**3GPP TSG RAN meeting #94e RP-213593**

**Electronic Meeting, December 6 - 17, 2021 (revision of RP-213563)**

**Source: vivo**

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

## Acronym: FS\_NR\_LPWUS

## 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

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

### 2.3 Other related Work Items and dependencies

|  |  |  |
| --- | --- | --- |
| 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 |  |
| 800094 | Study on UE Power Saving in NR |  |
| 830175 | UE Power Saving in NR |  |

## 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 that can support low latency in Rel-18, e.g. lower than eDRX latency.

Currently, UEs need to periodically wake up once per DRX cycle, which dominates the power consumption in periods with no signalling or data traffic. 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.

The study should primarily target low-power WUS/WUR for power-sensitive, small form-factor devices including IoT use cases (such as industrial sensors, controllers) and wearables. Other use cases are not precluded, e.g.XR/smart glasses, smart phones.

## 4 Objective

### 4.1 Objective of SI

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 target substantial gains compared to the existing Rel-15/16/17 UE power saving mechanisms, where the gains may include UE power saving and/or lower latency. Other aspects such as detection performance, coverage, UE complexity, should be covered by the evaluation.

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

* Identify use cases to focus, evaluation methodology & KPIs [RAN1]
  + Prioritize IoT and wearable use cases.
  + The KPIs include at least UE power consumption, coverage and wake-up latency.
* 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 wake-up signals [RAN2, RAN1]
* Study potential UE power saving gains compared to the existing Rel-15/16/17 UE power saving mechanisms and their coverage availability, as well as latency impact. System impact, such as network power consumption, coexistence with non-low-power-WUR UEs, network coverage/capacity/resource overhead should be included in the study [RAN1]
  + Note: The need for RAN2 evaluation will be triggered by RAN1 when necessary.

### 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 | Internal TR | *Study on low-power wake up signal and receiver for NR* | RAN#101 (Sep. ’23) | RAN#102 (Dec. ’23) | *TR rapporteur:*  *Xiaodong Shen, vivo,*  [*shenxiaodong@vivo.com*](mailto:shenxiaodong@vivo.com)  *The TR is led by RAN1.* |
|  |  |  |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **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](mailto:shenxiaodong@vivo.com)

## 7 Work item leadership

Primary: RAN WG1

Secondary: RAN WG2, WG4

## 8 Aspects that involve other WGs

## 9 Supporting Individual Members

|  |
| --- |
| Supporting IM name |
| vivo |
| Guangdong Genius |
| Panasonic |
| Spreadtrum |
| CAICT |
| InterDigital |
| Everactive |
| FUTUREWEI |
| Apple |
| CATT |
| Qualcomm |
| Sony |
| Philips |
| Xiaomi |
| SHARP |
| NTT DOCOMO |
| Ericsson |
| Lenovo |
| Motorola Mobility |
| Transsion |
| CEWiT |
| ZTE corporation |
| Sanechips |
| Samsung |
| Continental Automotive |
| OPPO |
| Robert Bosch GmbH |
| Huawei |
| HiSilicon |
| Nokia |
| Nokia Shanghai Bell |
| Intel |
| Vodafone |
| Fraunhofer IIS |
| Fraunhofer HHI |
| CMCC |
| China Telecom |
| LG Electronics |
| China Unicom |
| Verizon |
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