**3GPP TSG-RAN WG2 Meeting #131 R2-250xxxx**

Bangalore, India, 25th – 29th August 2025

**Agenda item: 8.4.2**

**Source: Huawei/HiSilicon**

**Title: Summary of [Post130][222][LPWUS] Potential solution to support enabling/disabling LP-WUS monitoring in IDLEI/NACTVE per UE (Huawei)**

**WID: NR\_LPWUS-Core**

**Document for: Discussion and Decision**

# Introduction

This document aims to collect views from companies for the following email discussion:

* [Post130][222][LPWUS] Potential solution to support enabling/disabling LP-WUS monitoring in IDLE/INACTVE per UE (Huawei)

Intended outcome: Summary with proposals

Deadline: Long

Rapporteur would like to organize the email discussion in two phases:

Phase 1: Companies are invited to provide comments to the questions by 4th July.

Phase 2: Rapporteur provides the summary report + proposals by 15th July. Companies can further comment by 31st July; Rapporteur will finalize the summary + proposals by 8th August.

Please provide your contact information when responding.

|  |  |
| --- | --- |
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# Discussion

RAN2 discussed the summary of AT meeting email discussion on enabling/disabling of LP-WUS in RAN2-130. Below is the related excerpt from the chairman notes:

|  |
| --- |
| R2-2504738 Summary of [AT130][204][LPWUS] Proposals on whether/how to enable/disable LP-WUS, e.g. by RRC/NAS Huawei, HiSilicon discussion Rel-19   * Noted   *Proposal 1 (13/17): Support enabling/disabling LP-WUS monitoring in IDLE/INACTVE per UE.*  *Proposal 2 (13/17): A unified solution is preferred to enable/disable LP-WUS monitoring in IDLE/INACTIVE per UE.*  *Proposal 3: FFS how to enable/disable LP-WUS per UE for IDLE and INACTIVE. Following options can be considered: 1) NAS signalling 2) RRC signalling 3) both NAS and RRC signalling 4) No spec changes (i.e., if no convergence on NAS or RRC signalling)*  Discussions  - HW think P3 requires more discussion.  P1  - Samsung think it should be per cell, but do not have objection.  - vivo support P1. As WI rapp, vivo think it is end of the release so it we decided to do so we need to discuss solutions in the post meeting email and we need to inform our conclusion to other TSG/WG (e.g., R3, CT1). ZTE, Ericsson, NEC think this is reasonable.  - QC think before P1 we need to decide on P3 because we do not know what is the solution. QC think this is optimization and nothing is broken without it. Xiaomi, OPPO, Lenovo share this view.  - Xiaomi think SA2 is considering removing restriction for emergency service even for PEI, so in R2 we do not need to do anything.  - ZTE think we can conclude in R2 that we aim to support but keep the solutions open. Interdigital agree.  - Interdigital do not think LS to other WG/TSG is urgent. Ericsson think the impact is rather low.  - Nokia wonders whether it mandates UE to enable/disable. NEC think not.  - Apple think we do not need to do more, and think we do not have time. Lenovo also think so.  - CATT think we can rely on UE implementation and close the issue from R2 point of view.  - WI rapp think the conclusion of this issue does not impact the WID completion.  - DCM think from operator point of view we need to support a solution.   * RAN2 aim at supporting enabling/disabling LP-WUS monitoring in IDLE/INACTVE per UE, if the solution can be concluded in the August meeting.   P3  - Samsung think there is one more option, which is to use CN-based subgrouping. Apple agree. |

As there was no consensus on the solution to support enabling/disabling LP-WUS monitoring in IDLE/INACTIVE per UE, the email aims to collect the views from companies to check if a conclusion can be reached for the next meeting.

Before discussing the issue, let’s revisit the procedures for CN controlled and UE-ID based subgrouping methods described in Stage 2 running CR for LP-WUS [6]. AMF is responsible for assigning CN subgroup ID during the registration procedure as shown in Figure 1. Steps 1 to 3 in the Figure are part of Registration Procedure via NAS signalling.



Figure : Procedure for CN controlled subgrouping (from 38.300 running CR)

For UE-ID based subgrouping, the gNB and UE can determine the subgroup ID based on the UE ID and the total number of subgroups for UE-ID based subgrouping in the cell. The procedure is shown in Figure 2.



Figure : Procedure for UE-ID based subgrouping (from 38.300 running CR)

## Reasons to support enabling/disabling of LP-WUS for a UE

Companies presented different technical arguments on why disabling and re-enabling LP-WUS for a UE is needed. Following is a short summary of the arguments:

* + - Reducing false paging probability or increasing the reachability of the UE: NW (CN or RAN) decides whether to disable LP-WUS based on the conditions in the NW (e.g., radio resources) and/or characteristics of the UE (e.g., paging probability, shorter DRX cycle, etc) [1][2][3]
    - Disabling for UEs with delay-sensitive services: the UEs with delay-sensitive services may not be suitable to monitor LP-WUS considering the possible large wake up latency caused by LP-WUS which may have unexpected impacts on the delay-sensitive service [3][4][5]
    - Power Consumption: if the paging probability is high for some specific UEs, there will be frequent transitio
    - It’s better these specific UEs do not monitor LP-WUS [3]

## Different solution options to support enabling/disabling of LP-WUS for a UE

There are mainly three directions to disable/re-enable LP-WUS operator for a UE.

* NAS signalling
* RRC signalling
* No NAS/RRC spec changes
  + Apple’s method
  + CATT’s method

The following sections describe each option.

### NAS signalling

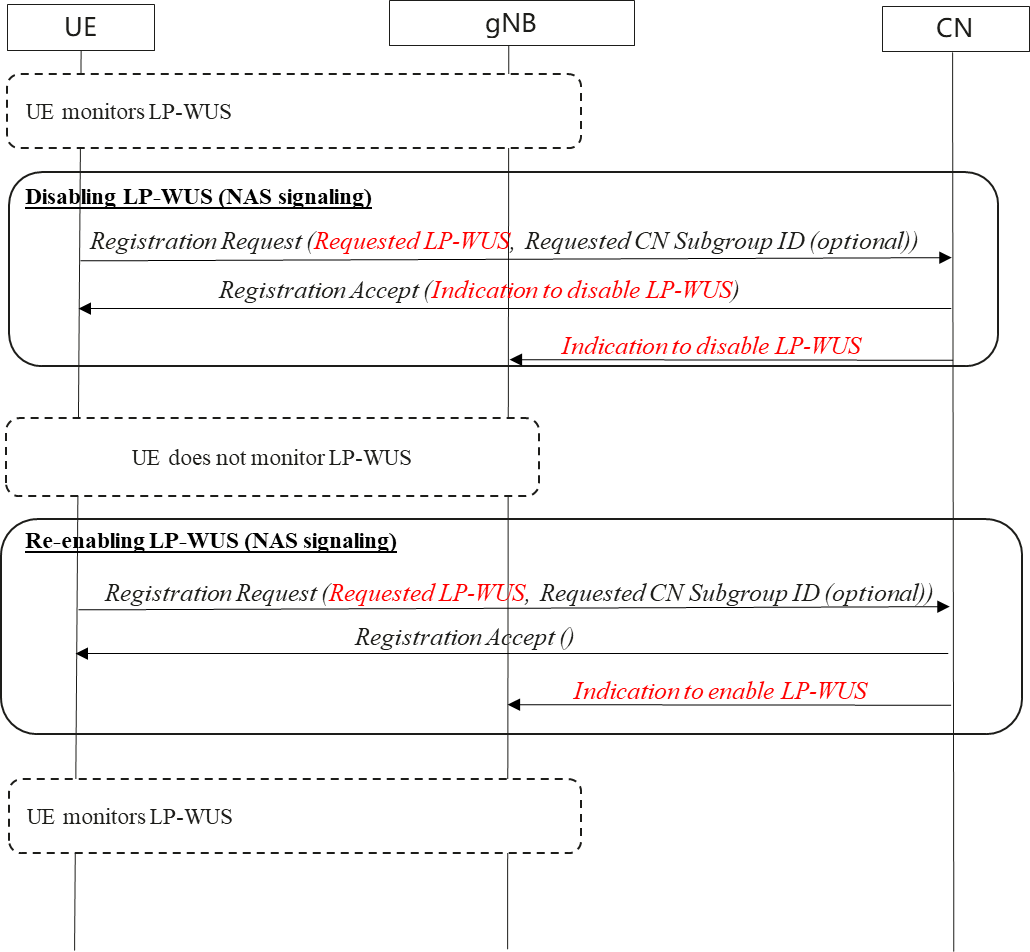


Figure : Disabling/Enabling of LP-WUS with NAS signaling

Assume that the UE is monitoring LP-WUS. CN decides to disable LP-WUS for the UE due to some conditions in the PLMN.

A brief description of the procedure and its impact to other WGs:

* **Disabling LP-WUS:** CN indicates explicitly to the UE to disable LP-WUS in the registration procedure. Even though the solution details are up to CT1, a new parameter “*Requested LP-WUS*” in Registration Request is needed. Otherwise CN is not aware whether UE supports LP-WUS or not if UE does not include the optional parameter “*Requested CN Subgroup ID*”
* **Enabling LP-WUS:** If the conditions in the NW are favourable to re-enable LP-WUS, CN will enable it in the subsequent registration procedure.
* **Impacts to other WGs:**
  + RAN3 and CT1

### RRC Signalling

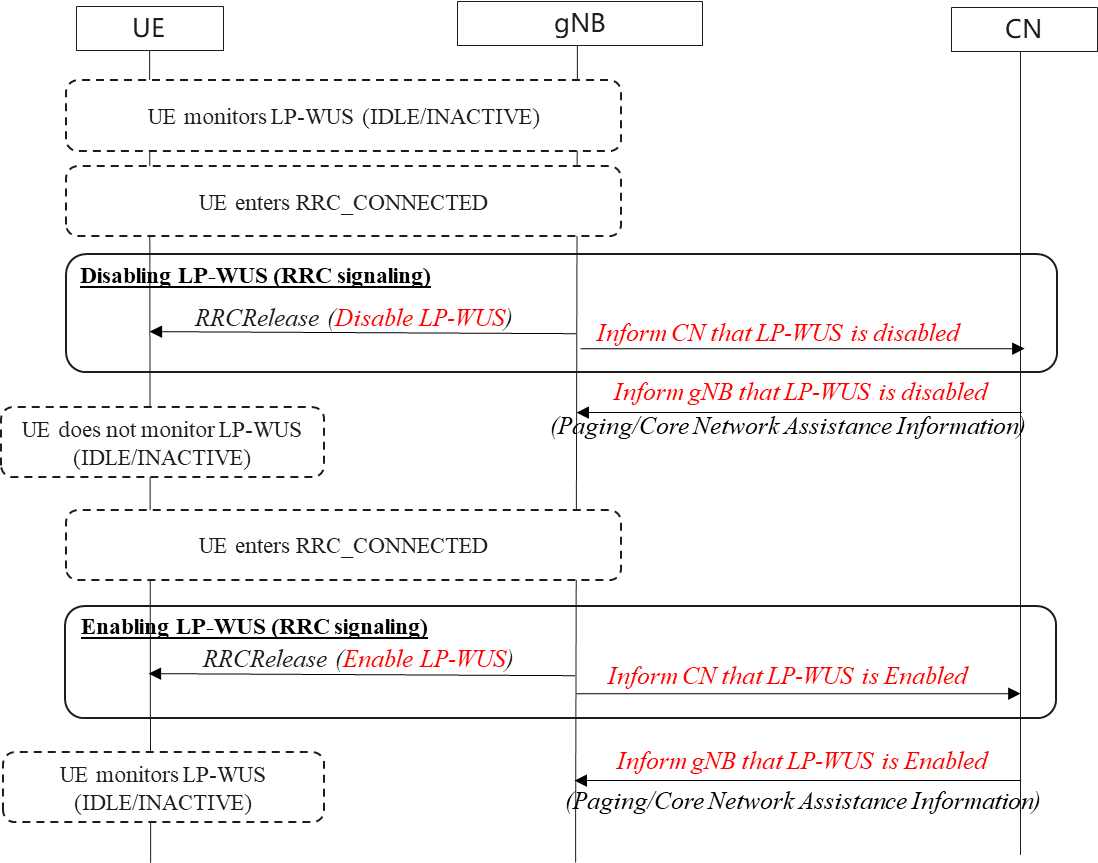


Figure : Disabling/Enabling of LP-WUS with RRC signaling

Assume that the UE is monitoring LP-WUS. RAN decides to disable LP-WUS for the UE due to some conditions in the NW.

A brief description of the procedure and its impact to other WGs:

* **Disabling LP-WUS:** gNB indicates explicitly to the UE to disable LP-WUS in *RRCRelease*. gNB also informs CN that LP-WUS is disabled for the UE so that CN does not use CN subgrouping. CN further informs gNB about disabling of LP-WUS in Paging and Core Network Assistance Information for RRC\_INACTIVE.
* **Enabling LP-WUS:** If the conditions in the NW are favourable to re-enable LP-WUS, gNB will enable it in the subsequent *RRCRelease*. gNB informs CN and CN will also include the information for Paging and Core Network Assistance Information procedures.
* **Impacts to other WGs:**
  + RAN3 and CT1

### No NAS/RRC changes

Apple proposed method addresses the issue without any changes to the spec [7].

CATT proposed method addresses the issue without any changes to NAS/RRC spec [8].

#### Apple’s method

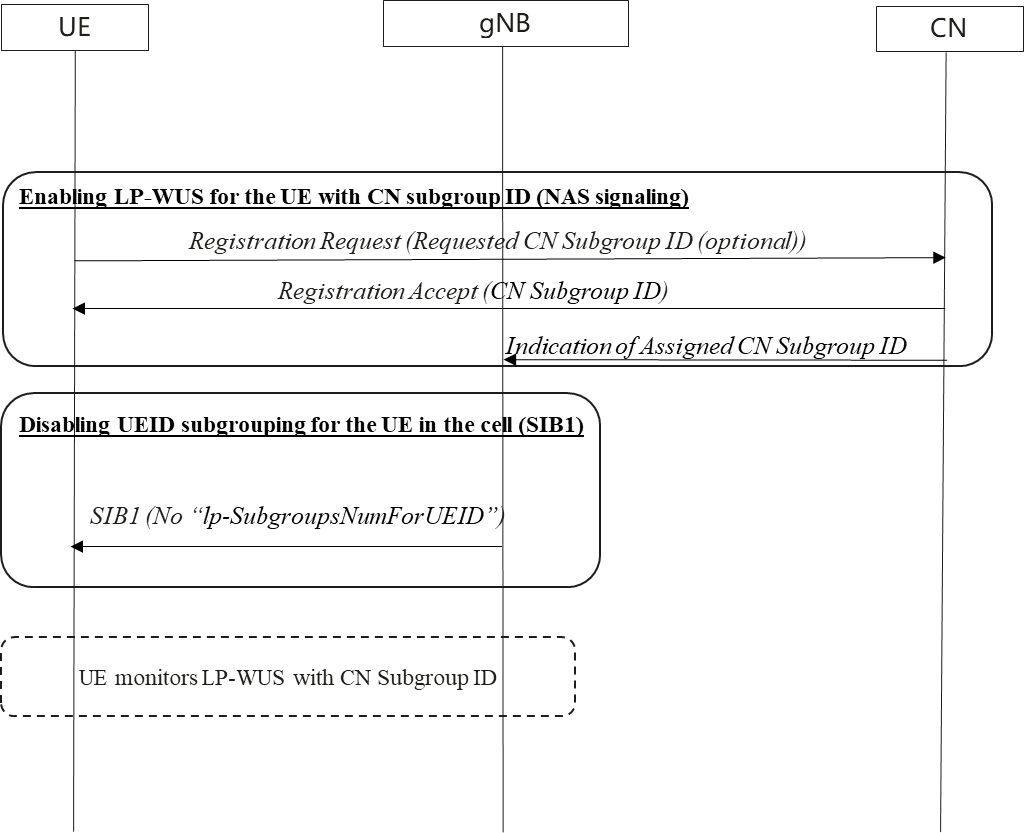


Figure : Enabling UE specific LP-WUS monitoring control by enabling the CN based subgrouping method in a cell

Figure 5 shows enabling UE specific LP-WUS monitoring by enabling CN subgrouping in a cell.

* CN enables CN subgrouping during registration procedure.
* gNB does not include “*lp-SubgroupsNumForUEID*” in SIB1. This implies that UE monitors LP-WUS with CN subgroup ID.

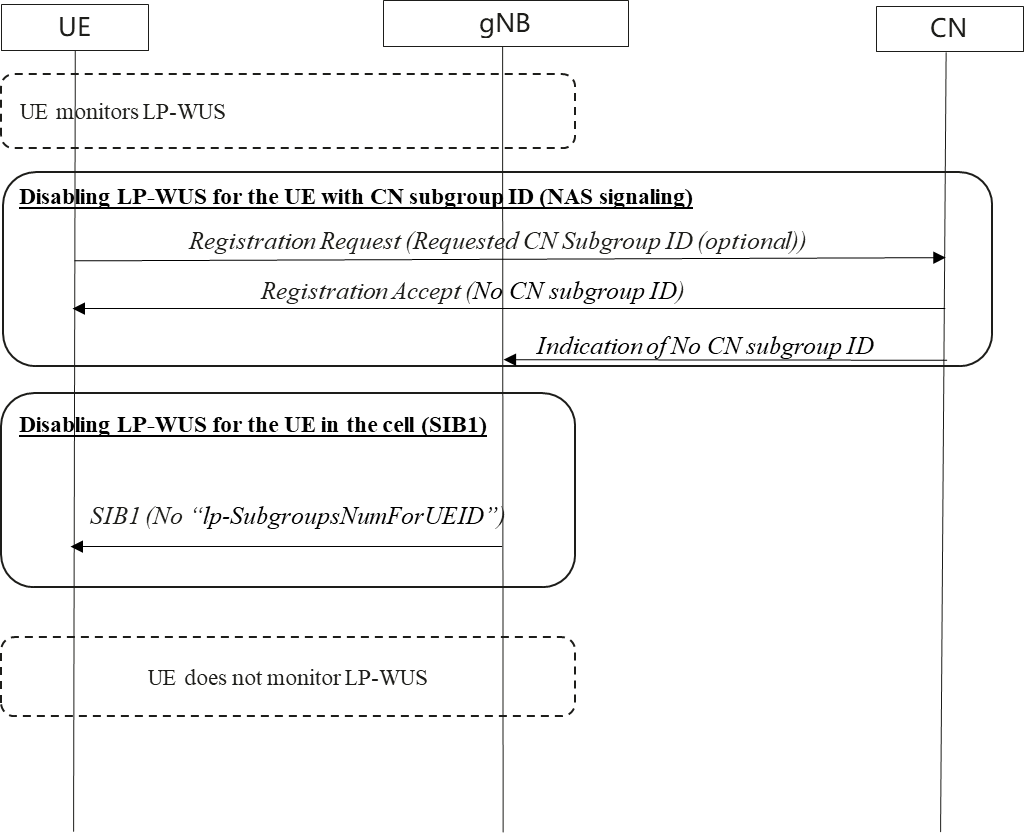


Figure : Disabling UE specific LP-WUS monitoring control for a particular UE by disabling CN based subgrouping method in a cell

Figure 6 shows disabling UE specific LP-WUS monitoring by disabling CN subgrouping:

* CN disables CN subgrouping during registration procedure
* gNB does not include “*lp-SubgroupsNumForUEID*” in SIB1. This implies that UE will not monitor LP-WUS as it is not assigned either CN subgrouping or UE-ID based subgrouping

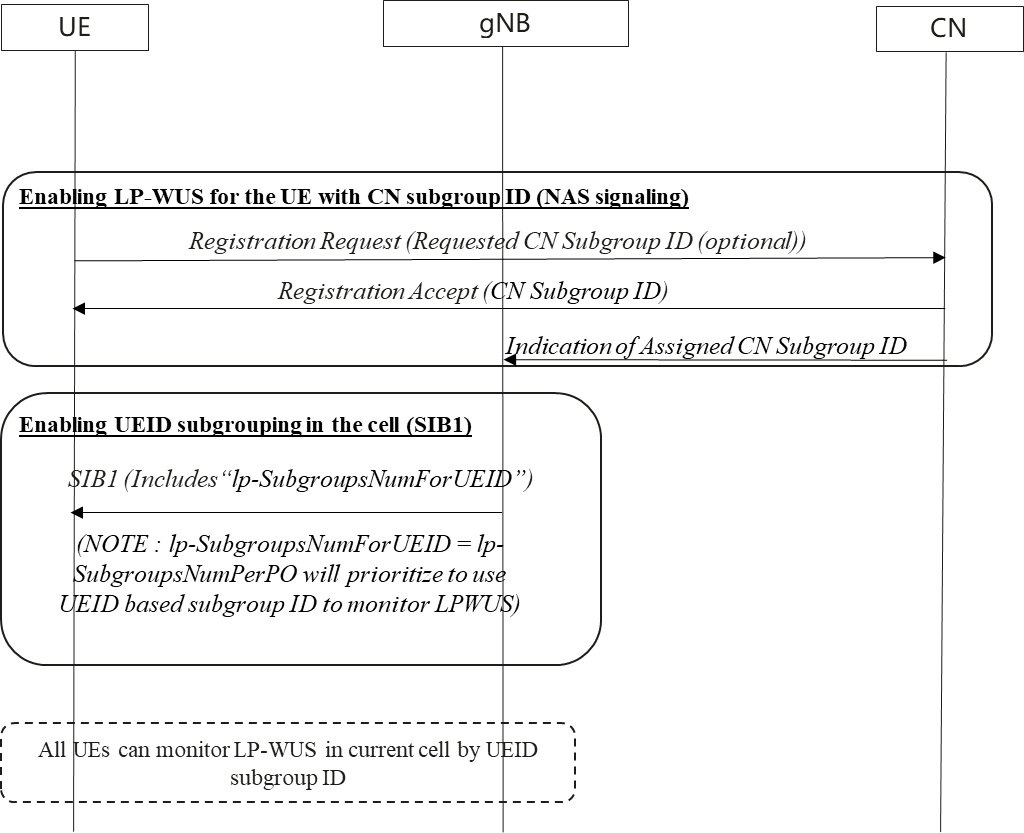


Figure : Enabling UE specific LP-WUS monitoring control in cell level by enabling UE-ID based subgrouping method in a cell

Figure 7 shows the procedure to disable UE specific LP-WUS in a cell (i.e., all UEs can monitor LP-WUS):

* CN enables CN subgrouping during registration procedure
* gNB includes “*lp-SubgroupsNumForUEID*” in SIB1. (NOTE: if *lp-SubgroupsNumForUEID* = *lp-SubgroupsNumForPO, UE-ID based subgrouping will be prioritized to monitor LP-WUS)*
* All UEs can monitor LP-WUS in current cell by UE-ID based subgrouping.

#### 2.2.3.2 CATT’s method

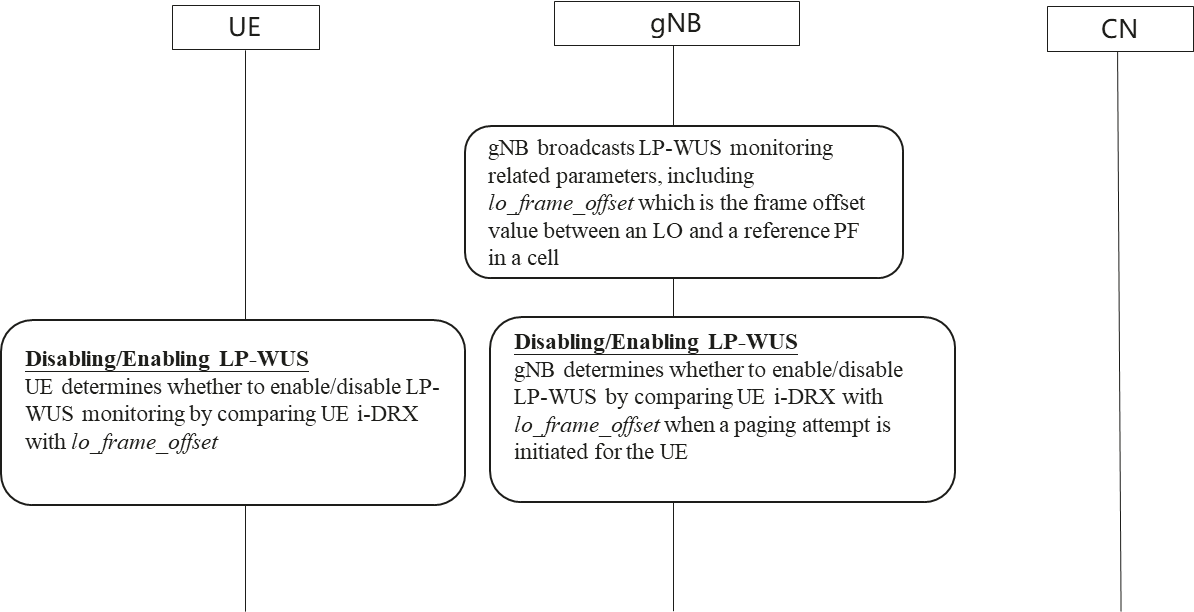


Figure : UE/gNB autonomously decides whether to enable/disabling LP-WUS monitoring

Figure 8 shows the procedure for the UE/gNB to enable/disable autonomously:

* Whether UE is using UE-ID or CN based subgroup does not matter.
* UE/gNB determines whether to enable/disable LP-WUS monitoring by comparing UE i-DRX (i,e., DRX cycle of the UE as specified in TS 38.304) with *lo\_frame\_offset*. If UE i-DRX is no less than the value of *lo\_frame\_offset*, the UE/network enables LP-WUS monitoring. Otherwise, the UE/network disables LP-WUS monitoring.
* Impact to other WGs:
* Only impact RAN2 without RRC spec change.

## Questions

#### Q: Which solution option(s) do companies prefer?

|  |  |  |
| --- | --- | --- |
| Company | Preferred Option | Comments |
| Ericsson | NAS signalling |  |
| CATT | CATT’s method | We think the main motivation to support enabling/disabling of LP-WUS for a UE is reduce the possible large wake up latency. Because LP-WUS has maximum 31 sub-groups, so that false paging probability is not a big issue. And if frequent transition between MR and LR impacts the power saving, smart UEs can decide not to monitor LP-WUS with UE implementation.  Thus, we prefer the method in clause 2.2.3.2, i.e., CATT method. UE/gNB determines whether to enable/disable LP-WUS monitoring by comparing UE i-DRX (i,e., DRX cycle of the UE as specified in TS 38.304) with *lo\_frame\_offset*. This method doesn’t impact other WGs. It only impacts RAN2 in TS 38.304.  For the method in clause 2.2.3.1, i.e., Apple’s method, we wonder how to disable LP-WUS for a UE if the UE doesn’t support CN assigned subgrouping for LP-WUS. |
| InterDigital | NAS signalling and RRC signalling | In our view, to reduce wake-up latency due to LP-WUS monitoring, one method with signalling (RRC-based or NAS-based) is necessary and at least network can control LP-WUS monitoring function for latency reduction purpose.  We support both solutions since both NW entity (CN node or gNB) can control and be involved (i.e., LP-WUS enabling/disabling) with different layers and signalling per a UE. If RAN2 needs to down-select one of them, then prefer RRC signalling, otherwise both approaches are fine. |
| DOCOMO | RRC signalling (and NAS signalling) | We prefer RRC signalling but are open to support NAS signalling in addition to RRC signalling.  RRC\_IDLE and RRC\_INACTIVE handling is based on gNB. As gNB has more knowledge of the situation in its serving cell and can toggle LP-WUS monitoring on every RRC transition to IDLE/INACTIVE if needed, RRC signalling should be suitable. On the other hand, NAS signalling may be preferrable to disable LP-WUS for power consumption reduction when eDRX cycle length is long because eDRX related parameters are determined by NAS signalling.  Regarding the Apple’s method, we share the same comment as CATT. It seems unclear how to disable LP-WUS if the UE does not support the CN assigned subgrouping.  For the CATT’s method, we think it is more complicated compared to the RRC and NAS signalling method in Section 2.2 as UE/gNB interpretations on the parameters are required. Therefore, we do not prefer it at this moment. However, if it is difficult to converge on the RRC and/or NAS signalling method due to the other WG impact, we would be fine to live with it. |
| NEC | RRC or NAS | We support dedicated enable/disable, can be open for both and will follow the one for which majority support.  BTW, for the method of RRC, one comment for the Figure-4 is that once CN receives LP-WUS enable/disable indication, **CN does not have to send this indication within *Core Network Assistance information for RRC\_INACTIVE*** as the gNB itself is aware of whether LP-WUS is enabled or disabled when initiating Uu paging for RRC\_INACTIVE UE or initiating Xn RAN paging msg.  The basic principle should be for RRC method, gNB informs CN of LP-WUS status while for NAS method, CN informs gNB of LP-WUS status. And when paging procedure is initiated, LP-WUS enable/disable will be indicated by Xn/Ng paging message (e.g., by UE radio paging capability). |
| Lenovo | Apple’s Method (or CATT’s Method) | We do not support dedicated enable/ disable of LP-WUS for Idle/ Inactive modes.  We do not think the motivation to support such signalling at the end of the release is well-justified.  False alarm is not a critical issue since LP-WUS is designed with 31 subgroups.  Latency also seems to not be critical since LP-WUS in Idle/ Inactive mode is mainly used for paging and that is generally not a latency-sensitive procedure.With respect to frequent transitions between MR and LR, we think that having different entry/ exit conditions on different radios already address this issue.  Since most companies would like to support having dedicated enable/ disable of LP-WUS, we are okay to support Apple’s or CATT’s method as a compromise since we would like to have minimal spec impact. |
| vivo | 1st priority: NAS  2nd priority: RRC | We prefer to have a solution that the network could enable/disable the LP-WUS functionality per UE. It should be up to NW to decide whether/how to control the UE to be able to use LP-WUS or not.  In our understanding, CN has more information on paging probability/UE type/service requirement information, etc., so NAS signaling approach is preferred.  Considering UE is in idle/inactive mode, which should be able to receive RAN configuration, RRC signaling approach is also fine for us.  We understand both CATT’s and Apple’s solution is not for the intention of per-UE enable/disable LP-WUS. If companies agree the intention in 2.1, we should figure out some solution(s) to address them. |
| OPPO | NAS signalling (and RRC signalling) | We support dedicated enabling/disabling of LP-WUS, and we think both NAS signalling and RRC signalling based controlling would have respective benefit. For NAS signalling based enabling/disabling, CN can enables/disables LP-WUS monitoring based on paging probability and CN configured i-DRX cycle. For RRC signalling based enabling/disabling, RAN can enables/disables LP-WUS monitoring based on RAN paging cycle. If RAN2 decides to down-select one of them, we think at least NAS signalling based enabling/disabling should be supported since CN has more information on UE characteristics.  Regarding Apple’s method, there may be an issue that how CN disables UE’s LP-WUS monitoring if the UE does not support CN assigned based subgrouping. Regarding CATT’s method, both UE and gNB determine whether to disabling/enabling LP-WUS monitoring based on UE’s i-DRX cycle. Then for a UE in RRC INACTIVE state, as gNB may configure a RAN paging cycle different from CN configured i-DRX cycle, there may be misalignment on the disabling/enabling state between UE/gNB and CN. |
| ZTE | RRC signalling | We prefer RRC signalling based, because:   1. NAS signalling design is out of RAN2 scope and whether to support it should not be determined in RAN2.   LP-WUS is sent from gNB to UE, gNB can know the time offset between LP-WUS and PO, and can determine whether to use LP\_WUS for a UE based on the time offset and UE types and/or traffic type , e.g., IIoT UE, (e) Redcap UE, NR UE with XR traffic and so on. For example, the UEs with delay-sensitive services may not be suitable to monitor LP-WUS with large time offset. CN does not know the time offset and cannot determine whether to use LP-WUS based on the LP\_WUS configuration. |
| Huawei, HiSilicon | NAS signalling |  |
| LGE | NAS signalling | No available information at gNB to decide whether to disable LP-WUS monitoring for each individual UE. |
| Xiaomi | 1st priority: CATT’s proposal  2nd priority: NAS | We are reluctant to introduce this feature in LP-WUS. As we pointed out online that CN is even considering to remove the restrictions for LP-WUS because the additional delay caused by LP-WUS may not be a problem for emergency call back.  For example, if UE capability reports a small wake-up delay, e.g., 70ms, and NW configures also a small offset, e.g., 80ms, then the additional delay caused by LP-WUS is marginal hence there is no reason to disable LP-WUS.  Hence for NAS solution to work, it may need more assistance information from gNB, e.g., the configured offset. An example is if NW configures a small offset, then CN do not need to disable LP-WUS for power saving’s point of view. And that would impact RAN3 which is not in RAN2’s scope.  For RRC solution, we strongly against it. As in previous online meetings, people has given many concerns that gNB is hard to make the decision as gNB is not aware of what session the UE is going on and what traffic UE is having and this need CN to give gNB some assistance information. The similar problem has been discussed in the main session (R2-2501752\_S2-2502427 Reply LS on emergency call back and paging, ZTE) and CN needs to indicate (e.g. via ARP value) to RAN for RAN being aware of such PDU session.  Also, what is UE’s behavior when UE changes the cell? That needs further discussed.  Hence, RRC solution has a huge drawback compared to NAS solution.  If we really want to choose a solution, we think CATT’s way has less impact on CT1/RAN3 and can be considered first. If that is not pursued, we can further consider NAS solution. |
| Qualcomm | Apple’s solution or existing mechanism (similar with CATT’s solution) | This is a kind of optimization and not critical function to close LP-WUS. Apple’s solution can address this issue. CN can based on implementation to determine which UEs are disabled for LP-WUS without additional information from UE.  Alternatively, currently, the offset i.e. *lo-Offset* will be configured to the UE, UE will compare the *lo-Offset* and supported wake-up delay to determine whether to monitor LO. Then gNB can configure a proper *lo-Offset* to disable LP-WUS. |
| Samsung | No NAS/RRC changes. (Apple’s or CATT’s method) | We do not see the need of additional signalling except existing method proposed by Apple. |
| Apple | No NAS/RRC spec change | For NAS solution, the existing CN assigned subgroup ID method can achieve it. We don’t need to introduce additional signaling/mechanism for it.  For RRC solution for UE specific control, it’s not appropriate for IDLE UE control, as it requires IDLE UE to establish the AS/NAS connection only for the LP-WUS disable/enable control, which is a waste of resources. |

## Summary

15 companies provided input and below is the summary.

* NAS signllaing: Ericsson, Vivo (1st prio), Huawei/HiSilicon, LGE, Xiaomi (2nd prio)
  + Xioami can consider NAS signalling if CATT’s way is not pursued
* RRC signalling: Vivo (2nd prio), ZTE
* NAS signalling and RRC signalling: IDC, DoCoMo, Oppo
  + IDC prefers RRC signalling if down-selecting between NAS signalling and RRC signalling
  + DoCoMo prefers RRC signalling and is open to support NAS signalling additionally
  + Oppo prefers NAS signalling if down-selecting between NAS signalling and RRC signalling
* NAS signalling or RRC signalling: NEC
  + Can follow majority view on either NAS or RRC signalling
* Apple’s or CATT’s method: Lenovo, QC, Samsung, Apple.
  + Samsung and Apple specifically mentioned that they do not see the need for NAS or RRC change.
* CATT’s method: CATT, Xioami (1st prio)

**Rapporteur’s input:**

* 9 out of 15 prefer to have either NAS or RRC signalling.
* If we consider only companies’ first preferred option OR option when down-selecting, 5 out of 15 (Ericsson, Vivo, Huawei/HiSilicon, LGE, Oppo) prefer NAS, 3 out of 15 (ZTE, IDC, DoCoMo) prefer RRC. NEC can support the majority.
* Considering 60% preferred to specify a solution and there is no convergence on the solution, we propose to down-select from NAS signalling or RRC signalling.

**Observation (9/15): Many prefer to specify either NAS or RRC signalling to support enabling/disabling LP-WUS per UE.**

**Proposal: (RRC-12) RAN2 to down-select from NAS signalling or RRC signalling to support enabling/disabling LP-WUS per UE.**

# Conclusions

Based on the inputs from companies, the following proposals are made:

**Observation (9/15): Many prefer to specify either NAS or RRC signalling to support enabling/disabling LP-WUS per UE.**

**Proposal: (RRC-12) RAN2 to down-select from NAS signalling or RRC signalling to support enabling/disabling LP-WUS per UE.**

# References

1. R2-2504288 Procedure and configuration of LP-WUS in RRC\_IDLE/RRC\_INACTIVE, Ericsson

[2] R2-2503900 Further discussion on the LP-WUS in RRC\_IDLE/INACTIVE mode, Huawei, HiSilicon

[3] R2-2503568 Discussion on LP-WUS in RRC\_IDLE INACTIVE, NEC

[4] R2-2503763 Procedure and configuration of LP-WUS for IDLE and INACTIVE mode, ZTE

[5] R2-2504363 Discussion on LP-WUS operation in RRC\_IDLE/INACTIVE modes, InterDigital

[6] Stage 2 running CR for LP-WUS

[7] R2-2503809 LP-WUS in RRC\_IDLEINACTIVE, Apple

[8] R2-2503659 Remaining issues on LP-WUS in IDLE and INACTIVE, CATT