**3GPP TSG-RAN WG4 Meeting # 112 R4-24xxxxx**

**Maastricht, Netherlands, 19th – 23rd August, 2024**

**Agenda item:** 8.22.5

**Source:** Moderator (vivo)

**Title:** WF for NR\_LPWUS

**Document for:** Approval

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

### Sub-topic 1-1 General aspects

**Issue 1-1-1: Cases/states to be considered for RRM relaxation and serving cell measurement offloading**

Agreement:

* Support case #3
  + For serving cell measurement, further discuss:
    - Option 1: Further discuss whether to combine the measurements across the two radios, i.e., MR and WUR
    - Option 2: From RAN4 requirement perspective, not consider combining the measurements across the two radios, i.e., MR and WUR
    - Option 3: It is up to UE implementation whether to combine the measurement across the two radios.
    - Other options are not precluded.

|  |  |  |  |
| --- | --- | --- | --- |
| RRM measurement case index | MR serving cell measurement | MR neighboring cell measurement | LR measurement |
| #3 Relaxed case b | On with relaxation measurement | On with relaxation measurement | ON |

* + Note: In RAN4 understanding, the discussion of the related measurement criteria (i.e., whether to use the legacy or new criteria) is out of RAN4 responsibility.

*Recommendations:*

*Suggest to discuss issues related to higher priority frequency layers under 1-1-11.*

*Continue discuss case 2 and other issues.*

**Issue 1-1-2: Measurement requirements to be specified for LP-WUR**

*Recommendations:*

* Check whether to 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*
    - *Measurement requirements for OFDM-based LP-WUR serving cell measurement based on existing PSS/SSS at Idle/Inactive state*

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

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

*Recommendations:*

*Suggest to discuss this issue on the separately issue listed as the following:*

* *On requirements for evaluating entry/exit criteria for LP-WUR monitoring*
* *On requirements for evaluating entry/exit criteria for RRM relaxation and serving cell measurement offloading*

**Issue 1-1-4-1: Entry/exit criteria evaluation when results from MR and/or LP-WUR are avaiable for WUS paging monitoring/LP-WUR measurement/MR RRM relaxation**

*Recommendations:*

*Companies are encouraged to provide views on whether combine results from LP-WUR and MR is needed or if so, solutions on how to combine*

**Issue 1-1-4-2: Reference signals and measurement types to be used for Entry/exit criteria evaluation for WUS paging monitoring/LP-WUR measurement/MR RRM relaxation**

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

*Recommendations:*

*To moderator’s understanding, criteria will be designed by RAN2. Better to consider other related issues except for the criteria itself.*

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

*Recommendations:*

*To moderator’s understanding, criteria will be designed by RAN2. Better to consider other related issues except for the criteria itself.*

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

*Recommendations:*

*To moderator’s understanding, criteria will be designed by RAN2. Better to consider other related issues except for the criteria itself.*

**Issue 1-1-8: On jointly consideration on issue 1-1-5, 1-1-6 and 1-1-7**

**Issue 1-1-9: LP-WUR status**

**Issue 1-1-10: UE measurement behivour after receiving LP-WUS signal**

*Recommendations:*

*Maybe it is not a RAN4 issue, suggest to check RAN1/2 for clarification.*

**Issue 1-1-11: Considerations on higher priority frequency layer**

*Recommendations:*

*Companies are encouraged to bring solutions/views on this issue.*

**Issue 1-1-12: Impact on specification**

*Recommendations:*

*Postpone the discussion until more RAN4’s conclusion are available.*

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

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

*Recommendations:*

*How and where to capture the accuracy requirement can be discussed later.*

**Issue 1-2-2: Possible interruption related requirements for LP-WUR**

*Recommendations:*

*Companies are encouraged to bring solutions/views on this issue.*

**Issue 1-2-3: Possible cell selection evaluation requirements for fully offloading case based on LP-WUR**

*Recommendations:*

*Companies are encouraged to bring solutions/views on this issue.*

**Issue 1-2-4: LP-WUR operating carrier frequency**

**Issue 1-2-5: Timeline on RRM requirement evaluation work**

*Recommendations:*

*Postpone the discussion on this issue.*

**Issue 1-2-6: Nubmer of Rx for LP-WUR requirements**

*Recommendations:*

*Encourage companies to check whether P1 of this issue is agreeable or not.*

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

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

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

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

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

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

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

*Recommendations:*

*Suspend discussion on this topic until more progress from other group.*

### Sub-topic 1-5 Others

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

*Recommendations:*

*Suggest postpone discussion on this issue.*

# Topic #2: Simulation assumptions and results

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

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

Agreement:

* + As starting point for RAN4 RRM simulation purpose only, -3dB, 0.5dB, 2dB dB Ês/Iot value is used for serving cell for both OOK based and OFDM based LP-WUR.
    - The SINR value can be updated if any update on the noise figure value in RF session.
  + FFS the side condition for RAN4 requirement.

**Issue 2-1-1-1: SNR setting for serving and interference cell derivation from SINR setting**

Agreement:

* + Consider two cells for RAN4 simulation: one serving cell and one interference cell.

Agreement:

To derive SNR for serving cell and interference cell from serving cell Ês/Iot, a relationship for the SNR or transmission power between serving cell and interference cell need be pre-defined.

Consider the SNR/transmission power of the interference cell is 9 dB or 6 dB lower compared with that of the serving cell. Other value can be considered.

**Issue 2-1-1-2: Same or different SINR setting for OOK based and OFDM based LP-WUR**

*Recommendations:*

*Covered by issue 2-1-1. Close this issue*

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

*Recommendations:*

*Follow RAN1’s conclusion*

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

Agreement:

*Residual frequency error:*

OFDM based receiver [5] ppm

OOK based receiver [ 10 20] ppm

**Issue 2-1-4: Accuracy baseline for simulation**

**Issue 2-1-5: Measurement interval**

Agreement:

Use 320ms for SSB based LP-WUR firstly.

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

Simulation assumptions

Note:

Parameters highlighted by green color are agreed during the meeting.

Other parameters are only for recommendation and information purpose.

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 initially  TBD for 15 KHz |
| Measurement period (in number of measurement samples) | LP-SS for OOK based LP-WUR: [4, 5, other number could be studied upon a need]  SSB for OFDM based LP-WUR: [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 (OOK based LP-WUR receiver) |  | OOK-1; or  OOK-4 with M = [2,4]  Note: M value [2 4] are up to company selection | when Cell 1 uses OOK-1; OOK-1 or NR signal is used for Cell 2  when Cell 1 uses OOK-4,  OOK-4 with same M value as cell 1 or NR signal is used for Cell 2 |
| LP-SS pattern |  | [M sequence]  [Golden sequence]  [Computer search sequence]  Note: Company can simulate one or all of them | [M sequence]  [Golden sequence]  [Computer search sequence]  Note: Company can simulate one or all of them |
| 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 [ 10 20] ppm | N/A |
| Timing error |  | Residual timing error  + timing drift (frequency offset\* 320ms (reference signal periodicity)  Residual timing error: company report |  |
| 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  Note: Determine the SNR based on based on agreement of Issue 2-1-1-1 | When Ês/Iot = -0.5 dB  Note: Determine the SNR based on based on agreement of Issue 2-1-1-1 |
| When Ês/Iot = 2 dB  Note: Determine the SNR based on based on agreement of Issue 2-1-1-1 | When Ês/Iot = 2 dB  Note: Determine the SNR based on based on agreement of Issue 2-1-1-1 |
| 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] |