3GPP TSG-RAN2 Meeting #123-bis R2-231xxxx

Xiamen, China, 9~14 October 2023

Agenda Item: 7.22.3

Source: Qualcomm

Title: Summary of [Post123][060][LPWUS] Low-power receiver in RRC Connected (Qualcomm)

Document for: Discussion and Decision

# **Introduction**

This report provides a summary of the following post-meeting email discussion:

* [Post123][060][LPWUS] Low-power recevier in RRC Connected (Qualcomm)

 Scope: Collect comments for and if possible progress proposals in RAN2 scope (e.g. impact to / relation to DRX, other MAC impacts). Can also collect comments for and discuss proposals for which RAN2 impact is not clear yet (e.g. not clear if MAC impact etc), up to Rapporteur what to include.

 Intended outcome: Report with agreeable points, points for discussion, FFS points, pave the way for a first set of agreements etc for RRC Connected.

 Deadline: Long

The deadlines for this discussion are the following:

* **September 19th 18:00 UTC:** deadline forcompanies’ feedback;
* **September 20th 18:00** **UTC**: deadline for the rapporteur to provide a summary for review;
* **September 22nd 18:00 UTC**: hard deadline for companies’ feedback on the summary.

# **Contact information**

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# **Discussion**

Per instruction by the Chair, the objective of this email discussion is to discuss possible use cases of low-power receiver in RRC Connected. The discussion points are generated based on proposals in the submitted contributions ([1]~[12]). If possible, we will try to produce a set of proposals for discussion and agreement at the next RAN2 meeting (RAN#123bis).

As this email discussion is for the SI, the rapporteur would like to suggest that we focus our discussion only on stage-2 issues. The discussion is organized into four areas, as follows:

* Whether and how LP-WUS may be used outside DRX active time (e.g. similar to legacy wakeup signaling for DRX on duration);
* Whether and how LP-WUS may be used inside DRX active time (e.g. associated with PDCCH monitoring adaptation);
* Whether and how LP-WUS may be used for RRM measurements in RRC Connected;
* Options for de-/activating LP-WUS monitoring.

## LP-WUS outside DRX active time

Many contributions have proposed that LP-WUS can be used in conjunction with DRX, e.g. LP-WUS is monitored outside DRX active time and can be used to wake up MR to start procedures related to DRX on duration timer ([1][4][5][6][7][8][9][10][11][12]).

However, there are different views on how exactly LP-WUS may be used in this use case. More specifically, the proposals may be classified into the following three options:

* LP-WUS replaces DCP and these two types of wakeup signals are not configured/used simultaneously ([4][5][6][10][11][12]);
* Both LP-WUS and DCP can be configured for a UE. However, UE may use only one of them at any time, e.g. depend on network configuration or link quality, etc. ([1][4][6][9]);
* LP-WUS is used in conjunction with DCP, e.g. LP-WUS first wakes up MR, which then monitors DCP ([4][6][8] [10][12]).

Next, we first discuss whether the use of LP-WUS outside DRX active time should be studied. Then for

**Q1. Which one of the following options do you support on the use of LP-WUS outside DRX active time, in which case LP-WUS wakes up MR to start procedures related to DRX timer(s)?**

1. **There is no need to study the use of LP-WUS for waking up MR to start procedures related to DRX timer(s);**
2. **LP-WUS replaces DCP and these two types of wakeup signals are configured/used simultaneously;**
3. **Both LP-WUS and DCP can be configured for a UE. However, UE may use only one of them at any time, e.g. depend on network configuration or link quality, etc.**
4. **LP-WUS is used in conjunction with DCP, e.g. LP-WUS first wakes up MR, which then monitors DCP.**

You may select more than one option in your reply.

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## LP-WUS and PDCCH monitoring adaptation

There are proposals on using LP-WUS to enhance legacy PDCCH monitoring adaptation (e.g. PDCCH skipping, SSSG switching, etc):

* In [1] [9], it is proposed that LP-WUS can be used to resume/activate PDCCH monitoring during active time;
* In [2], it is proposed that LP-WUS can be used to control PDCCH monitoring at any time;
* In [6], it is proposed to study the relationship between LP-WUS and legacy UE power saving techniques, e.g. C-DRX, DCP, PDCCH skipping, SSSG switching.

In legacy, PDCCH monitoring adaption has been mostly in RAN1’s domain and transparent to upper layers, with certain exceptions (e.g. UL transmissions such as SR triggers termination of PDCCH skipping). Therefore, the rapporteur would like to suggest that we discuss this topic from RAN2’s perspective, e.g. whether such a use case should be supported; if so, what RAN2 impacts should be studied.

**Q2. From RAN2’s perspective, do you think it is beneficial to support use of LP-WUS in conjunction with legacy PDCCH monitoring adaptation features (e.g. use cases listed above)? Or do you see any critical issues that prevent such uses (from RAN2’s perspective)?**

You may provide different answers to different specific use cases.

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| **Company** | **Yes (beneficial)****/No (issues)** | **Comments** (Please provide reasons if possible)  |
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**Q3. If you answered ‘Yes’ to Q3, what should RAN2 study to support the proposed enhancements?**

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## Use of LP-WUS in RRM measurement

There are multiple contributions discussing the use of low-power radio/signaling in RRM measurements but with mixed views. For example,

* In [1][10], it is proposed that LP-WUR can be used for serving cell measurements or neighbor cell measurements to reduce the use of measurement gaps;
* In [2][7], it is argued that RRM measurement by MR is enough for RRC connected. Use of LP-WUR for RRM measurements is not well justified.
* In [5][8][9], it is proposed that the study for RRM measurements based on LP-WUS in RRC Connected can be postponed until its feasibility is confirmed by RAN1 and RAN4.

The rapporteur thinks that these three views cover most of the possible options and hence would like to invite your views on them. When you comment, please keep in mind that our discussion here is only from RAN2’s perspectives.

**Q4. Which of the following three views would you support?**

1. **In RRC Connected, LP-WUR can be used for serving cell measurements and/or neighbor cell measurements (additional options in Q5);**
2. **Use of LP-WUR for RRM measurements in RRC connected is not studied.**
3. **The study for use of LP-WUR for RRM measurements in RRC Connected can be postponed until its feasibility is confirmed by RAN1 and RAN4.**

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**Q5. If you selected Option 1 in Q4, please indicate which one of the following options you support:**

1. **LP-WUR is used only for serving cell RRM measurements;**
2. **LP-WUR is used only for neighbor cell RRM measurements;**
3. **LP-WUR can be used for any type of RRM measurements.**

You may select more than one option. All options are for RRC Connected.

Again, our discussion here is only from RAN2’s perspective, if RAN1/4 can confirm their feasibility.

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## De-/activation of LP-WUS

There are a number of contributions discussing conditions for de-/activating LP-WUS monitoring ([1][4][5][6]). Since the proposals are rather diverse, the rapporteur summarize them as follows:

* Monitoring of LP-WUS is de-/activated based on NW indication;
* Network pre-configures UE with criteria for monitoring LP-WUR. UE then autonomously de-/activate its monitoring based on its evaluation whether the configured criteria is met.
* UL transmissions can be an additional criterion for UE to de-activate its monitoring.

**Q6. Which one of the following options do you support:**

1. **There is no need to study de-/activation of LP-WUS monitoring or it can be postponed to WI phase;**
2. **De-/activation of LP-WUS monitoring is based on network indication;**
3. **UE autonomously de-/activates its monitoring based on whether configured criteria are met or not;**
4. **UL transmissions can be an additional criterion for UE to de-activate its monitoring;**
5. **Other.**

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## Other issues

Please comment in the table below if you think there are other issues that should be studied but have been missed in the questions above.

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| **Company** | **Issues** (Please be specific, if possible) |
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# **Conclusions**

(To be added later)

# References

1. R2-2204523, Use of low-power receiver in RRC Connected, Qualcomm Incorporated.
2. R2-2307308, Discussion on LP-WUS/WUR in RRC\_Connected, vivo.
3. R2-2307260, Discussion on LP-WUR’s operation, OPPO.
4. R2-2307345, Discussing on LP-WUS monitoring for RRC\_Connected, Xiaomi Communications.
5. R2-2307424, Discussion on LP-WUS in RRC\_CONNECTED state, CATT.
6. R2-2307449, High layer procedures for LP-WUS in RRC\_CONNECTED state, Huawei, HiSilicon.
7. R2-2307462, Discussion on the considerations for LPWUS in RRC\_CONNECTED, NEC Corporation.
8. R2-2307592, RAN2 impacts of LP-WUS in connected mode ZTE Corporation, Sanechips.
9. R2-2307849, RAN2 impact of LP-WUS in RRC\_CONNECTED state, Apple.
10. R2-2308461, LP-WUS in RRC Connected Mode, Lenovo.
11. R2-2308532, Discussion on LP-WUS in RRC\_CONNECTED, Continental Automotive .
12. R2-2308810, LP-WUS/WUR for RRC Connected, Ericsson.