**3GPP TSG-RAN WG2 Meeting #115-e R2-21xxxxx**

**Online, Aug 16th – Aug 27th, 2021**

**Agenda item: 9.2.2**

**Source: MediaTek Inc.**

**Title: Summary of 9.2.2 Non continuous coverage**

**Document for: Discussion and Decision**

# 1 Introduction

This contribution is aimed at providing a summary of contributions submitted in Section 9.2.2 of IoT-NTN, identify potential agreements, (including confirming SI agreements), open points, potential alternatives, and further enhancements. The 16 contributions [2] ~ [17] are summarized.

**Note-1**: RAN Plenary (RP) recommendations are to keep scope small when assessing the proposals, i.e. focus on essential enhancements. Non-essential enhancements should be considered only if impact is small.

* [AT115-e][036][IoT-NTN] Non continuous coverage (Mediatek)

Scope: Treat documents under 9.2.2. Identify potential agreements (e.g. confirm agreements from SI), Open points, potential alternatives, potential further enhancements.

Intended outcome: Report

**Deadline: CB Monday W2**

Deadline for company’s input: **Friday Aug 20 11:00 UTC**

Deadline for rapporteur’s summary: **Friday Aug 20, 19:00 UTC**

**Note-2**: As TN-NTN mobility is out-of-scope of this Work Item, any contribution corresponding to TN-NTN mobility is not discussed in this summary.

# 2 Contact Information

|  |  |  |
| --- | --- | --- |
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# 3 Non Continuous Coverage

In the RAN2#114-e meeting, the Study Item (SI) on IoT-NTN was concluded with the following agreements on discontinuous coverage and power savings issues.

|  |
| --- |
| * [032] 9: From RAN2 point of view, the existing power saving mechanisms e.g. DRX, PSM, eDRX, relaxed monitoring, and WUS can be reused without enhancement. Can consider enhancements if found needed, to support discontinuous coverage. * [032] 10: Support of discontinuous coverage without excessive UE power consumption and without excessive failures / recovery actions, is essential, Expectation that this need to be taken into account at least for Idle mode, and that this is applicable for all reference scenarios (GEO, MEO and LEO). * [032] 12: Enhancements for power saving in connected mode power are not essential. Minor adaptations to enable support in NTN deployment of existing features e.g. EDT, PUR for GEO may be considered in WI phase. (no major changes for adaptation is assumed). |

Almost all the contributions [2] ~ [17] agree that discontinuous coverage without excessive UE power consumption is a necessary topic. The contribution in [6] has also observed the need for specification work to ensure IoT NTN devices can make use of the brief connection opportunities presented by sparse IoT NTN constellations. Hence, before proceeding into the discussion on discontinuous coverage and associated solutions, the rapporteur would like to confirm the study item agreements, made in RAN2#114-e, regarding the necessity of discontinuous coverage without excessive UE power consumption.

**Question 1: As agreed during the SI (RAN2#114bis-e), do companies confirm that support of discontinuous coverage, without excessive UE power consumption and without excessive failures/recovery actions, is essential, at least for Idle mode?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional comments** |
| Lenovo | Agree | For idle mode it is essential to avoid unnecessary cell search or measurement due to discontinuous coverage. For connected mode, avoiding excessive failures/recovery actions due to discontinuous coverage is also necessary. |
| Xiaomi | Agree | We should follow the previous agreements. |
| Qualcomm | Agree with comments | However, only if it can be achieved with minimal impact to specifications of RAN2 and other groups. |
| Huawei, HiSilicon | Agree |  |
| CATT | Agree |  |
| OPPO | Agree | The support of discontinuous coverage for Idle mode is beneficial for UE power saving. |
| FGI | Agree |  |
| Thales | Agree |  |
| Rakuten Mobile Inc | Agree | Not only Idle mode , we should consider connected mode scenario too to avoid cell search in discontinuos coverage. |
| Gatehouse | Agree |  |
| Apple | Agree |  |
| Nokia | Agree with comments | Support of discontinuous coverage without excessive UE power consumption and without excessive failures / recovery actions is one of the objectives in the WID. We think it is essential but only for idle mode in Rel-17. |
| CMCC | Agree |  |
| Sateliot | Agree |  |
| Sequans | Agree |  |
| Novamint | Agree |  |
| NEC | Agree |  |

**<Rapporteur Summary>**

3.1 Satellite Assistance and Coverage Prediction

A wide majority (12/16) of the contributions [2], [3], [5], [8], [9], [10], [11], [13], [14], [15], [16] and [17] have mentioned providing some form of satellite assistance to the UEs, so that UE can predict the discontinuity of satellite coverage. Based on these contributions, the rapporteur would like to ask the following question”

**Question 2: Do companies agree that satellite assistance (e.g. ephemeris information) will be useful to the UE for predicting coverage discontinuity and stopping unnecessary cell search in the Idle mode? The details of the assistance information is FFS and RAN2 will use any corresponding agreements made in NR-NTN.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Additional comments** |
| Lenovo | Yes | The network can provide some assistance information including the satellite ephemeris and time to start/stop serving, to help UE determine the coverage interruption period in discontinuous coverage. |
| Xiaomi | Yes | We should first determine the ephemeris data and then evaluate whether additional information needed or not for UE to predict discontinuous coverage. |
| Qualcomm | Yes | For Rel-17, this should be sufficient. |
| Huawei, HiSilicon | Yes | Agree in general. However, NR NTN agreements can only be used as a baseline and applicability to IOT NTN should be checked on a per agreement basis. |
| CATT | Yes | UE should avoid the unnecessary cell search based on the real satellite coverage to reduce power consumption. |
| OPPO | Yes | According to satellite assistance information, UE can predict the out-of-coverage area in order to avoid power consumption due to unnecessary cell search. For the details of satellite assistance information, in our understanding, we can further discuss for LEO with moving cell and LEO with earth-fixed cell, separately. |
| FGI | Yes | Agree. However, ephemeris may not be sufficient, e.g., for two satellites, one provides Earth-fixed cells, and another provides Earth-moving cells. They will result in different coverage discontinuity. |
| Thales | Yes |  |
| Rakuten Mobile Inc | Comment | We agree that UE can be provide ephemeris data but does NB IoT UE should be involve in calculating discontinuous converage ? Rather there should be simple timer based mechanism communicated in SI by network. |
| Gatehouse | Yes | As has been agreed in SI/WID, the NR NTN agreements should be used as baseline to IoT NTN and reused *where* possible (applicable) though in specific cases change/adjustment might be necessary. |
| Apple | Yes |  |
| Nokia | Yes with comment | NR NTN agreements can be used as the baseline, the applicability to IoT NTN may need to be checked. FFS on the enhancements to support discontinuous coverage . |
| CMCC | Yes | The satellite ephemeris information in R17 NTN could be reused, and other assistance information (e.g. cell footprint size) also can be provided, to help UE predict the discontinuous coverage. |
| Sateliot | Yes | Agree with moderator’s question.  And support the views of some companies above stating that corresponding agreements made for NR NRN can be the baseline but their applicability to IoT NTN has to be checked. |
| Sequans | Yes |  |
| Novamint | Yes | NR NTN agreements are the baseline and applicability to IoT NTN to be checked on per agreement basis. |
| NEC | Yes |  |

**<Rapporteur Summary>**

If the answer to Question 1 is “Yes”, then the UEs should be able to use the assistance information to predict the coverage discontinuity, stop any cell search [2], [5], [13] and enters in the dormant state [3]. The details of UE’s prediction on discontinuous coverage [9], [15], [16], [17] and its ability to detect when it is back in coverage and establish an RRC connection with the network is up to the UE implementation [8], [15]. Based on this information the rapporteur would like to ask the following question:

**Question 3: Do companies agree that the details of UE’s prediction of discontinuous coverage and its ability to detect when it is back in coverage with the network is up to UE implementation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Additional comments** |
| Lenovo | Yes with comments | It depends on what assistance information is provided to UE. If the assistance information is sufficient for UE to predict its coverage interruption period (start and end time of coverage hole), we think how to predict can rely on UE implementation. |
| Xiaomi | Yes | The assistance information provided by network should ensure that UE can predict the discontinuous coverage, how to predict and the UE behaviour in the discontinuous coverage should be left to UE implementation. |
| Qualcomm | Yes | We agree this can be up to UE implementation. |
| Huawei, HiSilicon | Yes | Agree that it does not need to be specified. However, the feasibility of accurate enough prediction should be confirmed. |
| CATT | Yes with comments | How to predict the cell coverage for a period of time is based on implementation. RAN2 can discuss what assistance information is needed. |
| OPPO | Yes | How to predict out-of-coverage period and the UE behaviour when UE is back in coverage is up to UE implementation. |
| FGI | Yes | Up to UE. |
| Thales | Yes |  |
| Rakuten Mobile Inc | Comment | Does NB IoT UE should be involve in calculating/detecting discontinuous converage ? Rather there should be simple timer based mechanism communicated in SI by network for idle mode & UE should be released before Discontinuous coverage in connected mode to avoid cell search. |
| Gatehouse | Yes | Agreed that this does not need to be specified and can dealt by UE implementation. However, the specification shall ensure that (accurate) predication is possible by providing the UE with assistance information. |
| Apple | Yes |  |
| Nokia | FFS | We agree it is UE’s implementation on how to predict the discontinuous coverage. However, the accuracy of coverage window predictions should be clarified. E.g. whether UE can always align the prediction-based wakeup with the actual satellite coverage window. According to table1 from R2-2104863, it is observed that UE may completely miss the satellite coverage window because of its prediction error (e.g. for the 3rd pass and the 5th pass). Furthermore, the requirement for NW to guarantee the prediction accuracy should be clarified, e.g. any requirement for NW on the assistance information signalling? |
| CMCC | Yes | The details of UE’s prediction can be up to implementation. |
| Sateliot | Yes with comments | Agree that the details of the UE’s prediction capabilities are up to the UE implementation but it is necessary to ensure that the satellite assistance information to be provided is sufficient to allow for accurate predictions and/or efficient network resource utilization. |
| Sequans | Yes |  |
| Novamint | Yes | Agree that it is up to UE implementation to predict the discontinuous coverage assuming that the assistance information provided is sufficient to allow accurate prediction as pointed out by several companies. |
| NEC | Yes | It should be baseline that prediction is up to UE implementation, of course the accuracy of the prediction can be discussed. |

**<Rapporteur Summary>**

3.2 Paging Issues

Contributions in [3], [5], [7], [8], [12], and [14] has mentioned the paging issues. As UEs in discontinuous coverage will be unable to monitor paging occasions, RAN should consider the UE unreachable (e.g., for paging purposes) and network should page the UE only when UE is in the coverage. Contributions in [8], [8] and [14] has raised the point of sending an LS to other groups, like SA2, CT1 and RAN3 for possible alignment work in their specification due to the support of discontinuous coverage as the core network needs to predict UE’s stay in the coverage hole to avoid paging the UE while it is out of coverage. Based on this, the rapporteur would like to ask the following question:

**Question 4: Do the companies agree that RAN2 needs to send an LS to SA2 and CT1 (cc: RAN3) for the possible alignment work in their specification due to the support of discontinuous coverage.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Additional comments** |
| Lenovo | Yes with comments | Alignment work with other WGs is necessary but we think it may be too early. It is better to send LS when we have some initial progress e.g., potential solutions and possible impacts to other WGs has been identified. |
| Xiaomi | No | The UE in discontinuous coverage can’t be paged by network, regardless of network paging or not paging, so we don’t clear what the issue is if the network still page UE when UE is in the discontinuous coverage. |
| Qualcomm | Yes | Other WGs need to be aware of this to enable necessary alignments.  One simple solution with only UE impact would be to make use of existing PSM. CT1 would also need to be informed for possible PLMN search and inter-RAT selection impact. If RAN2 sees this as useful, we suggest including the following:  Due to limited time for Rel-17, it is RAN2 understanding that PSM might be used to handle discontinuous coverage in Rel-17 with minimum specification effort (e.g. with some small UE impact but no new network impact). For example, there may be some alignment work needed in SA2 and CT1 regarding UE awareness of discontinuous coverage, and for PSM configuration and PLMN search handling by a UE during discontinuous coverage (e.g. when the UE has UL data to transmit). This is a suggestion and RAN2 assume that SA2 and CT1 would make any final decision. |
| Huawei, HiSilicon | Yes | PSM, Paging and UE reachability are Core Network functionalities, corresponding WGs should be aware of the issue to make any alignment needed in the their specification. |
| CATT | Yes |  |
| OPPO |  | LS to other groups can be considered after RAN2 has conclusion on UE behaviour for discontinuous coverage. |
| FGI | Yes |  |
| Thales | Yes |  |
| Rakuten Mobile Inc | Yes |  |
| Gatehouse | Yes | LS is seen as necessary, since RAN2 decisions and specifications in relation to discontinuous coverage will influence or rely on functionality specified by SA2 and CT1. |
| Apple | Yes | It is important that the network is aware that the UE is not reachable e.g., to avoid unnecessary paging |
| Nokia | Yes | The content may include paging issue for discontinuous coverage, and PLMN search for UE in no coverage area. |
| CMCC | Yes | LS to other WGs is essential since it is beneficial that UE and network are synchronized (i.e. when the UE is awake and reachable) to avoid unnecessary paging. |
| Sateliot | Yes | Support of discontinuous coverage operation actually impacts both RAN and CN functions, so we would be in favour of an early alignment. For example, paging and UE reachability functions within the CN should be made aware or be able to properly handle the fact that satellite RAN coverage over a given region is discontinuous in time (e.g. avoid triggering paging when the UE is not under RAN coverage). |
| Sequans | Yes |  |
| Novamint | Yes | LS to the other WGs is necessary at this stage to make them aware and trigger alignements in the specifications when/if needed. |
| NEC | Yes | In general, PSM, eDRX and paging are all NAS features, traditionally they are designed without considering discontinuous coverage, corresponding WGs should be aware of discontinuous coverage issue in IOT NTN and up to themselves to check over any necessary enhancement needed at NAS layer.  From RAN2 point of view, we can particularly mention several observations, e.g.:   * paging may fall into out of coverage window * UE will be in kind of PSM mode when it is out of coverage |

**<Rapporteur Summary>**

# 4 Power Savings

During the Study Item phase, power savings was discussed and it was agreed that existing power saving mechanisms, like DRX, PSM, eDRX, relaxed monitoring, and WUS can be reused without enhancement. Enhancements can be considered, if found needed, to support discontinuous coverage. Contributions in [2], [7], [12], [13], [14], [15], and [16] mentioned about power savings. Hence, the rapporteur would like to confirm the study item agreements, made in RAN2#114-e, regarding the power savings.

**Question 5: As agreed during the SI (RAN2#114bis-e), do companies confirm that from RAN2 point of view, the existing power saving mechanisms e.g. DRX, PSM, eDRX, relaxed monitoring, and WUS can be reused without enhancement. Enhancements can be considered, if found needed, to support discontinuous coverage?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Additional comments** |
| Lenovo | See comments | It may be too early to say “can be reused without enhancement”. In the SI phase there seems no detailed discussion on using DRX/eDRX/PSM/WUS and relaxed monitoring in discontinuous coverage. We think legacy mechanisms can be considered as baseline and further enhancements are necessary.  For example, in [10]R2-2107913, we observed that possible misalignment between PSM duration and coverage interruption period, and it could lead to unnecessary power consumption or unreachable MT services. Enhancements to PSM for aligning PSM duration with coverage interruption period at UE is needed.  We suggest follow the description in the latest WID RP-211601 objectives: Minor enhancements to the existing power saving mechanisms e.g. DRX, PSM, eDRX, relaxed monitoring, and (G)WUS can be considered, and if found needed, specified, to support discontinuous coverage; |
| Xiaomi | Yes | Before idle UE entering the discontinuous coverage, the UE can request eDRX/PSM configuration with the recommended parameters, such as DRX cycle, PTW, T3412 and T3324, and these parameters can be determined by UE with the discontinuous coverage information, |
| Qualcomm | Yes with comments | At least DRX, PSM and eDRX seem to be re-usable. We are not clear if relaxed monitoring and WUS are critical as it is not discussed if they work in LEO. However, any impact on PSM/eDRX is for SA2 and CT1 to decide and we think RAN2 can just convey a suggestion (e.g, as commented for Q4). |
| Huawei, HiSilicon | Yes | Need for enhancement, if any, should be triggered by SA2 |
| CATT | No strong view | In this stage, we are not sure whether there is any [potential](javascript:;) [influence](javascript:;). |
| OPPO | Yes | Considering the limitation of the timeline for Rel-17, we should firstly consider to re-use the existing power saving mechanisms, and if we found enhancement is needed indeed, we can consider minor enhancement. |
| FGI | Yes | Reuse legacy if no concern has been raised. |
| Thales | No strong view |  |
| Rakuten Mobile Inc | Yes | For this release it can be consider without enhancement & further optimization can be reviewed in furher discussion. However this eDRX/PSM configuration shall be used to match cycle with discontinuous coverage time. |
| Gatehouse | Yes | Linked to the previous question 4 on LS to SA2/CT1: If enhancements are necessary, it is important to have this aligned with or triggered by the SA WG. |
| Apple | Yes |  |
| Nokia | Yes with comments | Same as Q1. If needed, minor enhancements to the existing power saving mechanisms e.g. DRX, PSM, eDRX, relaxed monitoring, and (G)WUS is one of the objectives in the WID.  Please note, enhancement to GWUS should also be considered as indicated in WID. |
| CMCC | Yes | We can firstly reuse existing mechanism, and minor enhancement can be considered if found needed. |
| Sateliot | Yes with comments | Agree in general with the statement but we feel, as Lenovo points out, that related WID formulation is clearer:  “*Support of discontinuous coverage without excessive UE power consumption and without excessive failures / recovery actions. Minor enhancements to the existing power saving mechanisms e.g. DRX, PSM, eDRX, relaxed monitoring, and (G)WUS can be considered, and if found needed, specified, to support discontinuous coverage*”  Also, in connection with previous Question 4 about the need for a LS with SA2/CT1 and noting Huawei/HiSilicon’s comment above, it is important to raise awareness of all these issues to SA2 for them to be able to see the need of such enhancements or confirm that no enhancements are found necessary from a SA2 point of view. |
| Sequans | Yes but | The agreement was not saying that existing power saving mechanisms could be used without any enhancements in the context of supporting discontinuous coverage (on the contrary, it was suggesting minor enhancement might be required in that context) |
| Novamint | Yes | Agree with Lenovo, Nokia, Sateliot and Sequans comments: minor enhancements might be required to support discontinuous coverage as per the WID and we would prefer the WID formulation.  Agree as well with Huawei and Qualcomm comments: If enhancements are needed it should be aligned/triggered by SA2. Hence the importance to send the LS now. |
| NEC | Yes | We agree that we should strive to minimum enhancement on existing features to cope with discontinuous coverage. |

**<Rapporteur Summary>**

During the Study Item, it was also agreed in RAN2#114bis-e that enhancements to connected mode power savings are not essential. However, minor adaptations for supporting NTN deployments can be considered. Hence, based on this the rapporteur would like to confirm the following question:

**Question 6: As agreed during the SI (RAN2#114bis-e), do companies confirm that enhancements for power saving in connected mode power are not essential? Minor adaptations (no major changes) to enable support in NTN deployment of existing features e.g. EDT, PUR for GEO may be considered.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Additional comments** |
| Lenovo | See comments | For the normal data and signalling exchange in connected mode, power saving is not essential considering the characters of IoT services. But it was also mentioned in the latest WID RP-211601 objectives: Support of discontinuous coverage without excessive UE power consumption and without **excessive failures / recovery actions**.  In our view the **failures and recovery actions** are connected mode aspects. Considering that discontinuous coverage may cause unnecessary RLM, RLF detection and RRC re-establishment attempt at the UE, some enhancements may be necessary. |
| Xiaomi | Yes | If UE can predict discontinuous coverage based on the assistance information, the UE also can avoid unnecessary RLF detection and RRC re-establishment based on UE implementation. |
| Qualcomm | Yes | Power saving is beneficial whether it is in IDLE mode or connected mode so the existing features should be used wherever possible. |
| Huawei, HiSilicon | Yes | Note that in our understanding, enhancements to PUR are excluded from the WID |
| CATT | Yes |  |
| OPPO | Yes | For IoT NTN UE, since the time period in idle mode is far longer than that in connected mode, enhancement for idle mode can contribute more to the UE power saving. RAN2 focus on idle mode power saving enhancement firstly, and connected mode enhancement can be considered in future release. |
| FGI | Yes | Rel-17 aims for sporadic short transmission in RRC\_CONNECTED. |
| Thales | Yes |  |
| Rakuten Mobile Inc | Yes |  |
| Gatehouse | Yes | Agreed that enhancements for power saving in connected mode are not essential and that minor adaptations can be considered – if time is available and premits this. |
| Apple | Yes but | If any enhancements beyond legacy mehanisms are agreed for idle mode, they may also be applicable in connected mode and as such cannot be precluded at this point. |
| Nokia | Yes with comment | The enhancement for power saving in connected mode is not in the scope of WID, and it is agreed as not essential for Rel17 in the SI. We think the adaptions to support EDT, PUR for GEO should be low priority topics in WI. |
| CMCC | Yes | It was agreed that enhancements for power saving in connected mode power are not essential in RAN2#114-e meeting. |
| Sateliot | Yes |  |
| Sequans | Yes |  |
| Novamint | Yes | Not essential so minor adaptations for power saving in connected mode should be considered only if enough time. |
| NEC | Yes | We should strive to minimum enhancement if necessary. In general, we do feel connected mode is less problematic. |

**<Rapporteur Summary>**

# 5 Other Aspects

Other aspects in discontinuous coverage include

* Specifying assistance information that UE can provide to enable the network to detect when and where the UE will be back in coverage [8], [11], [16]
* Extension and updates of related timers, e.g. T301, T320 or T322 [9]
* Details of RRC release initiated by network or by the UE [4]
* Configuring paging windows based on the presence or outage of satellite coverage [12]

However, these details of UE assistance, timer extensions and RRC Release can be discussed once some basic progress and agreements in discontinuous coverage are made.

# 7 Conclusion

**<To be updated after responses from the companies are collected Rapporteur Summary>**

# 8 References

1. RAN2-114-e ChairmanNotes EOM Rev2.
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3. [R2-2107319](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2107319.zip), Discussion on discontinuous coverage, CATT.
4. [R2-2107400](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2107400.zip), UE behavior for Discontinuous coverage in NTN IoT, Rakuten.
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12. [R2-2108116](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2108116.zip), On support of Non-continuous coverage, Nokia, Nokia Shanghai Bell.
13. [R2-210](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_114-e/Docs/R2-2105254.zip)8171, Discussion on discontinuous coverage, Xiaomi.
14. [R2-2108325](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2108325.zip), Support of Non continuous coverage, NEC.
15. [R2-2108336](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2108336.zip), On Discontinuous coverage in IoT-NTN, MediaTek.
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