

3GPP RAN#102

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Views on scope for NR LP- WUS/WUR in Rel-19

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Outline

- Background
- LP-WUS Techniques
- WI Scope for Rel-19 LP-WUS/WUR

Background

- Rel-18 LP-WUS/WUR SI has been successfully finished in RAN1#104. RAN1 has studied LP-WUS/LP-SS in the aspect of waveform, receiver architecture, synchronization, LP-WUS monitoring scheme, RRM relax and offloading, and L1/UL procedures.
- In scoping R19 LP-WUS/WUR WI, followings aspects need to be considered.
 - Waveform
 - LP-WUS monitoring scheme
 - Synchronization method
 - RRM offloading
 - LP-WUS design
 - Idle and connected mode

LP-WUS Techniques

- **Waveform**

- Two directions were identified in RAN1#101.
 - Direction 1: Option 1 (OOK1/4), Option 3 (OOK1/4+OFDM), LP-SS
 - Direction 2: Option 3 (OOK1/4+OFDM), LP-SS
- In direction 1, RAN1 will down select between Option 1 and Option 3 during Rel-19 WI.
- In direction 2, RAN1 start WI from Option 3.
- → For the progress of WI, it would be better to down select in RAN#102 and scoping Rel-19 WI accordingly.
- → For Option 3, the OFDM sequence overlay should be used only for detection performance improvement rather than carrying additional information. Carrying additional information will introduce different LP-WUR device types, which leads to eco-system fragmentation. To avoid such issue, we make following proposal.
- **Proposal 1: RAN1 adopts waveform Option 3 for Rel-19 LP-WUS/WUR with condition that overlay OFDM sequence is used only for detection performance improvement rather than carrying additional information.**

- **LP-WUS Monitoring Scheme**

- RAN1 studied Duty Cycled Monitoring (DCM) and Continuous Monitoring (CM) scheme.
- DCM maintain good power consuming even at higher power consumption of LP-WUR (10+) → smaller NF, better coverage
- CM does not provide power saving gain if power consumption is larger than 1 → higher NF, limited coverage
- → **DCM allows better coverage and relaxed requirement on implementation yet providing reasonable power saving gain.**

LP-WUS Techniques

- **Synchronization based on LP-SS**

- RAN1 studied low power sync signal (LP-SS) based synchronization mechanism.
- LP-SS is a new reference signal having the same waveform as LP-WUS.
- LP-SS transmission periodicity could be order of hundreds ms and its overhead is less than 0.4%.
- → LP-SS is used not only for synchronization but also for offloading RRM serving cell measurements from main radio to LP-WUR.

- **LP-WUS design**

- The number of information bits carried in LP-WUS should provide at least similar capability as PEI.
- For small number of bits e.g., < 8-10 bits, **sequence based WUS** could provide better performance. For longer length, payload based scheme could be considered. The comparison study of these two scheme needs to be done during WI.
- With OOK waveform, Manchester coding could be also considered, which allow full utilization of energy at Tx signal, helping symbol synchronization, easier detection, etc.
- → Consider sequence-based LP-WUS based on OOK waveform with Manchester coding.

- **Idle mode and Connected mode**

- LP-WUS usage in Idle mode provides higher / more convincing power saving gain than that in Connected mode.
- Connected mode gain is limited to applications w/ very sparse traffic such as Instant messaging (IM).
- → Put higher priority for Idle mode design of LP-WUS.

LP-WUS Techniques

- **RRM serving cell measurement offloading**

- In Idle/Inactive mode, much of the power consumption comes from RRM measurements.
 - LP-WUR may not be able to reduce power consumption by a significant amount if the Main Radio needs to wake up frequently to perform RRM measurements, e.g., for cell-selection.
- Neighbor cell monitoring is already allowed to be relaxed by Rel-17 RRM Relaxation; potential extension to serving cell would further reduce power consumption.

- Offloading RRM measurements from MR to LP-WUR provides even higher power saving gain.
- **Only serving cell measurements is offloaded.**
- The measurements are done based on periodic LP-SS.
- LP-SS based measurements and evaluation for serving cell needs to be supported by LP-WUR.
 - **RRM serving cell measurement offloading** to the LP-WUR is based on UE satisfying certain criteria.
- RAN4 reviewed the **RRM serving cell measurement offloading** study performed by RAN1 and confirmed that evaluation methodology used by RAN1 is reasonable.
 - RAN4 shall determine measurement offloading related aspects such as LP-SS measurement delays, measurement accuracy and target SNR conditions during the WI phase.

- **Proposal 2: Support RRM serving cell measurement offloading to LP-WUR.**

WI Scope for Rel-19 LP-WUS/WUR

- Specify OOK-based Low-power wake-up signal (LP-WUS) for RRC idle/inactive and connected mode [RAN1]
 - RRC idle/inactive mode for IoT use case is prioritized. Same design can apply to connected. No connected mode specific optimization.
 - Coverage target is PUSCH Msg3
 - WUS design is based on OOK sequence at least for small number of information bits.
 - Optional OFDM sequence overlaid on top of OOK symbol to improve detection performance rather than carrying additional information.
- Specify OOK-based low power synchronization signal (LP-SS) for synchronization of LP-WUR and RRM serving cell measurement by LP-WUR.
- Specify wake-up receiver (LP-WUR) procedures
 - L1/L2 procedures including duty cycled LP-WUS monitoring scheme, main radio wake-up operation, activation/deactivation of LP-WUS, LP-SS based synchronization [RAN1, RAN2]
 - RRM serving cell measurement offloading mechanisms to LP-WUR based on LP-SS for serving cell and LP-SS measurement metrics [RAN1,RAN2, RAN4]
 - Time/frequency tracking function, and beam management function, should be provided.
- Specify RAN4 core requirements for the above [RAN4]



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