3GPP TSG-RAN WG2 Meeting #109bis-e Tdoc R2-2003926

Electronic meeting, 20th – 30th April 2020

Agenda Item: 7.1.6

Source: Ericsson

Title: Report on [AT109bis-e][411][eMTC] Idle mode mobility for non-BL UEs - Open issues

Document for: Report

# 1 Introduction

This is the report of the following discussion, based on offline discussion during RAN2#109bis-e and the summary document submitted prior to the meeting in [R2-2003791](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003791.zip):

* [AT109bis-e][411][eMTC] Idle mode mobility for non-BL UEs - Open issues (Ericsson)

 Scope: Remaining open issues on Idle mode mobility for non-BL UEs.

 Intended outcome: Report including a list of proposals categorized as agreeable, need further discussion etc.. The outcome can be provided in R2-2003926.

 Deadline: Friday, Apr. 24th 10:00 UTC

Questions are added in Appendix for companies to provide input on the topic.

**Text from summary in** [**R2-2003791**](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003791.zip)**:**

This document contains summary of the following tdocs submitted to AI 7.1.6:

[R2-2002879](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2002879.zip) Non-BL UE in enhanced coverage mode in “normal” cell Intel Corporation discussion Rel-16 LTE\_eMTC5-Core

[R2-2003344](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003344.zip) Enhancements to idle mode mobility for non-BL UEs Huawei, HiSilicon discussion Rel-16 LTE\_eMTC5-Core

[R2-2003353](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003353.zip) S-Criterion interpretation for non-BL UEs Ericsson discussion LTE\_eMTC5-Core

The discussion in the submitted documents and in number of previous RAN2 meetings has been mostly about the following FFS captured in RAN2#107:

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| * FFS if, from Rel-16, it should be possible for a non-BL UE that fullfills S criteria for normal coverage to camp in a “normal” cell, i.e. not standalone, in enhanced coverage.
* This discussion will continue as part of the AI 12.1.8 Improvements for non-BL UEs.
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This document summarizes the discussion and proposals in above documents submitted to RAN2#109bis-e.

# 2 Discussion (from summary document)

The following proposals have been presented in the submitted documents:

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| [R2-2002879](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2002879.zip), Intel | **Proposal 1:** As in legacy eMTC operation, a Rel-16 non-BL UE in RRC\_IDLE can camp in a cell in normal coverage either in BR mode (if SIB1-BR is used) or in WB, i.e. non-BR mode (if SIB1 is used).**Proposal 2**: Network control to limit non-BL UE camping on a cell in normal coverage in BR mode is postponed to future release. |
| [R2-2003344](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003344.zip), Huawei  | **Proposal 1:** Non-BL UE is allowed to camp on enhanced coverage mode when S criteria for normal coverage is fulfilled.**Proposal 2:** The following TP is adopted:

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| If cell selection criteria S in normal coverage is fulfilled for a cell, UE may consider itself to be in enhanced coverage, e.g. if *SystemInformationBlockType1* cannot be acquired but UE is able to acquire *MasterInformationBlock, SystemInformationBlockType1-BR* and *SystemInformationBlockType2*. |

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| [R2-2003353](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003353.zip), Ericsson  | [**Proposal 1:** Except for standalone LTE-M cell, non-BL UE shall camp in enhanced coverage only if S-criterion for normal coverage is not fulfilled and S-criterion for enhanced coverage is fulfilled.](#_Toc37401958) |

The arguments in [R2-2002879](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2002879.zip) are mostly about whether the current specification allows non-BL UEs to camp in EC without any restriction, where the conclusion is this is possible already in legacy specifications, arriving at conclusion this should be possible in Rel-16 as well and further proposes possible network control to be postponed to be discussed in later releases.

[R2-2003344](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003344.zip) and [R2-2003353](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003353.zip) focus more on impacts on energy and power consumption, paging, complexity and network resources and performance. However, the observations and conclusions are almost completely opposite to each other. The latter document claims there would be potential negative impacts in e.g. paging, complexity, network resources/performance while the former claims none of these would be significantly affected. Therefore, the proposals are opposite. Furthermore, [R2-2003344](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003344.zip) proposes a clarification in 5.2.3.2 in TS 36.304 to account for non-BL UEs camping in EC.

As only three companies submitted contributions, where 2 companies would prefer allowing the functionality mentioned in the FFS and one company wouldn’t, it seems likely further discussion will be needed to conclude the discussion related to the non-BL UE behaviour on camping in enhanced coverage when normal coverage criterion is fulfilled.

However, it would be good to conclude this discussion. Otherwise, if no conclusion is reached, the UE behaviour and interpretation of the specifications will remain unclear in the coming releases. Based on the input to RAN2#109bis-e, but also based on earlier discussions, it seems there are different understandings e.g. on how non-BL UE implementations would (or should) work.

1. There are different interpretations of non-BL UE behaviour related to camping in enhanced coverage when normal coverage criterion is fulfilled. Unless RAN2 finds a conclusion to this discussion, the behaviour will remain unclear.

Therefore, the sourcing company thinks this discussion needs to be concluded in one way or another.

As there doesn't seem to be any "easy agreements", it is proposed to further discuss the companies understanding and concerns related to potential impacts (see e.g. [R2-2003344](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003344.zip) and [R2-2003353](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003353.zip)) and then in general whether the camping behaviour should be allowed or not.

1. If non-BL UEs that fulfil S criteria for normal coverage may camp in enhanced coverage in non-standalone cell, discuss further the potential impacts e.g. on
	1. Network performance (e.g. radio resources, paging)
	2. UE energy/power consumption
	3. UE complexity

Based on further discussion, the following should be concluded:

1. Discuss further on whether it should be possible for a non-BL UE that fulfils S criteria for normal coverage to camp in enhanced coverage in a non-standalone cell.

# 3 Summary of the offline

Based on the discussion and replies in Appendix, the following is proposed to be agreed:

1. Non-BL UEs are allowed to camp in enhanced coverage when S-criterion for normal coverage is fulfilled. This behaviour can be enabled or disabled by indication provided in SI.

# References

1. [R2-2002879](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2002879.zip), "Non-BL UE in enhanced coverage mode in “normal” cell", Intel Corporation, RAN2#109bis-e
2. [R2-2003344](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003344.zip), "Enhancements to idle mode mobility for non-BL UEs", Huawei, HiSilicon, RAN2#109bis-e
3. [R2-2003353](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003353.zip) , "S-Criterion interpretation for non-BL UEs", Ericsson, RAN2#109bis-e
4. [R2-2003791](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_109bis-e/Docs//R2-2003791.zip), " Summary of AI 7.1.6 Improvements for non-BL UEs", Ericsson, RAN2#109bis-e

# Appendix for company inputs

Related to Proposal 1, the following potential impacts have been identified and discussed (see e.g. documents [2] and [3] in above summary), assuming it would be possible for non-BL UEs to camp in enhanced coverage in non-standalone when S-criteria for normal coverage is fulfilled:

a) Network performance (e.g. availability of radio resources)

b) UE energy/power consumption

c) UE complexity

d) Impact on paging

e) Other (please elaborate)

Companies are asked to provide their views on whether they think there are impacts on the following aspects. Please consider impacts from both UE and network side, and both possible positive and negative impacts:

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| **Company** | **View on possible impacts (UE side, NW side, positive and negative impacts)** |
| Apple | b) Allowing the UE to camp in enhanced coverage has showed significant savings in power.c) UE complexity is reasonable in such cases, especially if it has to manage both normal and BR SIBs. There are not much additional requirements imposed on the UE in handling an additional set of SIB instances.d) No impact in UE page performance is expected. |
| Intel | We thank companies for providing their analysis on the contribution submitted in this and previous meetings. As this topic has already been discussed for few meetings, and we are almost closing the Rel-16 WI, we suggest focusing the discussion on the solution space, if any. Said that as we mentioned in our contribution [1], it is our understanding that there are already legacy non-BL UE implementing such feature in the field and they are seen to provide UE energy/power saving for camping on BR mode/enhanced coverage mode in normal coverage. Since it is already implemented by legacy non-BL UE, UE complexity seems trivial to discuss.***Observation#1: Legacy BL UE is already doing this and see benefit in terms of UE power saving******Observation#2: Since legacy BL UE is already doing it, it seems strange to discuss UE complexity***As for paging and radio resources, this had been discussed in Rel-13 when eMTC was introduced whether the UE should inform the network when it changes CE levels and between enhanced coverage mode and wideband mode in idle mode. It is a concious decision at that time to not to do this because of the signalling overhead for idle to active transition. As a consequence of that decision, it is the understanding that it would be left to the network paging strategy to handle such situation (i.e. network can try to page at the last CE level and decide what it has to do if it does not get a response – to go to page a PDCCH or MPDCCH at higher CE level etc.) ***Observation#3:Paging impact was discussed in Rel-13 for CE level changes and between PDCCH and MPDCCH for non-BL UE and it is a concious decision NOT to inform the network about the change to reduce idle to active transition signalling overhead. It is left to network paging strategy to handle this.*** ***Observation#4: Network already need to handle CE level changes and UE switching between PDCCH and MPDCCH since Rel-13 for non-BL UE.***  |
| Thales | We should not only look on normal devices supporting also BL mode operation, but consider also BL-mode only devices which need to camp in said configuration.When non-BL UEs not needing any coverage enhancements (which could also camp in normal mode) also start camping in BL-mode this massively increases paging load on MPDCCH and hence depends on grouping of paging or in combination with features such as WUS it increases the power consumption of the BL-mode only devices. As outlined in our document (R2-2000251).  |
| Nokia | The UE behavior of selection of CE mode have direct impact on the network paging strategy and also effectiveness of the paging strategy. If the UE chooses the CE level as per radio condition, then network paging strategy starts with lower CE level for first paging then to increase for further works well as the second level of paging will be required only if the UE moves to extended coverage. Otherwise the UE is reachable for first page itself.Now if the UE behavior of selection of CE mode is left to UE implementation, it impacts the above strategy. And if we assume the UE selects to use enhanced coverage for more than 90% of cases in normal coverage, the above paging strategy will lead to reaching UE only after retransmission for 90% of the cases. So deterministic UE behavior is needed for network to align its paging in this case.Moreover when feature intended for enhanced coverage such as WUS is introduced, blind paging and WUS on MPDCCH increases the false wake up to other enhanced coverage UE. So the impact is more severe in these cases.Either network control or deterministic UE behavior is needed to avoid the above issue.If the non-BL intend to use enhanced coverage in idle mode always for energy saving, it could be negotiated and agreed with MME at-least. In this case, the paging message can indicate whether UE to be paged first in MPDCCH or PDCCH. |
| Sequans | Agree with Thales and Nokia. Even if UE complexity is negligible as evidenced by legacy UE implementing that strategy, it does not take into account the effects this has on other UEs and the NW, especially as the number of deployed UEs rises. |
| Ericsson | Agree with Thales, Nokia and Sequans. Our views on impacts are provided in [R2-2003791](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_109bis-e/Docs/R2-2003791.zip), but in short:a) and d) If the UEs may choose freely, there is an impact in use of network resources, especially from paging point of view which may affect also other UEs. - Impact on paging performace: Paging would still work, but the reliability of the information eNB may upload in MME regarding UE's coverage level (i.e. resources used for MPDCCH) would become more unreliable or even useless. - Impact on other devices: Especially with higher loads, MPDCCH resource may become more congested. This may affect negatively e.g. to BL UEs with low paging probability which need then to wake up more frequently, increasing their power consumtion. b) We don't agree with Apple that there are significant savings in power for the UE – we have seen one analysis but it is not clear based on that what all traffic scenarios or network loads have been studied, or what is the impact on other UEs and paging in wider setting.We agree there may be a benefit in UE power consumption in some cases, but this is implementation dependent and further depends on scheduling and the network configuration, e.g. how many repetitions are scheduled in CE Mode A, and what is the network load.c) Acquiring and maintaining both versions of SIBs results in some added complexity, but this doesn't seem to be signifcant, we agree with that. d) In addition to above, the network paging strategy will be affected.  |
| LG | Agree with Thales, Nokia and Sequans and Ericsson. If non-BL UEs are allowed to operate in BL mode even if the S-criteria is fulfilled for normal coverage, it would have a performance impact on the UEs as well as the network.  |
| Qualcomm | Agree with Thales, the system level impact of allowing uncontrolled operation of non-BL UE as a BL UE in idle mode is severely being underestimated.This was well known issue from the beginning. It is very unfortunate that some companies have misinterpretation with what RAN2 officially agreed. See below agreements.RAN2#91bis2: The UE uses normal mode if the cell is suitable according to legacy/normal S criteria, and otherwise, the UE uses EC mode if the cell is suitable according to EC S criteria. RAN2#92=>  Non-LC UEs supporting EC but in NC monitor only legacy paging. Paging strategy to successfully page the UE is left to network implementation (no additional signalling from UE at coverage level change). |

**Rapporteur summary:** 6 companies think there are system level impacts and have concerns, 1 company doesn't think there are impacts on UE page performance. 1 company mentions paging but doesn’t explicitly mention impact related to this discussion, other than that NW would need to handle CE level changes anyways.

1. Majority of companies have concern on impacts and think there are system level impacts e.g. related to paging.

Another topic which has been discussed during earlier meetings as well is whether the discussed behaviour is supported by the current (i.e. pre-Rel-16) specifications and subsequently, if behaviour in P2 would be allowed, would there be additional specification impact? References to specifications are encouraged:

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| **Company** | **In your view, is the behaviour discussed in P2 supported by (pre-Rel-16) specifications? Please elaborate.** |
| Apple | In our view the existing pre-Rel-16 behavior should be retained. |
| Intel | Yes, we do not see further specification impact for legacy non-BL UE as explained in proposal 1 [1].**Proposal 1:** As in legacy eMTC operation, a Rel-16 non-BL UE in RRC\_IDLE can camp in a cell in normal coverage either in BR mode (if SIB1-BR is used) or in WB, i.e. non-BR mode (if SIB1 is used). |
| Thales | The behavior of normal devices camping in BL-mode even though no coverage enhancement is required (S-criteria is still fulfilled) was not intended by the specifications but we agree that it is also not precluded.  |
| Nokia | OK for not impacting legacy non-BL UE. But some changes needed for UE supporting WUS or from Rel-15 onwards. |
| Sequans | This behavior, while unintended, is not precluded in legacy. However, going forward the NW should be able to prohibit it in a cell. |
| Ericsson | We share the view this was not the intended behavior.Note that TS 36.300 24.7b specifies:*A UE in enhanced coverage is a UE that requires the use of enhanced coverage functionality to access the cell.* |
| Qualcomm | Agree with Thales the intention of the specification was to allow non-BL UE to operate as BL UE when due to coverage it cannot operate as non-BL UE (i.e. only if S-criteria for normal coverage is not met). This is an exceptional case rather than a normal case hence system level impact is negligible. |

Especially if you reply "no" above, please consider the following:

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| **Company** | **If behaviour in P2 is allowed, would there be specification impact?** |
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**Rapporteur summary:** Although most companies did not directly reply to the question, as summary, 4 of 7 companies mention the behaviour is not precluded in the specifications and 4 of 7 companies mention this was not the intended behaviour. One company things some changes would be needed supporting WUS from Rel-15 but no details are provided.

Based on the above discussion and company inputs, companies are asked to provide their view on P2, i.e., whether the behaviour should be allowed or not. Additionally, companies are asked to provide their input whether P2 would be acceptable with network control, e.g. using a SIB bit to indicate whether it is allowed for a non-BL UE that fulfils S criteria for normal coverage to camp in enhanced coverage in a non-standalone cell:

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| **Company** | **Allow behaviour in P2?**  | **Allow behaviour in P2 with NW control?** | **Additional comments** |
| Huawei, HiSilicon | Yes | No need | It’s clear from previous discussions that different vendors have different interpretations of the current specification, we can allow both interpretations, and this can be supported simply with the TP given in our TDoc which is anyway needed to support the standalone case. |
| Apple | Yes | No Need | This is purely idle mode behavior, and the UE can toggle from normal to extended coverage based autonomously. We do not feel the need for a NW control for this Idle UE behavior. |
| Intel | Yes | No need | Since it is already supported for legacy non-BL UE and based on our Observation#1-4, we do not see why we need to restrict Rel-16 UE from camping on a cell in enhanced coverage mode if normal coverage criteria is fulfilled. At this late stage, we do not see a motivation to introduce network control. |
| Thales | Yes | Yes | Depending on the impact that is observed/may happen for BL-mode only devices, a network needs to have the mechanisms to control further camping of normal UEs in BL-mode, in case they also could camp in normal mode.BL-mode operation was mainly introduced for low end devices where power saving is key.  |
| Nokia | Yes | Yes | Network control via system information or Network awareness via NAS signaling on UE preference to stay in CE mode is needed. |
| Sequans | Yes | Yes | NW indication is needed to avoid cases of regular UEs congesting resources for BL UEs. NW awareness can also be used in addition (but not instead of). |
| Ericsson | Yes | Yes | We are OK to clarify this by allowing but network should be able to control this from R16 onwards using a bit in system information. |
| LG | No | Yes | We think legacy non-BL UEs should not operate in BL mode if S-criteria for normal coverage is fulfilled. So, we do not support P2. However, if majority want to allow this, we will follow the majority view. P2 is acceptable to us as long as it is controlled by the network. Otherwise, both UEs and the network performance would have performance impact.  |
| Qualcomm | No | May be | If P2 behavior is to be allowed then it must be controlled by network so that it can manage BL resource loading. |

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| **Company** | **Any other comments, feedback, issues we should discuss?**  |
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**Rapporteur summary:** There are 9 replies to this question:

* 7 companies say the behavior in P2 can be allowed, 2 companies say no
	+ Of the 7 companies replying "yes", 4 companies say behavior can be allowed with NW control, 3 say no need.
	+ Of the 2 companies replying "no", both say that if the behavior is to be allowed, there should be NW control.

In conclusion, 6 companies would be OK to allow the behaviour with NW control, the 3 other companies allow the behaviour with no control.

Based on these replies and earlier discussions, rapporteur thinks it should, as a compromise, be agreeable to explicitly allow/disallow the behaviour with network control and finally conclude this discussion, therefore:

1. Non-BL UEs are allowed to camp in enhanced coverage when S-criterion for normal coverage is fulfilled. This behaviour can be enabled or disabled by indication provided in SI.