**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

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| --- | --- |
| 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) |
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# 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

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| --- |
| 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. |
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**Rapporteur Summary**

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## 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 |
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**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.**

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| --- | --- | --- |
| 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. |
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## 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?

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| --- | --- | --- |
| 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. |
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**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?**

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| --- | --- | --- |
| 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 |  |
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## 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?**

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| 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. |
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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?**

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| --- | --- | --- |
| 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. |
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**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?**

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| --- | --- | --- |
| 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 |  |
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**Rapporteur Summary**

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## 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?**

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| --- | --- | --- |
| 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. |
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**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

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| [**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 |