**3GPP TSG RAN meeting #94e RP-21xxxx**

**Electronic Meeting, December 6 - 17, 2021 (revision of RP-212733)**

**Source: vivo (Moderator)**

**Title: New SID on low-power Wake-up Signal / Receiver for NR**

**Document for: Approval**

**Agenda Item: 8A.1**

3GPP™ Work Item Description

Information on Work Items can be found at <http://www.3gpp.org/Work-Items>
See also the [3GPP Working Procedures](http://www.3gpp.org/specifications-groups/working-procedures), article 39 and the TSG Working Methods in [3GPP TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm)

# Title: Study on low-power Wake-up Signal / Receiver

## Acronym: NR\_LP-WUSWUR

## Unique identifier: xxxxxx

|  |  |
| --- | --- |
| **This WID includes a Core part** |  |
| **This WID includes a Performance part** |  |

## 1 Impacts

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Affects:** | UICC apps | ME | AN | CN | Others (specify) |
| **Yes** |  | X | X |  |  |
| **No** | X |  |  |  | X |
| **Don't know** |  |  |  | X |  |

## 2 Classification of the Work Item and linked work items

### 2.1 Primary classification

This work item is a

|  |  |
| --- | --- |
|  | Feature |
|  | Building Block |
|  | *Work Task* |
| X | Study Item |

### 2.2 Parent Work Item

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| Parent Work / Study Items  |
| Acronym | Working Group | Unique ID | Title (as in 3GPP Work Plan) |
|  |  |  |  |

### 2.3 Other related Work Items and dependencies

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| --- |
| Other related Work Items (if any) |
| Unique ID | Title | Nature of relationship |
| 860035 | Study on support of reduced capability NR devices |  |
| 860047 | UE power saving enhancements for NR |  |
| 900062 | Support of reduced capability NR devices |  |

## 3 Justification

5G systems are designed and developed targeting for both mobile telephony and vertical use cases. Besides latency, reliability, and availability, UE energy efficiency is also critical to 5G. Currently, 5G devices may have to be recharged per week or day, depending on individual’s usage time. In general, 5G devices consume tens of milliwatts in RRC idle/inactive state and hundreds of milliwatts in RRC connected state. Designs to prolong battery life is a necessity for improving energy efficiency as well as for better user experience.

Energy efficiency is even more critical for UEs without a continuous energy source, e.g., UEs using small rechargeable and single coin cell batteries. Among vertical use cases, sensors and actuators are deployed extensively for monitoring, measuring, charging, etc. Generally, their batteries are not rechargeable and expected to last at least few years as described in [TR 38.875]. Wearables include smart watches, rings, eHealth related devices, and medical monitoring devices. With typical battery capacity, it is challenging to sustain up to 1-2 weeks as required.

The power consumption depends on the configured length of wake-up periods, e.g., paging cycle. To meet the battery life requirements above, eDRX cycle with large value is expected to be used, resulting in high latency, which is not suitable for such services with requirements of both long battery life and low latency. For example, in fire detection and extinguishment use case, fire shutters shall be closed and fire sprinklers shall be turned on by the actuators within 1 to 2 seconds from the time the fire is detected by sensors, long eDRX cycle cannot meet the delay requirements. eDRX is apparently not suitable for latency-critical use cases. Thus, the intention is to study ultra-low power mechanism with low latency in Rel-18.

Currently, UEs need to periodically wake up once per DRX cycle, which dominates the power consumption in RRC idle/inactive state. If UEs are able to wake up only when they are triggered, e.g., paging, power consumption could be dramatically reduced. This can be achieved by using a wake-up signal to trigger the main radio and a separate receiver which has the ability to monitor wake-up signal with ultra-low power consumption. Main radio works for data transmission and reception, which can be turned off or set to deep sleep unless it is turned on.

The power consumption for monitoring wake-up signal depends on the wake-up signal design and the hardware module of the wake-up receiver used for signal detecting and processing.

## 4 Objective

### 4.1 Objective of SI

The study should primarily target low-power WUS/WUR required by IoT use cases, i.e., power-sensitive, small form-factor devices such as industrial sensors or controllers. Other use cases are not precluded.

As opposed to the work on UE power savings in previous releases, this study will not require existing signals to be used as WUS. All WUS solutions identified shall be able to operate in a cell supporting legacy UEs. Solutions should give justifiable gains compared to the existing Rel-15/16/17 UE power saving mechanisms. Aspects such as UE power consumption, detection performance, coverage, UE complexity, should be covered by the evaluation.

**The study item includes the following objectives:**

* Identify use cases, evaluation methodology & KPIs [RAN1]
* Study and evaluate low-power wake-up receiver architectures [RAN1, RAN4]
* Study and evaluate wake-up signal designs to support wake-up receivers [RAN1, RAN4]
* Study and evaluate L1 procedures and higher layer protocol changes needed to support the detection of wake-up signals [RAN2, RAN1]
* Study potential system impact, such as network power consumption, coexistence with non-low-power-WUR UEs, network coverage/capacity, latency, and gains compared to the existing Rel-15/16/17 UE power saving mechanisms [RAN1, RAN2]

### 4.2 Objective of Performance part WI

### 4.3 RAN time budget request

**additional comments to the time budget request in the attached Excel table:**

## 5 Expected Output and Time scale

|  |
| --- |
| **New specifications** *{One line per specification. Create/delete lines as needed}* |
| Proposed Spec no. or series | Type (see note 1)  | Title | For info at TSG#  | For approval at TSG# | Remarks |
| 38.8xx | TR | *Study on low-power wake up signal / receiver for NR* | RAN#101(Sep. ’23) | RAN#102(Dec. ’23) | *TR rapporteur:* *Xiaodong Shen, vivo,*shenxiaodong@vivo.com |
|  |  |  |  |  |  |

|  |
| --- |
| **Impacted existing TS/TR** *{One line per specification. Create/delete lines as needed}* |
| TS/TR No. | Description of change  | Target completion plenary# | Remarks |
|  |  |  |  |
|  |  |  |  |

## 6 Work item Rapporteur(s)

Xiaodong Shen, vivo, shenxiaodong@vivo.com

## 7 Work item leadership

Primary: RAN WG1

Secondary: RAN WG2, WG4

## 8 Aspects that involve other WGs

## 9 Supporting Individual Members

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| Supporting IM name |
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