**3GPP TSG-RAN WG2 Meeting #121 R2-2301952**

**Athens, Greece, Feb 27 – March 03, 2023**

**Agenda item: 8.6.4**

**Source: MediaTek Inc.**

**Title: [AT121][102][IoT NTN enh] Discontinuous coverage (Mediatek)**

**Document for: Discussion and Decision**

# 1 Introduction

This document is aimed at discussing on the open issues, related to Discontinuous Coverage of IoT-NTN and identify potential agreements for possible convergence.

**[AT121][102][IoT NTN enh] Discontinuous coverage (Mediatek)**

Initial scope: Discuss proposals in 8.6.4

Initial intended outcome: Summary of the offline discussion with e.g.:

* List of proposals for agreement (if any)
* List of proposals that require online discussions

Important Dates:

**Deadline for companies' feedback: Wed 2023-03-01 06:00 EET**

**Deadline for rapporteur's summary (in R2-2301952): Wed 2023-03-01 12:00 EET**

# 2 Contact

|  |  |
| --- | --- |
| Company | Delegate Contact |
| MediaTek | Abhishek Roy (Abhishek.Roy@mediatek.com) |
| InterDigital | Brian Martin (brian.martin@interdigital.com) |
| Ericsson | Ignacio Pascual (Ignacio.pascual.pelayo@ericsson.com) |
| Lenovo | Min Xu (xumin13@lenovo.com) |
| Qualcomm | Bharat Shrestha (bshrestha@qti.qualcomm.com) |
| Google | Ming-Hung Tao (mhtao@google.com) |
| Xiaomi | Xiaolong Li (lixiaolong1@xiaomi.com) |
| ZTE | Lu Ting (lu.ting@zte.com.cn) |
| Apple | Yuqin Chen (yuqin\_chen@apple.com) |
| Turkcell | İzzet Sağlam ([izzet.saglam@turkcell.com.tr](mailto:izzet.saglam@turkcell.com.tr)) |
| Sateliot | Ramon Ferrús (ramon.ferrus@sateliot.com) |
| Ericsson | Emre Yavuz ([emre.yavuz@ericsson.com](mailto:emre.yavuz@ericsson.com)), Ignacio Pascual ([Ignacio.pascual.pelayo@ericsson.com)](mailto:Ignacio.pascual.pelayo@ericsson.com)/) |
| Nordic | Jouni Korhonen (Jouni.korhonen@nordicsemi.no) |
| Samsung | j.sedin@samsung.com |
| NEC | Zonghui XIE (xie\_zonghui@nec.cn) |
| CMCC | Jiayao Tan (tanjiayao@chinamobile.com) |
| OPPO | Haitao Li (lihaitao@oppo.com) |
| CATT | zhangxiangdong@catt.cn |
| Novamint | Thierry Bérisot (tberisot@novamint.com) |
| Sharp | Ed Sugiyama (esugiyama@sharplabs.com) |
| Intel | Tangxun (xun.tang@intel.com) |
| Huawei | Xubin(xubin@huawei.com) |
| Nokia | Srinivasan Selvaganapathy (srinivasan.selvaganapathy@nokia.com) |

# 3 Discussion

Discontinuous coverage was originally introduced as part of R-17 IoT-NTN Work Item. In R-18 IoT-NTN Work Item Description (WID), further enhancement to discontinuous coverage has been proposed, as mentioned in table below:

Table 1: Discontinuous Coverage in R-18 IoT-NTN WID

|  |
| --- |
| 4.1.3 Further enhancement to discontinuous coverage  - Study and specify, if needed, mobility management enhancements and power saving enhancements for discontinuous coverage, taking into account the conclusions from the SA2 study FS\_5GSAT\_Ph2. [RAN2, RAN3]. |

Based on these WID objectives, several companies have provided contributions in RAN2 121. These contributions are categorized into different categories for possible discussion and agreements:

## 3.1 UE Assistance on Unreachability Period

Contributions in R2-2300878, R2-2300890, R2-2300982, R2-2301057, R2-2300501 and R2-2301603 have mentioned about UE providing out-of-coverage information as UE assistance to the network. Has further suggested the UE to reuse NR MUSIM procedure to leave RRC\_CONNECTED. Based on these contributions the rapporteur would like to ask the following question:

**Question 1: Do companies agree that UE should provide out-of-coverage information as an assistance to the network (gNB)?**

|  |  |  |
| --- | --- | --- |
| Company | Agree / Not Agree | Comments |
| InterDigital | FFS | SA2 agreed that UE provides unreachability information in the registration request. We need to discuss whether this is sufficient or not. |
| Lenovo | Yes | Information of UE prediction can help in network configuration on connection management as well as PSM. |
| Qualcomm | Yes with comments | In our understanding SA2 solution is to provide the unreachability period in the registration update and based on what CN can configure PSM/eDRX and other timers accordingly. We do not see what eNB will do this information.  If this is about out-of-coverage indication to assist eNB for proper RRC release procedure to optimize resources, e.g., avoiding sudden RLF, then we can discuss it. |
| Google | Yes | Such information can facilitate the network (gNB) to determine when to release a connected UE. |
| Xiaomi | No | Agree with InterDigital that SA2 already agreed that UE provides unreachability information to the CN. There is no need to send the out-of-coverage information to gNB repeatedly. |
| ZTE | Yes with comments | We agree it’s beneficial to inform the out-of-coverage period or unreachability period to RAN node, e.g, for optimization on RRC release or paging.  But we think both UE and core network are the possible nodes to provide this information to RAN node. |
| Apple | Yes | This could to some extent help RAN in terms of resource scheduling. |
| Turkcell | Yes | It should be beneficial for scheduling. |
| Ericsson | Not agree | Considering that it is RAN that provides the satellite coverage information to the UE we do not see the need that the UE provides assistance information on satellite coverage.  It is not clear yet whether there is any impact on RAN specifications due to the conclusions captured in the related SA2 TR. Note that SA2 has made some conclusions regarding the need to provide information on “unreachability periods” from the UE to the CN via NAS signaling. This is based on the assistance information provided in SIB32, which is provided by RAN and the intention seems to be to optimize, for example, eDRX, PSM configurations. |
| Samsung | FFS | As SA2 has agreed that it is done over NAS, I think we need to have a good motivation for it. It is mentioned that it may be needed by eNB for certain procedures discussed by SA2 – this we think should be studied more.  We can discuss indicating out-of-coverage time for the purpose of graceful connection release in earth-moving case, but note that this may for instance be solved through RSRP measurements or similar. Also note that IoT supports extreme repetitions, so a UE can potentially remain in connected mode for a very long time – a good network implementation should release the UE in good time. |
| NEC | Agree | When the satellite stops serving the area it is currently covering, UE would suddenly lose the connection and initiate corresponding recovery actions, i.e., radio link failure recovery, which lead to excessive power consumption for UE. For Network unware of UE’s being out of coverage, it may also lead to waste of energy and sources.  The impact of this problem is more serious for earth moving cells, considering the time for each UE being out-of-coverage varies depending on the UE’s location. |
| CMCC | Yes | The information can assist the network to release the UE. |
| OPPO | No | Share the same view as InterDigital |
| CATT | See comments | It is not sure the meaning of out-of-coverage information, how the eNB will use the out-of-coverage information if provided. for IDLE UE, the eNB will not maintain the information of the UE; for INACTIE UE, the eNB may have the location of the UE, and the eNB can confirmation the UE coverage information. |
| Novamint | Not agree | Same views as Ericsson |
| Sharp | Agree | The out of coverage information may assist with enhancements with determining timing of connection release but should be discussed further |
| Intel | Yes | For a connected UE, it can help NW to release it timely |
| Huawei, HiSilicon | FFS | SA2 already agreed UE centric coverage prediction. We should first discuss whether that information can be reused for RAN to predict the coverage, e.g. provided from CN to RAN. |
| Nokia | FFS | Assistance information need not be known to GNB. UE can make use of this information to optimise release/RLF. But it needs to be further discussed. |
|  |  |  |
|  |  |  |

**Rapporteur Summary**

.

## 3.2a Earth moving cells additional Assistance Information to UE

In earth moving cell, it is possible that when UE attempts to initiate a connection establishment, the remaining time of coverage is too short to complete the connection establishment process. Hence, once the UE predicts the time of losing coverage, it can check whether the remaining time of current cell’s coverage it long enough to accommodate a connection establishment. If the remaining time is too short for the UE to establish a connection, it might be better not initiate the connection establishment to save power consumption. For quasi-earth fixed cell, t-service in SIB31 is provided, it indicates the time when cell stop provide coverage. However, for earth moving cell, there is no information in Rel-17 for UE to predict the time of losing coverage. Based on this understanding, the contributions in R2-2300926, R2-2301106 and R2-2300266 suggest including serving cell footprint information as an optional field in SIB31. Based on these contributions the rapporteur would like to ask the following question:

**Question 2a): Do companies agree that for earth-moving cells, the serving cell footprint information can be broadcast in SIB31 to allow the UE to verify if the remaining time of current cell’s coverage is sufficient to accommodate a new connection establishment.**

|  |  |  |
| --- | --- | --- |
| Company | Agree / Not Agree | Comments |
| InterDigital | Agree | We think a similar solution as NR can be used, however the details are still under discussion. |
| Lenovo | Agree |  |
| Qualcomm | Agree |  |
| Google | - | In NR we had similar discussion on how to determine the stop time of an Earth-moving cell (serving cell). Here the UE can rely on the same signaling/mechanism as in NR to determine when the serving cell will stop providing the coverage, but it should be up to UE implementation whether to continue with the connection establishment even if the remaining time is not enough. |
| Xiaomi | Agree with comment | Agree with Google that the solution discussed in NR NTN session can be reused. |
| ZTE | Not Agree | For discontinuous coverage scenario, the SIB32 can already provide footprint information of serving cell (both earth moving cell and quasi-earth fixed cell are supported). |
| Apple | See comments | We should wait for NR NTN discussion and not duplicate the discussion in two WI(s). |
| Turkcell | Agree |  |
| Ericsson | Agree, but | We suggest postponing the discussion until after RAN2 agrees a solution for NR NTN |
| Samsung | Agree |  |
| NEC | Agree | The LTE and NR solutions should be harmonized as much as possible. |
| CMCC | Partially agree | We agree the similar solution as NR NTN can be used, i.e. the serving cell footprint information can be broadcast in SIB31 for earth-moving cell. However, we think it is up to UE implementation whether to continue the connection establishment if the remaining time of current cell is not enough. |
| OPPO | - | Agree with Google |
| CATT | See comments | Agree to postponing the discussion |
| Novamint | See comments | Need to wait after RAN2 has agreed a solution for NR NTN. In addition, not the highest priority to be addressed considering the use cases targeted by IoT NTN |
| Sharp | Agree | Agree with Ericsson |
| Intel | agree | We can follow NR NTN solution |
| Huawei, HiSilicon | See comments | For the serving cell footprint information, it can be aligned with NR NTN discussion.  For whether to establish an RRC connection, it should be up to UE implementation. |
| Nokia | Agree | UE can calculate the remaining time with footprint. But use of it for triggering connections upto UE implementation |
|  |  |  |
|  |  |  |

**Question 2b) Do the companies agree that the UE will not initiate the connection establishment if this remaining time in the current cell is not sufficient for a new connection establishment.**

|  |  |  |
| --- | --- | --- |
| Company | Agree / Not Agree | Comments |
| InterDigital | FFS | We do not think this is prevented even in R17, it’s up to UE implementation. |
| Lenovo |  | This can be UE implementation. |
| Qualcomm |  | This is up to UE implementation. |
| Google |  | This should be up to UE implementation. |
| Xiaomi |  | It is up to UE implementation. |
| ZTE | Agree | We see some benefit of such process.  Since connection establishment is triggered from NAS, some new AS-NAS interaction may be needed. |
| Apple |  | Up to UE. |
| Turkcell |  | It can be part of the UE implementation. |
| Ericsson | Agree | It is up to UE implementation when to initiate the connection establishment procedure, but it would be beneficial to introduce a configurable threshold that is broadcast by the network to prevent overly optimistic UEs from initiating the procedure unnecessarily. |
| Samsung | FFS | It is not prevented, but note that this is not only for the benefit of the UE, but also the network. A configurable threshold could be an option, or similarly a note in Stage 2 that the UE should not initiate a connection if the remaining time is too short. |
| NEC | See in comment. | In our understanding this is UE implementation, but we are open to discuss whether network should aware of this. |
| CMCC | - | It is up to UE implementation. |
| OPPO |  | It should be up to UE implementation |
| CATT | Agree but | But this can be left UE implementation. |
| Novamint | FFS | Up to the UE – edge case |
| Sharp | FFS | This may be implemented by UE and hence further discussion may be necessary to determine if network should force UE not to execute connection establishment |
| intel |  | It is up to UE implementation. |
| Huawei, HiSilicon |  | UE implementation |
| Nokia |  | UE implementation |
|  |  |  |
|  |  |  |

**Rapporteur Summary**

## 3.2b Additional measurement assistance information

In NR NTN, neighbour satellite information in SIB19 includes, among other things, ephemeris, and cell measurement assistance information, i.e., PCI and carrier frequency. In contrast, the present contents of SIB32 in IoT NTN only encompasses satellite and coverage related information. In R2-2301870, it is proposed to include additional measurement assistance information, such as PCI or carrier frequency, in SIB32 to assist UEs in accelerating measurements and re-gaining uplink sync more efficiently after a coverage gap.

Question 2c) Do companies agree that additional measurement assistance information may help UE accelerate measurements and re-gain uplink sync more efficiently?

|  |  |  |
| --- | --- | --- |
| Company | Agree / Not Agree | Comments |
| Lenovo | FFS | For now we do not see clear need or benefit. |
| Qualcomm | Agree |  |
| Google | FFS | Indeed there might be some gain but it will also bring additional signaling overheads. May need to further study the cost vs. gain before proceeding with the proposal. |
| Xiaomi | Agree | The assistance information can assist UE to access NTN quickly when UE returns to the NTN coverage. |
| ZTE | Not Agree | At least now, we think the existing *serviceInfo* (*tle-EphemerisParameters* and *t-ServiceStart*) and *footprintInfo* in the configuration for the upcoming satellites in SIB32 would be enough. |
| Apple | Agree with the intention | Carrier frequency information is critical when UE performs measurement. |
| Turkcell | Agree |  |
| Ericsson | Agree (proponent) | This type of assistance information, which is already present in NR NTN for neighbor cells, will help UEs in discontinuous coverage to re-gain uplink sync faster, avoid missing Paging Occasions, and save power during cell (re-)selection. |
| Samsung | FFS | We are a bit confused by the paper. It mentions leveraging similar configurations in between different NTN coverage cells.  The problem in this question is a bit unclear. Why is the additional measurement assistance information needed? A UE can use stored information – likely from the previous satellite pass on what frequency is used. Or is it imagined that different satellites are using different frequencies? |
| CMCC | FFS |  |
| OPPO | FFS | We are not sure how much gain it would bring. |
| CATT | FFS | Agree with Google. |
| Novamint | FFS | Agree with the intention and same views as Google |
| Sharp | Agree | The use of RRC signalling for satellite information will also allow moving UEs to accurately determine discontinuous coverage times |
| Intel | Agree |  |
| Huawei, HiSilicon | FFS | We should check RAN4’s progress on measurement requirement of neighbour cell for IoT-NTN first. |
| Nokia | Agree | This information will be useful for quick sync when UE returns to in coverage |
|  |  |  |
|  |  |  |
|  |  |  |

**3.3 Use of Dedicated signalling**

In R-18 IoT-NTN the option of providing satellite assistance information via dedicated signalling was raised and discussed briefly. However, it was not pursued due to lack to time. The contributions in R2-2300926, R2-2301254 and R2-2301870 suggest using dedicated RRC signalling for providing satellite information. Based on these contributions the rapporteur would like to ask the following question:

**Question 3: Do companies agree that dedicated RRC signalling will be used for providing satellite information corresponding to discontinuous coverage?**

|  |  |  |
| --- | --- | --- |
| Company | Agree / Not Agree | Comments |
| InterDigital | Agree | To overcome broadcast signalling limitation this seems like a reasonable approach. |
| Lenovo | Agree | OK to have |
| Qualcomm | Agree |  |
| Google | No strong view |  |
| Xiaomi | Agree |  |
| ZTE | Not Agree | The high level against reason is that we should not provide satellite information that is common to many UEs via dedicated signalling. That’s signalling inefficient.  Moreover, it’s already possible to include different satellites in different SIB32. And UE can decide which satellites have been received via satellite ID. |
| Apple | No strong view | We are open for discussion. |
| Turkcell | Agree |  |
| Ericsson | Agree | We think this would be beneficial to overcome the TBS limitations when broadcasting system information. |
| Nordic | Agree |  |
| Samsung | Agree | We think it can be done via RRC release. The reason is because otherwise we would have to define some type of request procedure to request the dedicated RRC signalling and an RRC release message is when the UE actually needs the information. |
| NEC | FFS | We need more discussions on the pros of RRC signalling. |
| CMCC | Agree | It can provide more satellite assistance information. In addition, other solutions, e.g. SIB segmentation, multiple SIBs can also be considered. |
| OPPO | Disagree | Providing satellite information corresponding to discontinuous coverage via SIB is sufficient. No need to use dedicated RRC signalling |
| CATT | See comments | For the connected UE, we wonder if there are any more satellites in addition to the ones broadcast in SIB.  But for INACTIVE UE, we think it is useful to provide multi-hop satellites information for coverage prediction. |
| Novamint | No strong view | We are open for discussion |
| Sharp | FFS | By default, idle mode suspends the mentioned processes. If the intention is that the processes are suspended before transitioning to idle mode, i.e., before rrc connection release, then further discussions are needed. |
| Intel | Not agree | It’s sufficient to use broadcast signalling |
| Huawei, HiSilicon | Maybe not | We don’t see a strong motivation for this and how the current broadcast is not enough. |
| Nokia | Agree | Will allow UE specific target cell information and selected parameters instead of complete SIB. |
|  |  |  |

## 3.4 Connected Mode Changes

UE behaviour in connected mode is discussed in R2-2300501, R2-2300582, R2-2300751 and R2-2301254. Almost all these contributions suggest that upon detecting discontinuous coverage UE will enter the idle mode and suspend RLM, RLF detection, and RRC re-establishment process. Based on these contributions the rapporteur would like to ask the following question:

**Question 4a): Do companies agree that upon detecting discontinuous coverage a connected UE will enter the idle mode and suspend RLM, RLF detection, and RRC re-establishment process?**

|  |  |  |
| --- | --- | --- |
| Company | Agree / Not Agree | Comments |
| InterDigital | FFS | The question doesn’t make sense. If UE enters RRC\_IDLE then there is no RLM/RLF to suspend. We think that one of the following options make sense:   1. UE is released to RRC\_IDLE 2. UE stays in RRC\_CONNECTED and suspends RLM/RLF. |
| Lenovo | FFS | This depends on Q1, i.e.:  If UE can report its prediction, network can release UE at right time and thus suspending RLM, RLF detection, and RRC re-establishment process is not necessary.  Else UE can suspend RLM, RLF detection, and RRC re-establishment process based on its prediction. |
| Qualcomm | See comments | We have similar view as InterDigital. Declaring discontinuous coverage means UE will go to IDLE mode, there is no RLM/RLF. |
| Google | Yes | Agree with InterDigital that we may need to change the sequence of the UE behaviors in this question. The UE should first suspend RLM, RLF detection and RRC reestablishment, and then enters the idle mode. |
| Xiaomi | See comments | A connected UE will go to idle mode when detects the discontinuous coverage and there is no need to suspend RLM, RLF detection, and RRC re-establishment. |
| ZTE | FFS | We are not clear what’s the details of “UE stays in RRC\_CONNECTED and suspends RLM/RLF” and what’s the benefit?  In R17, it’s already allowed that UE goes to IDLE silently when the current coverage stops. In R18, we are open to discuss the optimization on RRC release and reusing PSM/eDRX. |
| Apple | See comments | The normal case is network would take care of it and release UE to idle.  If network does not do so, UE may encounter into two cases. One is UE would be out of coverage for a long time where UE is free to avoid performing RRC reestablishment. But if the “out of coverage” state is temporary, UE can still follow legacy behavior (declaring RLF/performing RRC re-establishment) but only skip RRM. |
| Turkcell | FFS | The question isn’t clear for us. The UE should be in connected mode to suspend RLM/RLF |
| Ericsson | Not agree | The question is not formulated clearly. Maybe the rapporteur intended to make a reference to RLF and wanted to discuss whether the UE should move to idle mode while suspending AS functionality related to RLF and RRC re-establishment in NTN? |
| Nordic | FFS | Agree Apple’s comments. |
| Samsung | FFS | As explained in Q1, it can be discussed. However, what is likely to happen when a UE is connected to a larger earth-moving NTN cell is that the coverage will continuously slowly getting worse and the RSRP will degrade, causing more and more repetitions needing to be performed to maintain connectivity. A good network implementation would release the UE in time before the repetitions get excessive. |
| NEC | See in comment | Upon detecting discontinuous coverage, it is reasonable to introduce mechanisms to avoid unnecessary recovery actions. |
| CMCC | Yes | Agree with InterDigital. |
| OPPO | Yes | It is beneficial for UE power saving |
| CATT | Agree with ZTE |  |
| Novamint | FFS | Agree with Apple’s comments. |
| Intel | Not agree | We suggest to follow legacy, i.e., released by NW |
| Huawei, HiSilicon | FFS |  |
| Nokia | FFS | Simple solution will be to allow UE to enter into IDLE mode. UE can make use of leave indication in UAI to inform the same and release the connection after timeout. RLF and Re-establishment enhancements may be needed depending on the time to re-enter into coverage. |
|  |  |  |
|  |  |  |

**Rapporteur Summary**

Some companies have also suggested enhancements of RRC release procedure to support the discontinuous coverage. While the contribution in R2-2301057 suggests a new “Release Reason”, the contribution in R2-2301254 suggests releasing UE before discontinuous coverage and providing the new cell information for quick recovery. On the other hand, the contribution in R2-2301106 suggests introducing a redirect message to the UE. Based on these contributions the rapporteur would like to ask the following question:

**Question 4b): Do companies agree that RRC Release message needs some changes/enhancement to enhance discontinuous coverage?**

|  |  |  |
| --- | --- | --- |
| Company | Agree / Not Agree | Comments |
| InterDigital | FFS | It is not clear what the reason is. Already in R17 the NW can release the UE, and UE is allowed not to perform idle mode tasks.  The main purpose would be to ensure UE comes back afterwards, we think it would be better to keep UE connected or suspended (e.g. in this case perhaps RRC Release can indicate certain things for suspend) for this purpose. |
| Lenovo | Yes | More information can be provided to UE e.g., configuration for resuming connection after the coverage interruption. |
| Qualcomm | Not agreed | Motivation is not clear what change and what is its UE impact. |
| Google | Not agree | Not clear what are the benefits of enhancing the RRC Release message. It looks like some of the benefits can be already achieved if we can agree question 4a) |
| Xiaomi | Not agree |  |
| ZTE | Yes | A new release reason, e.g., ‘Release due to discontinuous coverage’ as that introduced in RAN3, can be introduced in RRC release message for indicating UE to stop the subsequent AS layer processes after it is released to idle mode.  In other word, this new reason is used to differentiate the release due to discontinuous coverage from the normal release. |
| Apple | FFS |  |
| Turkcell | FFS |  |
| Ericsson | Maybe | This depends on what sort of changes/enhancements RAN2 intends to make. For example, it would be good to discuss if RAN2 should introduce any means as part of the release message to prevent UEs from initiating connection establishment if there is data pending in the UL. |
| Nordic | FFS | Related to e.g. Q4a there could be additional information added. |
| Samsung | Agree | We agree that a new release reason could be useful.  Actually we think that the dedicated RRC satellite assistance information would optimally be in a release message.  However the point in R2-2301106 is that when a UE is re-directed towards a NTN discontinuous coverage network, there needs to be further information provided such as satellite assistance information. This is because the idle mode procedures when re-directed may not work well if the discontinuous coverage network is not present at that specific moment. If this is not available, then entering a discontinuous coverage network is a bit of a power consuming chicken and egg problem, where you need SAI to know when to wake up to connect to the cell, but you need to connect to the cell to receive SAI. |
| NEC | FFS | It depends on the network behaviour when aware UE is approaching coverage hole. |
| CMCC | Agree | It is similar to Q3 that more information can be provided to the UE for prediction of discontinuous coverage or quick recovery. |
| OPPO | Disagree |  |
| CATT | Agree | The detail can be discussed. |
| Novamint | FFS | Depends on the enhancements sought |
| Sharp | Agree | RRC Release will suspend tasks mentioned in Section 3.4 question 4a. Furthermore, the release message may provide additional information such as duration of discontinuous coverage |
| Intel | Not agree |  |
| Huawei, HiSilicon | No | Don’t see the clear benefit for the new reason. |
| Nokia | Yes | Some assistance information related to latest changes which can help to fine tune the out of coverage prediction may be useful. |
|  |  |  |

**Rapporteur Summary**

## 3.5 Paging and Power Saving Issues

Many companies have suggested changes and improvements in paging and power saving aspects. The contributions in R2-2300582, R2-2300654, R2-2300751, R2-2300926, R2-2300982, R2-2301057 and R2-2301603 have suggested extension of monitoring, PTW adjustment, updating the PH and PO calculations, eDRX enhancements etc. As the solutions are quite wide, the rapporteur would first like to ask the following question:

**Question 5: Do companies agree that enhancement in paging and eDRX are needed to enhance discontinuous coverage?**

|  |  |  |
| --- | --- | --- |
| Company | Agree / Not Agree | Comments |
| InterDigital | Agree | All of the proposed options have pros and cons, we at least agree that it’s not always possible to ensure existing eDRX parameters can be matched to coverage and therefore the possibility exists that UEs can be unreachable for long periods of time.  We think this proposal would be a good first step then we can discuss the various options. |
| Lenovo | Agree | At least for PSM configuration. |
| Qualcomm | Not agree | Enhancement to paging and eDRX is not in RAN2 scope. |
| Google | Agree | But the details may need to be discussed in SA2 or CT1 instead of RAN2. |
| Xiaomi | Not agree | We understand the proposed the enhancements is discussing in SA2 and CT1. |
| ZTE | Agree | Similar view as InterDigital.  And we think there are impacts on RAN2. |
| Apple | Agree | We agree that some of the solutions involve SA2/CT1 but RAN2 can initiate the discussion. |
| Turkcell | Agree |  |
| Ericsson | Agree | OK to discuss the potential enhancements for paging and eDRX within the context of discontinuous coverage. |
| Nordic | Agree |  |
| Samsung | FFS | We can wait until SA2 and CT1 has progressed. |
| NEC | Agree | At least from UE perspective, there should be some modifications for paging monitoring and eDRX behaviours considering discontinuous coverage. |
| CMCC | Agree | The details can be further discussed. |
| OPPO |  | It should be discussed in SA2 |
| CATT | Agree | At least for INACTIVE UE, RAN2 can give some discussion. |
| Novamint | Agree |  |
| Sharp | Agree/FFS | Enhancements to paging, eDRX and possible PSM have potential to match the discontinuous coverage period and hence, radio activities will be limited during no coverage period. Therefore, recommend further discussion |
| Intel | agree |  |
| Huawei, HiSilicon | Agree | In case of different satellite over time, the configured eDRX may not match with the coverage windows, which may cause service delay. |
| Nokia | Agree | Paging enhancements and eDRX changes for DC to be addressed in SA2 mainly. For further course adjustments of PTW there can be assistance information to RAN. |

**Rapporteur Summary**

**.**

## 3.6 Store Forward Architecture

The joint contribution in R2-2301886 by IoT-NTN operators suggests extending IoT-NTN in Store and Forward mode to facilitate cost-effective deployment of IoT NTN services and enable an immediate operational service with sparse LEO constellations and reduced ground segment infrastructure. According to this contribution, this could be simply performed by adding a new optional information element in SystemInformationBlockType31 to signal that the cell is operating in store and forward mode. Based on this contribution the rapporteur would like to raise the following question:

**Question 6: Do companies agree to include a new IE in SIB 31 to signal that the cell is operating in store and forward mode?**

|  |  |  |
| --- | --- | --- |
| Company | Agree / Not Agree | Comments |
| InterDigital | Not agree / FFS | While we have nothing against the technical proposal, since this is discussed in the context of a SA1 Rel-19 study and not currently in the scope of the R18 RAN work item then the issue is a matter for RAN, we don’t think RAN2 can make any decision at this time. |
| Lenovo | FFS | Not quite sure about the necessity. |
| Qualcomm | Not agree | It is not clear what is store and forward, there is no description in specification. What is UE’s different behavior based on this indication.  So this is not just introduction of a bit indication. It requires more work across different working groups for something that is not part of WID objective. |
| Google | FFS | We agree with InterDigital. |
| Xiaomi | FFS | We think it was discussed during the R18 workshop, but it was not included in the WID finally. |
| ZTE | Not agree | Similar view as InterDigital (this is still under discussion of R19 requirements) and Qualcomm.  We also not clear what’s the relationship between store/forward mode and regenerative payload? In current spec, only transparent payload is supported. |
| Apple | FFS | First, we also think this is a Rel-19 feature.  Second, our understanding is store and forward can only work in regenerative payload mode, the feasibility of which in Rel-18 is not clear now. |
| Turkcell | FFS | It can be port of Rel-19. |
| Sateliot | Agree | Description of the S&F concept and use cases are reported in TR 22.865 since v0.1.0 (September 2022).  While we agree that there are several aspects related to the support of S&F operation that needs further studies and that Rel-19 could be the proper placeholder for that work, we think the proposed modification is a low-hanging fruit that would allow a minimum support for S&F already from the initial IoT NTN specs.  In our view, in the same way that discontinuous coverage is expected to be key for initial service delivery with sparse LEO constellations, S&F support is also seen key for initial service delivery in areas visited by the satellites where there is no ground infrastructure deployed.  Indeed, the support of S&F operation mode is the approach being already taken by some satellite companies such as Sateliot, and puts the 3GPP IoT NTN solution on par with other non-3GPP solutions intended for massive satellite IoT, which natively already supports S&F. |
| Ericsson | FFS | Further discussion is needed on whether including a new IE in SIB31 would be the best solution to address the store forward architecture described in the related contribution, but first the proposal needs to be discussed in RAN. |
| Nordic | FFS | Agree for the need and usefulness. However, agree also with the expressed release concerns. |
| Samsung | FFS | Store and Forward is an interesting topic, but was not included in the WID. We also further understand that this is likely deployment mode for IoT NTN.  What we understand from the contribution is that there may be minor enhancements introduced in RAN2 to support this, where most of changes are either done in CT1 or SA2. The issue is that neither SA2 or CT1 is dealing with this topic. If SA2 or CT1 treats this topic and then comes back with small changes needed, then we can introduce them.  But at this point it is not clear how the technical changes should be used by a UE. |
| NEC | Not Agree | It’s out of R18 scope. It can be discussed in later release when we have a clearer picture on how this indication works. |
| CMCC | Not agree in R18 | We share similar view with InterDigital. |
| OPPO | Disagree | Agree with Qualcomm |
| CATT | FFS |  |
| Novamint | Agree | The intention here is only to address a low hanging fruit which is informing the UE when the serving satellite is in Store and Forward operational mode. This is a minimum to be supported in line with current market needs and which will be extremely beneficial to the targeted use cases to be supported by IoT NTN:  - Asset tracking: it is very valuable for the UE to know when the serving satellite is in Store and forward mode and when is not as the asset will be moving from one situation to another  - Asset monitoring: it is as well very valuable as the situation of the serving satellites of a stationary UE can change in the life of a constellation: new ground station supported so feeder link is now available for the serving satellite or at the opposite, issue with the ground station and no more feeder link available for the UE serving satellite(s) |
| Sharp | FFS |  |
| Intel | Not agree | This is a R19 topic |
| Huawei, HiSilicon | FFS | Not in the scope of R18. |
| Nokia | FFS | This functionality is needed for DC scenario which also includes DC towards CN connectivity. But to be discussed in next release |
|  |  |  |

**Rapporteur Summary**

## 3.7 Others

Other contributions on this topic include the following:

* Specify AS-NAS interactions: R2-2300501, R2-2301057 supports, R2-2300926 opposes
* supporting discontinuous coverage in Inactive state: R2-2300751
* providing TN coverage information in discontinuous coverage: R2-2301188

As the support for most of these proposals is less and some might need SA2’s involvement, rapporteur would like not to raise discussions on these aspects in the current meeting.

# 4 Conclusion

**<To be Uploaded later>**

# 5 References

|  |  |  |
| --- | --- | --- |
| [**R2-2300206**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2300206.zip) | Discussion on enhancements to discontinuous coverage | CATT |
| [**R2-2300266**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2300266.zip) | On Enhancements to discontinuous coverage | MediaTek Inc. |
| [**R2-2300501**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2300501.zip) | Impact of the UE Unreachability Periods on UE AS | Google Inc. |
| [**R2-2300582**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2300582.zip) | IoT-NTN discontinuous coverage enhancements | Interdigital, Inc. |
| [**R2-2300654**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2300654.zip) | Discussion on power saving enhancements for supporting discontinuous coverage | Spreadtrum Communications |
| [**R2-2300751**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2300751.zip) | Support on discontinuous coverage in IoT NTN | Apple |
| [**R2-2300878**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2300878.zip) | Considerations on Supporting Discontinuous Coverage | NEC Europe Ltd |
| [**R2-2300890**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2300890.zip) | RRC release procedure in discontinuous coverage | Qualcomm Incorporated |
| [**R2-2300926**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2300926.zip) | On IoT-NTN enhancements for discontinuous coverage | Nokia, Nokia Shanghai Bell |
| [**R2-2300982**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2300982.zip) | On mobility and power saving issues for discontinuous coverage | Lenovo |
| [**R2-2301057**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2301057.zip) | Discussion on discontinuous coverage enhancements | ZTE Corporation, Sanechips |
| [**R2-2301106**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2301106.zip) | Discontinuous coverage enhancements | Samsung Electronics Nordic AB |
| [**R2-2301188**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2301188.zip) | Discussion on enhancements to discontinuous coverage | Xiaomi |
| [**R2-2301210**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2301210.zip) | Discussion on the discontinuous coverage | Huawei, Turkcell, HiSilicon |
| [**R2-2301254**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2301254.zip) | Discussion on the discontinuous coverage for IoT-NTN | CMCC |
| [**R2-2301603**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2301603.zip) | Discussion on enhancement to discontinuous coverage for IoT NTN | Transsion Holdings |
| [**R2-2301862**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2301862.zip) | Complementing discontinuous coverage with minimum support for discontinuous feeder link operation | Sateliot, GateHouse, Novamint, Intelsat, Airbus |
| [**R2-2301870**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2301870.zip) | IoT NTN Enhancements to discontinuous coverage | Ericsson |
| [**R2-2301886**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121/Docs/R2-2301886.zip) | Complementing discontinuous coverage with minimum support for discontinuous feeder link operation | Sateliot, GateHouse, Novamint, Intelsat, Airbus, Hispasat, ESA, TNO |