3GPP RAN WG2 Meeting #122 R2-230xxxx

Incheon, Korea, May 22nd – 26th, 2023

Agenda Item: 7.6.4

Source: Huawei, HiSilicon (Rapporteur)

Title: Report of [Post122][113][IoT NTN Enh] Discontinuous coverage (Huawei)

Document for: Discussion, Decision

# Introduction

This document is intended to discuss possible enhancements for discontinuous coverage (e.g. paging enhancements, RRC connection release enhancements, UE behaviour when in discontinuous coverage) based on contributions submitted to RAN2#122, as per the following:

* [Post122][113][IoT NTN Enh] Discontinuous coverage (Huawei)

Scope: Discuss possible enhancements for discontinuous coverage (e.g. paging enhancements, RRC connection release enhancements, UE behaviour when in discontinuous coverage)

Intended outcome: Summary of the email discussion

Deadline for companies' feedback: Monday 2023-08-08 10:00 UTC

Deadline for rapporteur's summary: Thursday 2023-08-10 10:00 UTC

# Contact information

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| --- | --- |
| Company | Email address |
| NEC | xie\_zonghui@nec.cn |
| Qualcomm Inc. | bshrestha@qti.qualcomm.com |
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# Background

In RAN2#121 the following agreements were made:

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| Agreements:   1. RAN2 can continue to check whether dedicated RRC signalling can be used for providing satellite information corresponding to discontinuous coverage. 2. RAN2 will support enhancements in paging and eDRX, in alignment with the work in SA2 and CT1. FFS on the details 3. RAN2 may consider enhancements for connected UE upon detecting discontinuous coverage (e.g., suspend RLM, RLF detection, and RRC re-establishment process) 4. Companies supporting the store and forward approach can bring a proposal to the plenary for TEI18 or for updating the WID |

In RAN2#121bis the following agreements were made:

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| Agreements:   1. RAN2 will not introduce any enhancement to allow a UE in RRC Connected to stay in RRC\_CONNECTED during/after a coverage gap (e.g. suspend RLM/RLF, activation time in RRC Reconfiguration, CHO enhancement) 2. RAN2 to introduce enhancement to RRC Release using one of the following options (FFS which one):   - Explicit RRC Release using a new RRC Release cause  - UE Autonomous release (e.g. timer based or upon detection of coverage gap) |

# Discussion

## Discussion of paging enhancements

The following summarizes contributions from RAN2#122 discussion paging ehancements:

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| References | Proposals |
| [1] | Proposal 1: Introduce paging offset to solve the misfit issue of the PH/PTW which is currently determined by UE ID.  Proposal 2: Consider the PTW extension solution as a complementary solution.  Proposal 3: UE assistance information via NAS signaling (unreachability period in TAU) can be used for PTW adjustment when UE finds out the mismatch issue.  Proposal 4: Send an LS to SA2/CT1 on unevenly distributed coverage period caused by unevenly distributed satellite from multiple satellites. |
| [2] | Proposal 7：UE/NW autonomous adjustment can be considered for paging and eDRX enhancement |
| [3] | Proposal 2: There is no RAN impacts to adjust the PTW configuration. It is up to UE and eNB implementation to skip the PTW within the discontinuous coverage. |
| [5] | Proposal 2：The network can predict multiple coverage windows by implementation and takes them into account when paging a UE. |
| [6] | Proposal 5: Update the PTW if it falls in a coverage gap by applying an offset. FFS how to determine/configure the offset.  Proposal 6: Send an LS to SA2 indicating that RAN2 <have agreed/are considering> shifting the PTW if it falls in a coverage gap, asking what the content/granularity of “UE unreachability period is, whether it can be provided to the gNB, and whether adjusting the PTW is feasible from SA2 point of view. |
| [8] | Proposal 4: RAN2 confirm the PTW position should be configurable (FFS to configure one or multiple PTW positions, FFS the configuration is an offset or replacement of the calculated PTW position), send LS to SA2/CT1 asking for collaboration. |
| [9] | Proposal 5: The PSM and eDRX configurations can be configured to align with the estimated UE unreachability period. The configuration is out of RAN2’s scope.  Proposal 6: Network can extend the paging before/after the coverage window if the UE does not respond to paging within the estimated coverage window.  Proposal 7: UE can extend the paging monitoring outside the estimated coverage window if radio coverage is available. UE may report to the network to realign the paging monitoring and coverage windows.  Proposal 8: UE may report to the network to realign the paging monitoring and coverage windows if UE notices there is radio coverage before or after the expected reachability period.  Proposal 9: RAN2 to discuss how to handle UE movement within the same TA during discontinuous coverage. |
| [12] | Proposal 1: In order to ensure that the UE can be reachable when paging arrives, the PTW should aligns with the time duration of coverage and the following two options can be taken into further consideration:  Option 1: both UE and network adjust PTW based on a predefined rule  Option 2: network provides multiple PTW info  Proposal 2: From RAN2 point of view, the existing PSM mechanism needs to be enhanced in order to get better power effect.  Proposal 3：The PSM starting mechanism needs to be modified to adapt to the scenario of discontinuous coverage.  Proposal 4: A time threshold needs to be introduced for UE to determine whether to start T3324 timer. |
| [13] | Proposal 3: The CN should be aware of the UE’s discontinuous coverage period to CN to avoid paging issues.  Proposal 4: The satellite assistance information or the discontinuous coverage information predicted by UE can be provided to CN for paging. |
| [14] | Proposal 1: The issue that UE ends up with no PTW in the in-coverage period should be addressed.  Proposal 2: AMF configures the start position (PH) of PTW window. |
| [15] | Proposal 1a: If legacy eDRX is used for keeping alignment between UE and NW during discontinuous coverage, in order to align the starting time of PTW with the out-of-coverage period or unreachability period, it’s suggested to introduce a configurable offset to shift the starting time of PTW.  Proposal 1b: The out-of-coverage period or unreachability period should be informed to RAN, e.g., from core network node, to assist RAN to provide a more appropriate paging schedule for UE in idle mode. |

Rapporteur understands the issue mainly comes from that it may be difficult for the CN to align the the configuration of eDRX/PTW with the distribution of coverage windows, leading to no PTW in a coverage window. The potential causes for the issue are as follows:

* The coverage window may be unevenly distributed while the eDRX/PTW is evenly configured
* The position of PTW within the eDRX cycle is determined by the formular rather than configured by CN
* The UE may move within one TA, so that the previous discontinuous coverage information referred to by CN for configuring the PTW is outdated

Solutions are provided by some of the proposals to solve this issue while there is also opinion that this can be left to NW implementation.

Based on the above, the following question is asked:

**Q1a) Which of the following options do you prefer for paging enahncements?**

* **Option 1:** The start position of PTW can be adjusted by gNB and UE based on the discontious coverage information, FFS by an configured offset or by pre-defined rule (The gNB needs to be aware of the discontinuous coverage information)
* **Option 2:** Leave it to NW implementation
* **Option 3:** Others (Please describe)

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| **Company** | **Prefered Option** | **Additional comments** |
| NEC | Option1 with comments | We prefer option1, because UE and network has to be aligned with regarding to where the adjusted PTW is.  Suggest to change gNB=> NW in the sentence “(The gNB needs to be aware of the discontinuous coverage information)” or delete this sentence. For paging enhancement purpose, it can be either gNB or CN needs to be aware of the disconitnous coverage information depending on who adjusts the PTW. |
| Qualcomm | Option 2 | Core network knows UE’s ID and when exactly the eDRX/PTW starts and when UE will become unreachable. PTW start error is rather small by 2.56s.  SA2/CT1 is working on UE reporting unavailability period to resolve issue. Network does not need to accept the same value reported by UE. It can also set proper values for unreachability period to align with eDRX. Network could configure eDRX properly or with shorter eDRX cycles. Network can also ask UE to send “in-coverage” indication at the end of unavailability period or can configure PSM or can configure proper value of periodic TAU timer.  During unreachability period, UE can go to sleep regardless of coverage or PTW. This is the one enhancement we should work in our scope.  PTW/eDRX is configured by core network so UE or RAN should not be adjusting it autonomously. Therefore, this whole enhancement should be mainly in the scope of SA2. |
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Besides, it is also mentioned by some proposals that an LS is needed to SA2.

**Q1b) Do you think an LS to SA2 is needed?**

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| **Company** | **Yes/No** | **Additional comments** |
| NEC | Yes |  |
| Qualcomm | Yes | As described in Q1a, coordination is needed with SA2. |
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## Enhancements of RRC connection release

The following summarizes contributions from RAN2#122 discussing enhancements of RRC connection release:

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| References | Proposals |
| [1] | Proposal 5: Do not introduce new release cause for coverage gap in RRCRelease message. |
| [2] | Proposal 5：No new RRC Release cause is needed for discontinuous coverage scenario.  Proposal 6：UE Autonomous release enhancement for discontinuous coverage is not needed, if AMF/MME shares the UE unreachability period to RAN node. |
| [3] | Proposal 3: A new cause value ‘Release due to discontinuous coverage’ is introduced in RRCRelease message.  Proposal 4: The UE can provide the out-of-coverage information to RAN node for e.g, optimization on RRC release or paging.  Proposal 5: The UE out-of-coverage information can be kept by RAN node when the UE enters into idle mode. |
| [5] | Proposal 1: UE can indicate “RRC\_IDLE” to the Network as the preferred RRC state when it is going to enter a coverage gap and start a timer, similar as the mechanism designed by R17 MUSIM. |
| [6] | Proposal 2: RAN2 to discuss what new behaviour is expected from the UE when NW releases the UE using a new cause e.g. “discontinuous coverage” in the following cases:  Case 1: Release to RRC\_IDLE  Case 2: Release to RRC\_INACTIVE |
| [8] | Proposal 1: Consider to support UE providing assistance information on being out-of-coverage to gNB for RRC connection management.  Proposal 2: Consider to include remaining coverage time in out-of-coverage information. |
| [9] | Proposal 10: RAN2 to discuss support for UE request for RRC connection release based on DC estimation. FFS support for implicit RRC connection release. |
| [10] | Proposal 1 If the UE is able to predict when the discontinuous coverage starts, reuse NR MUSIM procedure to leave RRC\_CONNECTED state where the UE indicates the out-of-coverage to network and starts an out-of-coverage timer.  Proposal 2 Reuse NR MUSIM timer T346g behavior, i.e., upon expiry of the out-of-coverage timer, the UE performs the actions upon leaving RRC\_CONNECTED, with release cause 'other'.  Proposal 3 Further discuss the details on the values of the out-of-coverage timer and message to carry out-of-coverage information. |
| [11] | Proposal 3: UE autonomous release for discontinuous coverage is not pursued.  Proposal 4: Explicit RRC Release using a new RRC Release cause for discontinuous coverage is introduced.  Proposal 5: Certain idle mode procedures are paused if a UE receives an RRC release with the new RRC release cause.  Proposal 6: The new RRC release cause is used to re-direct a UE from a non-discontinuous coverage network to a discontinuous coverage network.  Proposal 7: Discontinuous coverage-related information is provided in a re-direct message when being re-directed to a discontinuous coverage network. |
| [13] | Proposal 5: The explict RRC release using a new RRC Release cause(e.g. coverage discontinuity) can be used before the covearage gap. |
| [15] | Proposal 2a: 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.  Proposal 2b: An AS-NAS interaction (e.g., an indication from AS to NAS) also needs to be introduced for indicating UE to stop the subsequent NAS layer processes after it is released to idle mode due to discontinuous coverage.  Proposal 2c: The legacy IE extendedWaitTime can be reused to stop the subsequent NAS layer processes after UE is released to idle mode due to discontinuous coverage. The extension to the value range of extendedWaitTime needs to be discussed.  Proposal 2d**:** The UE in connected mode could provide out-of-coverage period or unreachability period information as an assistance to the network (eNB). |

During RAN2#121bis, the following agreement was made:

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| **Agreement:**  RAN2 to introduce enhancement to RRC Release using one of the following options (FFS which one):  - Explicit RRC Release using a new RRC Release cause  - UE Autonomous release (e.g. timer based or upon detection of coverage gap) |

There are proposals for either of the two solutions and it is also noted that there is also opinon that neither of the two solutions is needed.

Based on the above, the following question is asked:

**Q2) Which of the following options do you prefer for enahncements of RRC connection release?**

* **Option 1:** Explicit RRC Release using a new RRC Release cause (The gNB needs to be aware of the discontinuous coverage information)
* **Option 2:** UE Autonomous release (e.g. timer based or upon detection of coverage gap)
* **Option 3:** No enhancement is needed

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| **Company** | **Prefered Option** | **Additional comments** |
| NEC | Option 1 | There are two cases for UE leaving RRC\_CONNECTED after provding out-of-coverage information:   * Awaring of UE is going to lose the coverage, eNB can release UE explicitly. * After providing the out-of-coverage information, upon declaring RLF, UE skip cell search and leave RRC\_CONNECTED directly. |
| Qualcomm | Option 2  See comment, probably (option1+option2) | Option 1 is not clear on what is new change other than a new RRC release cause. If network wants to release a UE, it can do that any time, it does not have to wait until coverage is gone.  It is also not clear what is the purpose of the new release cause. Regardless of release cause, UE and eNB both would know DC is going to happen and follow that procedure. AS NAS interaction on DC is already left to UE implementation.  However, option 2 handles the situation where UE and network might have DC state mismatch. It is not a new concept as it is already supported in MUSIM.  After providing out-of-coverage information, UE either can receive RRC release (or any pending DL data) from network or let the timer expire to go to IDLE mode autonomously. |
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## UE behaviour in discontinuous coverage

The following summarizes contributions from RAN2#122 discussing UE behaviour in discontinuous coverage:

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| References | Proposals |
| [2] | Proposal 9: If the remaining time of current cell’s coverage is not sufficient to accommodate a new connection establishment, the UE behavior can be left to UE implementation, no specification impact is expected. |
| [3] | Proposal 6: It is up to UE implementation whether to initiate the connection (re)establishment if the remaining time in the current cell is not sufficient for a new connection establishment, additional assistance information is not needed. |
| [5] | Proposal 3：After RLF is triggered, UE enters RRC\_IDLE if the remaining serving time is less than a threshold in discontinuous coverage scenario. |
| [6] | Proposal 3: It is beneficial in terms of UE power saving if the UE can enter RRC\_IDLE upon detecting a coverage gap without executing the RLF procedure. |
| [8] | Proposal 3: After providing the out-of-coverage information, UE follows legacy operation in declaring RLF but skip cell search, and leave RRC\_CONNECTED directly. |
| [9] | Proposal:11 leave the decision on whether the UE initiates the connection (re-) establishment to the UE implementation when the remaining time in the current cell during discontinuous coverage is insufficient to complete a new connection establishment procedure  Proposal 12: RAN2 to discuss UE behavior when the UE has limited remaining GNSS validity duration and the remaining discontinuous coverage time is also short. |
| [11] | Proposal 2(a): The UE verifies whether it has sufficient coverage time to complete a given RRC procedure (or a new connection establishment).  Proposal 2(b): The UE initiates a given RRC procedure if it has sufficient coverage time to complete this procedure. Otherwise, the UE will not initiate the procedure or will wait for the next available satellite coverage period. |
| [14] | Proposal 3: If UE is in discontinuous coverage, there is no need to perform recovery during T1 and T2. |

Based on the above proposals, there are two kinds of opinions related to the UE behaviour when RLF is triggered, upon detecting a discontinuous coverage. One is that it is beneficial for UE to directly go to RRC\_IDLE if anyway there is not enough time for the UE to finish the procedure of RRC re-establishement due to the discontinuous coverage. The other one is that this can be left to UE implementation. Based on this, the following question is asked:

**Q3) Do you think it is beneficial for the UE** **to directly go to RRC\_IDLE after RLF is triggered, if there is not enough time for the UE to finish the procedure of RRC re-establishement due to the discontinuous coverage?**

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| **Company** | **Yes/No** | **Additional comments** |
| NEC | Yes | If UE is going to lose the coverage, it’s not worth it for UE to go back to RRC\_CONNECTED. But UE and eNB need to be consistence in this situation. Therefore, we think the RLF behaviour should be:  After providing the out-of-coverage information, UE follows legacy operation in declaring RLF but skip cell search, and leave RRC\_CONNECTED directly. |
| Qualcomm | See comments | This can be handled by UE imeplementation as UE would know when the DC starts and there is no point to start a RRC connection if there is not sufficient time left, which can already happen today. |
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## Necessity of providing additional information

The following summarizes contributions from RAN2#122 discussing whether to provide additional information:

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| References | Proposals |
| [2] | Proposal 3：RAN2 evaluates the effort of introducing new SIB and SIB segmentation for additional satellite information (up to 4) transmission.  Proposal 4：RRC Release message can be used to transmit additional satellite information to UE. |
| [3] | Proposal 1: RAN2 discuss to transfer more satellite assistance information via SIB segmentation or multiple SIBs. |
| [4] | Proposal 1 Provide measurement assistance information, e.g., PCI or carrier frequency, in SIB32 to facilitate cell selection and reduce service interruption after an NTN coverage gap. |
| [6] | Proposal 4: RAN2 to discuss how to support signalling of additional satellite information using one of the following options:  Option1: Dedicated signalling  Option 2: Additional information in SIBs e.g. using an additional new SIB or SIB segmentation |
| [7] | Proposal 2: At least for the same satellite before and after coverage interruption, RAN2 to consider enhancements to RRC connection recovery configuration before coverage interruption, so that UE can recovery RRC connection when coverage restores. |
| [9] | Proposal 2: RAN2 to discuss the provisioning of additional satellites’ ephemeris via dedicated RRC signaling.  Proposal 3: RAN2 to discuss how a UE can read only a subset of the SIB with additional satellite assistance information, when the SIB has different information content at different SIB transmission occasions.  Proposal 4: RAN2 to include footprint information for the earth-moving cell in discontinuous coverage as an optional field in SIB31. |
| [11] | Proposal 1: Measurement assistance information can be provided to control how the UE shall perform idle mode tasks (i.e. whether a UE can power down specific frequencies during discontinuous coverage) in a discontinuous coverage NTN. |
| [14] | Proposal 4: The assistance information of target cells can be provided to UE in advance for UE performing cell selection/reselection when UE returns to coverage and the assistance information could be frequency, PCI and SSB configuration. |

The above proposal are related to provding additional information as follows:

* Additional satellite information, e.g., ephemeris or footprint information
* Meassurement information, e.g., PCI, SSB configuration or carrier frequency

Also where to provide the related information is also mentioned, e.g, in SIB or RRC dedicated signaling. Based on the above, the following question is asked:

**Q4) Which of the following information do you think is needed to be provided additionally and where to provide them specifically:**

1. Ephemeris
2. Footprint information
3. PCI
4. SSB configuration
5. Carrier frequency
6. Other information (Please describe)

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| **Company** | **Additional information** | **Additional comments(why and where to provide)** |
| Qualcomm | 1, 2, 5 | Dedicated signaling can be used to provide additional satellite information with ephemeris, foot print information and frequency. |
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## Others

Note that the offline only targets on solving the common issues identified by companies.

For a small amount of issues not covered by this offline which is highlighted in Section 6 (mostly never discussed before and mentioned by only one company), they can be submitted to the next meeing via company’s contribution. But in case you think it is urgent, please indicate here and other companies can provide their opinions correspondingly.

For the details depending on the ouput of the above questions, we can also discuss them later (e.g., whether and how to provide discontinuous coverage information to gNB).

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| **Company** | **Other urgent issues** |
| Qualcomm | UE behavior for TN and NTN IDLE mode tasks during UE’s reported unavailability period. |
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# Conclusions

***To be added***

# References (In alphabetical order by company)

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| **Reference** | **TDoc** | **Title** | **Company** | **Proposals** |
| [1] | R2-2306167 | Support on discontinuous coverage in IoT NTN | Apple | Proposal 1: Introduce paging offset to solve the misfit issue of the PH/PTW which is currently determined by UE ID. |
| Proposal 2: Consider the PTW extension solution as a complementary solution. |
| Proposal 3: UE assistance information via NAS signaling (unreachability period in TAU) can be used for PTW adjustment when UE finds out the mismatch issue. |
| Proposal 4: Send an LS to SA2/CT1 on unevenly distributed coverage period caused by unevenly distributed satellite from multiple satellites. |
| Proposal 5: Do not introduce new release cause for coverage gap in RRCRelease message. |
| Proposal 6: RAN2 to discuss whether to support discontinuous coverage scenario in inactive state. |
| [2] | R2-2304896 | Discussion on enhancements to discontinuous coverage | CATT | Proposal 1：Some enhancement is needed for HARQ process with HARQ enabling when there is no enough time for ACK/NACK feedback because of the incoming coverage hole. |
| Proposal 2：RAN2 to discuss the AS overload control enhancement to avoid excessive signalling load on the network upon the network coverage coming back. |
| * LS can be sent to SA2 to check detail understanding of the NAS waiting time solution, if necessary |
| Proposal 3：RAN2 evaluates the effort of introducing new SIB and SIB segmentation for additional satellite information (up to 4) transmission. |
| Proposal 4：RRC Release message can be used to transmit additional satellite information to UE. |
| Proposal 5：No new RRC Release cause is needed for discontinuous coverage scenario. |
| Proposal 6：UE Autonomous release enhancement for discontinuous coverage is not needed, if AMF/MME shares the UE unreachability period to RAN node. |
| Proposal 7：UE/NW autonomous adjustment can be considered for paging and eDRX enhancement. |
| Proposal 8：No additional information is needed to assist the UE to verify if the remaining time of current cell’s coverage is sufficient to accommodate a new connection establishment. |
| Proposal 9: If the remaining time of current cell’s coverage is not sufficient to accommodate a new connection establishment, the UE behavior can be left to UE implementation, no specification impact is expected. |
| [3] | [R2-2305612](file:///C:\Data\3GPP\Extracts\R2-2305612%20Discussion%20on%20the%20discontinuous%20coverage%20for%20IoT-NTN.docx) | Discussion on the discontinuous coverage for IoT-NTN | CMCC | Proposal 1: RAN2 discuss to transfer more satellite assistance information via SIB segmentation or multiple SIBs. |
| Proposal 2: There is no RAN impacts to adjust the PTW configuration. It is up to UE and eNB implementation to skip the PTW within the discontinuous coverage. |
| Proposal 3: A new cause value ‘Release due to discontinuous coverage’ is introduced in RRCRelease message. |
| Proposal 4: The UE can provide the out-of-coverage information to RAN node for e.g, optimization on RRC release or paging. |
| Proposal 5: The UE out-of-coverage information can be kept by RAN node when the UE enters into idle mode. |
| Proposal 6: It is up to UE implementation whether to initiate the connection (re)establishment if the remaining time in the current cell is not sufficient for a new connection establishment, additional assistance information is not needed. |
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| [4] | R2-2306466 | Enhancements to discontinuous coverage | Ericsson | Proposal 1 Provide measurement assistance information, e.g., PCI or carrier frequency, in SIB32 to facilitate cell selection and reduce service interruption after an NTN coverage gap. |
| [5] | R2-2304812 | Discussion on discontinuous coverage | Huawei, HiSilicon | Proposal 1: UE can indicate “RRC\_IDLE” to the Network as the preferred RRC state when it is going to enter a coverage gap and start a timer, similar as the mechanism designed by R17 MUSIM. |
| Proposal 2：The network can predict multiple coverage windows by implementation and takes them into account when paging a UE.  Proposal 3：After RLF is triggered, UE enters RRC\_IDLE if the remaining serving time is less than a threshold in discontinuous coverage scenario.  Proposal 4：UE stops the AS idle mode tasks related to TN only when there is no TN cells in the discontinuous coverage. |
| [6] | R2-2305171 | IoT-NTN discontinuous coverage enhancements | Interdigital, Inc. | Proposal 1: For eMTC and NB-IoT: A UE in R17 is allowed not to perform RRC\_IDLE mode tasks during a UE unreachability period. Consider whether to explicitly clarify that this means that if a UE in RRC\_IDLE or RRC\_INACTIVE determines it is in a UE unreachability period, the UE may choose not to perform measurements of the serving cell or neighbour cells, and may postpone moving to “any cell selection” state, and is allowed not to attempt to monitor paging occasions which occur during a UE unreachability period. |
| Proposal 2: RAN2 to discuss what new behaviour is expected from the UE when NW releases the UE using a new cause e.g. “discontinuous coverage” in the following cases:  Case 1: Release to RRC\_IDLE  Case 2: Release to RRC\_INACTIVE  Proposal 3: It is beneficial in terms of UE power saving if the UE can enter RRC\_IDLE upon detecting a coverage gap without executing the RLF procedure. |
| Proposal 4: RAN2 to discuss how to support signalling of additional satellite information using one of the following options:  Option1: Dedicated signalling  Option 2: Additional information in SIBs e.g. using an additional new SIB or SIB segmentation |
| Proposal 5: Update the PTW if it falls in a coverage gap by applying an offset. FFS how to determine/configure the offset.  Proposal 6: Send an LS to SA2 indicating that RAN2 <have agreed/are considering> shifting the PTW if it falls in a coverage gap, asking what the content/granularity of “UE unreachability period is, whether it can be provided to the gNB, and whether adjusting the PTW is feasible from SA2 point of view. |
| [7] | R2-2305714 | Further considerations on discontinuous coverage | Lenovo | Proposal 1: RAN2 to consider enhancements to UE reporting its estimation of coverage interruption to eNB. |
| Proposal 2: At least for the same satellite before and after coverage interruption, RAN2 to consider enhancements to RRC connection recovery configuration before coverage interruption, so that UE can recovery RRC connection when coverage restores. |
| Proposal 3: RAN2 to consider enhancements to disable neighbour cell measurement triggering in RRC\_CONNECTED before coverage interruption due to discontinuous coverage. |
| [8] | R2-2305307 | Considerations on Supporting Discontinuous Coverage | NEC Europe Ltd | Proposal 1: Consider to support UE providing assistance information on being out-of-coverage to gNB for RRC connection management. |
| Proposal 2: Consider to include remaining coverage time in out-of-coverage information. |
| Proposal 3: After providing the out-of-coverage information, UE follows legacy operation in declaring RLF but skip cell search, and leave RRC\_CONNECTED directly. |
| Proposal 4: RAN2 confirm the PTW position should be configurable (FFS to configure one or multiple PTW positions, FFS the configuration is an offset or replacement of the calculated PTW position), send LS to SA2/CT1 asking for collaboration. |
| [9] | R2-2305863 | On RAN impacts for Discontineous coverage enhancements | Nokia, Nokia Shanghai Bell | Proposal 1: CN provides the unreachability period(s) for a UE to the RAN. |
| Proposal 2: RAN2 to discuss the provisioning of additional satellites’ ephemeris via dedicated RRC signaling. |
| Proposal 3: RAN2 to discuss how a UE can read only a subset of the SIB with additional satellite assistance information, when the SIB has different information content at different SIB transmission occasions. |
| Proposal 4: RAN2 to include footprint information for the earth-moving cell in discontinuous coverage as an optional field in SIB31. |
| Proposal 5: The PSM and eDRX configurations can be configured to align with the estimated UE unreachability period. The configuration is out of RAN2’s scope.  Proposal 6: Network can extend the paging before/after the coverage window if the UE does not respond to paging within the estimated coverage window.  Proposal 7: UE can extend the paging monitoring outside the estimated coverage window if radio coverage is available. UE may report to the network to realign the paging monitoring and coverage windows.  Proposal 8: UE may report to the network to realign the paging monitoring and coverage windows if UE notices there is radio coverage before or after the expected reachability period. |
| Proposal 9: RAN2 to discuss how to handle UE movement within the same TA during discontinuous coverage.  Proposal 10: RAN2 to discuss support for UE request for RRC connection release based on DC estimation. FFS support for implicit RRC connection release.  Proposal:11 leave the decision on whether the UE initiates the connection (re-) establishment to the UE implementation when the remaining time in the current cell during discontinuous coverage is insufficient to complete a new connection establishment procedure  Proposal 12: RAN2 to discuss UE behavior when the UE has limited remaining GNSS validity duration and the remaining discontinuous coverage time is also short. |
| [10] | R2-2305201 | RRC release procedure in discontinuous coverage | Qualcomm Incorporated | Proposal 1 If the UE is able to predict when the discontinuous coverage starts, reuse NR MUSIM procedure to leave RRC\_CONNECTED state where the UE indicates the out-of-coverage to network and starts an out-of-coverage timer. |
| Proposal 2 Reuse NR MUSIM timer T346g behavior, i.e., upon expiry of the out-of-coverage timer, the UE performs the actions upon leaving RRC\_CONNECTED, with release cause 'other'. |
| Proposal 3 Further discuss the details on the values of the out-of-coverage timer and message to carry out-of-coverage information. |
| [11] | R2-2305785 | Enhancements to discontinuous coverage | Samsung Shenzhen | Proposal 1: Measurement assistance information can be provided to control how the UE shall perform idle mode tasks (i.e. whether a UE can power down specific frequencies during discontinuous coverage) in a discontinuous coverage NTN. |
| Proposal 2(a): The UE verifies whether it has sufficient coverage time to complete a given RRC procedure (or a new connection establishment). |
| Proposal 2(b): The UE initiates a given RRC procedure if it has sufficient coverage time to complete this procedure. Otherwise, the UE will not initiate the procedure or will wait for the next available satellite coverage period. |
| Proposal 3: UE autonomous release for discontinuous coverage is not pursued. |
| Proposal 4: Explicit RRC Release using a new RRC Release cause for discontinuous coverage is introduced. |
| Proposal 5: Certain idle mode procedures are paused if a UE receives an RRC release with the new RRC release cause. |
| Proposal 6: The new RRC release cause is used to re-direct a UE from a non-discontinuous coverage network to a discontinuous coverage network. |
| Proposal 7: Discontinuous coverage-related information is provided in a re-direct message when being re-directed to a discontinuous coverage network. |
| [12] | R2-2305560 | Discussion on power saving enhancements for supporting discontinuous coverage | Spreadtrum Communications | Proposal 1: In order to ensure that the UE can be reachable when paging arrives, the PTW should aligns with the time duration of coverage and the following two options can be taken into further consideration: |
| Option 1: both UE and network adjust PTW based on a predefined rule |
| Option 2: network provides multiple PTW info |
| Proposal 2: From RAN2 point of view, the existing PSM mechanism needs to be enhanced in order to get better power effect. |
| Proposal 3：The PSM starting mechanism needs to be modified to adapt to the scenario of discontinuous coverage. |
| Proposal 4: A time threshold needs to be introduced for UE to determine whether to start T3324 timer. |
| [13] | R2-2305372 | Discussion on enhancement to discontinuous coverage for IoT NTN | Transsion Holdings | Proposal 1: RAN2 needs to consider the RACH congestion issue as a large number of UEs may try to access the NTN cell at the next satellite’s service start time. |
| Proposal 2: The discontinuous coverage wait timer can be used in AS to avoid RACH congestion. |
| Proposal 3: The CN should be aware of the UE’s discontinuous coverage period to CN to avoid paging issues. |
| Proposal 4: The satellite assistance information or the discontinuous coverage information predicted by UE can be provided to CN for paging. |
| Proposal 5: The explict RRC release using a new RRC Release cause(e.g. coverage discontinuity) can be used before the covearage gap. |
| [14] | R2-2305672 | Enhancements to discontinuous coverage | Xiaomi | Proposal 1: The issue that UE ends up with no PTW in the in-coverage period should be addressed. |
| Proposal 2: AMF configures the start position (PH) of PTW window. |
| Proposal 3: If UE is in discontinuous coverage, there is no need to perform recovery during T1 and T2. |
| Proposal 4: The assistance information of target cells can be provided to UE in advance for UE performing cell selection/reselection when UE returns to coverage and the assistance information could be frequency, PCI and SSB configuration. |
| [15] | R2-2305959 | RAN2 enhancements for discontinuous coverage | ZTE Corporation, Sanechips | Proposal 1a: If legacy eDRX is used for keeping alignment between UE and NW during discontinuous coverage, in order to align the starting time of PTW with the out-of-coverage period or unreachability period, it’s suggested to introduce a configurable offset to shift the starting time of PTW. |
| Proposal 1b: The out-of-coverage period or unreachability period should be informed to RAN, e.g., from core network node, to assist RAN to provide a more appropriate paging schedule for UE in idle mode. |
| Proposal 2a: 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. |
| Proposal 2b: An AS-NAS interaction (e.g., an indication from AS to NAS) also needs to be introduced for indicating UE to stop the subsequent NAS layer processes after it is released to idle mode due to discontinuous coverage. |
| Proposal 2c: The legacy IE extendedWaitTime can be reused to stop the subsequent NAS layer processes after UE is released to idle mode due to discontinuous coverage. The extension to the value range of extendedWaitTime needs to be discussed. |
| Proposal 2d**:** The UE in connected mode could provide out-of-coverage period or unreachability period information as an assistance to the network (eNB). |