshold) evaluation, define requirement x

For requirements on exit criteria(threshold) evaluation, define requirement y, y can be the same as x or not.

**Option 2: Yes**

**Issue 1-2-3a: On requirements for entry/exit criteria(threshold) evaluation for Case 1**

* For evaluation requirements for LP-WUR for case 1, discuss the following options,
* Option 1: Define evaluation requirements used for corresponding **entry/exit** conditions evaluation using the **LP-WUR measurement period**. (vivo, Samsung, Xiaomi, LGE)
* Option 2: Define evaluation requirements used for corresponding **entry/exit** conditions evaluation using a duration **longer** than corresponding LP-WUR measurement period, FFS on detail. (QC, Apple, MTK, Samsung, HW, E///, CATT)
* Option 3: Define evaluation requirements used for corresponding **entry** conditions based on option 2, and **exit** conditions based on option 1. (Xiaomi, HW, E///, vivo, Nokia)
* Other options are not precluded. (LGE)
* Note: for entry condition, it is for case 3 to case 1.

**Issue 1-2-3b: On requirements for entry/exit criteria(threshold) evaluation for Case 3**

* For evaluation requirements for LP-WUR for LP-WUS monitoring/fully offloading (case 1), discuss the following options,
* Option 1: Define evaluation requirements used for corresponding **entry/exit** conditions evaluation using the corresponding **LP-WUR measurement period**.
* Option 2: Define evaluation requirements used for corresponding **entry/exit** conditions evaluation using a duration **longer** than corresponding LP-WUR measurement period, FFS on detail.
* Option 3: Define evaluation requirements used for corresponding **entry** conditions based on option 2, and **exit** conditions based on option 1.

**Issue 1-2-3c: On requirements for entry/exit criteria(threshold) evaluation for LP-WUS monitoring**

**Issue 1-2-1: Accuracy requirements**

* 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. (xiaomi LG CMCC CT ZTE Apple Ericsson Huawei MTK)
	+ P2: If “using a margin to reflect accuracy performance of LP-WUR in core specs”, is used for LP-WUR, for MR, the following options could be considered (vivo)
		- Option 1: For MR, **margin is also introduced** when **MR** serving cell measurement result comparing with a threshold, this margin will be based on legacy MR accuracy requirements.
		- Option 2: For MR, margin is **not** **introduced** when **MR** serving cell measurement result comparing with a threshold, as that of the legacy specs.
	+ P3: Conclude final accuracy requirement details after simulations have been collected and compared (Nokia)

**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)**

* Proposals
	+ P1: LR status is ON (xiaomi)
	+ P2: LP-WUR can be ON or OFF for serving cell measurement. If the threshold for LP-WUS monitoring and LP-WUR RRM measurement are same the LP-WUR can be OFF, else if the threshold for LP-WUS monitoring is higher than for the LP-WUR RRM measurement the LP-WUR can be ON. (LG)
	+ P3-1: LP-WUR is ON for serving cell measurement, but when and how to turn on LR for serving cell measurement is up to UE implementation. (Apple)
	+ P3-2: When a LP-based threshold is configured, at legacy case LP-WUR needs be “ON” at least some duration early before comparing with a LP-based threshold. (vivo Huawei Ericsson)
		- No need define any LR measurement requirements when a UE is at legacy case (vivo Huawei)

*Background:*

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

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

*Note: update the title to discuss the LP-WUR status at legacy state, not only for before entering LP-WUS monitoring or after exiting LP-WUS monitoring*

**Recommendations**:

Check the following:

LP-WUR is ON for serving cell measurement, but when, how to turn on LR and the duration of “ON” for serving cell measurement is up to UE implementation, and no LP-WUR requirement will be applied.

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

* Proposals
	+ P1: Define at least {M,L} pairs {2, 8} and {4, 16} for alignment purposes. FFS other pairs, upon need. Define at least 2 binary sequences, one for L=8 and one for L=16, to be agreed offline during the week of RAN4#113 preferably (Apple)
	+ P2: Define a specific binary sequence for serving cell and a specific binary sequence for the interference cell. Interfering binary sequence shouldn’t be known to the UE, but also should not be random (Apple)
	+ P3: RAN4 to align the LP-SS binary sequence pattern for M=4, such as Cell 1: [1010] Cell 2: [0101] (Ericsson)
	+ P4: For OOK-based LP-WUR, use LP-SS binary sequence L=24 for OOK-4 (M=2) and L=56 for OOK-4 (M=4). The binary sequence is selected to meet the target timing accuracy agreed by RAN1 and RAN4. (MTK)
	+ P5: M=1, LP-SS=[1 0 1 0 1 0 1 0]; M=2, LP-SS= [1 0 1 0 0 1 1 0]; M=4, LP-SS= [1 0 1 0 1 0 1 0 1 0 1 0 0 1 0 1] (vivo)

**For discussion:**

To moderator’s understanding, binary sequence maybe available at RAN1 119 meeting.

Align the LP-SS sequence

Wait for one more meeting: QC

In case RAN1 does not have fixed sequence, RAN4 will figure out the LP-SS for simulation purpose at the next meeting.

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

* Proposals
	+ P1: RAN4 to agree data and control channel subcarrier spacing as follow. (Ericsson)
		- OFDM based: The same as SSB subcarrier spacing
		- OOK based: the same as one of the SCS(s) used for other NR transmission
	+ P2: RAN4 to agree only using SCS = 30KHz in the simulation. (vivo Ericsson)

*Recommendations:*

*Check whether only using SCS = 30KHz in the simulation is agreeable*

|  |  |
| --- | --- |
| *Subcarrier spacing* | *30KHz initially**TBD for 15 KHz* |

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

* Proposals
	+ P1: Ideal RSRP is derived from the serving cell signal after the fading channel; Ideal RSRQ is derived based on ideal RSRP divides the calculated RSSI (Ericsson)
	+ P2: Suggest to discuss and align the ideal RSRP calculation (vivo)
	+ Method 1: The first one is the RSRP is pass the fading channel and with the perfect channel estimation and the real RSRP pass the same channel.
	+ Method 2: The second one assumes the impact of the fading channel can be completely removed hence the ideal RSRP does not need pass the channel whereas the real RSRP will pass the fading channel.

*Recommendations:*

*Ideal RSRP is derived from the serving cell signal after the fading channel*

**Issue 2-1-11: On simulation campaign**

* Proposals
	+ P1: RAN4 RRM to compile a simulation results summary spreadsheet to be updated during every RAN4 meeting based on the contributions of the interested companies. RAN4 RRM to agree on an initial summary of simulations spreadsheet format, including an interested company to take care of it, by the end of RAN4#113.(Apple)
	+ P2: Agree on a set of simulation scenarios each company provides to the next meeting (Nokia)