3GPP TSG-RAN WG2 Meeting #116bis Electronic R2-2200674

Elbonia, January 17-January 25 2022

**Agenda item: 9.2.5**

**Source: Nokia, Nokia Shanghai Bell**

**Title: Discussion on [AT116bis-e][047][IoT-NTN] UE capabilities**

**WID/SID: LTE\_NBIOT\_eMTC\_NTN - Release 17**

**Document for: Discussion and Decision**

# 1 Introduction

Following e-mail discussion was agreed to progress on potential agreements related to UE capabilities for IoT-NTN.

* [AT116bis-e][047][IoT-NTN] UE capabilities (Nokia)

 Scope: Take into account proposals of documents submitted under 9.2.5, find agreements if possible (can agree offline), identify open points. This discussion is offline only.

 Intended outcome: Report

 Deadline: EOM

In this discussion paper, company views submitted in the document for 9.2.5 related to different aspects of UE capabilities are analysed for proposals having consensus across documents and include questions on company views for different proposals.

# 2 Discussion

## 2.1 User Plane Capability

The company views presented in the submitted documents for UE capabilities related to user plane aspects can be divided into essential user plane capabilities and optional user plane capabilities. Summary of views on these aspects are given below.

**Essential user plane plane capabilities**

* **Features related to RACH procedure enhancements.**
	+ The features needed for RACH procedure to work for IoT NTN connectivity can be considered as mandatory. TA-pre-compensation, RAR window adjustments and MAC contention resolution timer adjustments are essential for RACH access procedure for IoT-NTN [1] [5].
	+ As per [3] TA Pre-compensation is essential UP functionality for IoT-NTN.
* **Connected mode Timer adjustments**
	+ For connected mode user plane operation the timer adjustments RLC t-Reordering timer and PDCP discardTimer (for eMTC) are basic features for NTN connectivity [1].
	+ PDCP-Discard-Timer changes are mandatory [5]. Re-ordering timer and SR-Prohibit-Timer changes are optional.
	+ All timer adjustments at RLC/MAC/PDCP layers are mandatory user plane capability [6] [7].

**Optional user plane plane capabilities**

* TA reporting in connected mode will improve the connected mode operation. This can be indicated as optional in capability via ***UECapabilityInformation*** and ***UECapabilityInformation-NB*** messages. TA reporting related features are indicated as separate capabilities [5] [6].
* Timer adjustment related to PUR functionality can be considered as optional UE capability [7] [3].

Based on the above views we suggest the following proposals for offline discussion and agreement.

**Proposal 1: TA Pre-compenstation , RAR Window adjustments and MAC contention resolution Timer adjustments are essential user plane capabilities for IoT-NTN for RACH procedure.**

**Q1. Do companies agree on P1 as mandatory user plane capability for RACH enhancements. (Yes/No/Additional comments)**

|  |  |
| --- | --- |
| Company  | Views (Yes/No/Additional comments) |
| Ericsson | Yes |
| MediaTek | Yes |
| Spreadtrum | Yes |
| Intel | Yes |
| Lenovo, Motorola Mobility | Yes |
| Qualcomm | Yes, assuming the intention of question is “conditionally mandatory” based on the support of NTN access. |
| Xiaomi | Yes |
| ZTE | Yes |
| NEC | Yes |
| OPPO | Yes |
| Nokia | Yes |

**Proposal 2: Timer adjustments for PDCP/RLC/MAC for NTN operation are part of mandatory User plane capabilities. (Yes/No/ comments).**

**Q2. Do companies agree on P2 as mandatory user plane capability for timer adjustments for user plane operation**

|  |  |
| --- | --- |
| Company  | Views (Yes/No/ if No specific timer to be excluded from mandatory list and reason) |
| Ericsson | Yes |
| MediaTek | Yes |
| Spreadtrum | Yes |
| Intel | Yes |
| Lenovo, Motorola Mobility | Yes |
| Qualcomm | Yes, assuming the intention of question is “conditionally mandatory”. |
| Xiaomi | Yes |
| ZTE | Yes |
| NEC | Yes |
| OPPO | Yes |
| Nokia | Yes |

**Proposal 3 : TA Reporting and PUR Timer adjustments are optional UE capabilities.**

**Q3. Do companies agree on P3 related to optional UE capability for user plane.**

|  |  |
| --- | --- |
| Company  | Views (Yes/No/Additional comments) |
| Ericsson | Yes |
| MediaTek | Yes |
| Spreadtrum | Yes |
| Intel | Yes |
| Lenovo, Motorola Mobility | Yes |
| Qualcomm | Yes. Additionally, they would need separate indications. |
| Xiaomi | Yes |
| ZTE | Yes for TA reporting. No for PUR timer adjustments. PUR timer enhancement is essential if PUR is used in IoT NTN. So, if UE indicates the capability of supporting PUR to IoT NTN network, that means it mandatorily supports PUR timer enhancement. |
| NEC | Yes, TA report is optional.For PUR timer adjustments, should it be conditionally mandatory to PUR feature? If it is optional, how should we interpret if a UE indicates support of PUR but not support the timer adjustment?  |
| OPPO | Yes |
| Nokia | Yes |

**Rapporteur Summary:**

All companies agreed to the mandatory features provided in P1 and P2 as mandatory capability of IoT UE for NTN access.

Draft proposal for agreement is given below.

|  |
| --- |
| **P1: General capability for IoT-NTN is introduced comprises of support for following user plane functionalities.*** **TA Pre-compensation, RAR Window adjustments and MAC contention resolution Timer adjustments.**
* **Timer adjustments for PDCP/RLC/MAC for NTN operation.**
 |

For the optional UE capability discussion, All companies agreed that TA Reporting and PUR timer adjustments are optional UE capabilities for IOT-NTN. Separate capability can be introduced for each of the functionality as TA reporting is needed for better MAC operation for all scenarios. PUR Timer adjustment is specific to support of PUR functionality. Two companies indicated that PUR timer adjustment can be conditional mandatory feature for PUR feature.

In Rapporteur view, the PUR timer adjustment is not essential for all satellite deployments so it need not be linked to the basic PUR functionality. UE can indicate it as independent capability. It is upto network to activate the PUR feature depending on these capabilities and need for the capability for network deployments.

Draft Proposal for agreement

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| **P2: TA Reporting and PUR Timer modifications are optional UE capabilities with separate capability indication from UE.** |

## 2.2 Control Plane Capability

Following are the analysis and proposals related to mandatory and optional control plane capabilities for IoT-NTN

**Essential control plane capabilities**

* Support for soft TAC update related functionality and acquisition of new SIB should be considered as basic functionality needed for IoT-NTN connectivity. [1] [5].

**Optional control plane capabilities**

|  |  |
| --- | --- |
| Support of non-continuous coverage | [1] [5] [6] |
| Cell Reselection based on stop Timer | [1] [6] |
| CHO for NTN | [6] |

**GNSS Capability**

[1] and [7] proposes that GNSS capability is part of basic IoT-NTN capability.

Based on the above views following are the proposals for further offline discussion and agreements.

**Proposal 4: Soft TA Procedure support .new SIB acquisition and GNSS capability are mandatory UE capabilities for control plane.**

**Q4. Do companies agree on P4 on mandatory control plane capabilities**

|  |  |
| --- | --- |
| Company  | Views (Yes/No/Additional comments) |
| Ericsson | Yes, these should all be mandatory. GNSS capability is already in the WID, new SIB acquisition is crucial to access cell and without mandatory support of soft TA it would be very challenging for network to control idle mode mobility.  |
| MediaTek | Soft TA procedure: Could be mandatory only for LEO (NGSO), but not for GEO.  |
| Spreadtrum | Yes, agree with Ericsson. |
| Intel | Yes |
| Lenovo, Motorola Mobility | Yes |
| Qualcomm | Similar to NR NTN, it should be conditional mandatory based on the support of NTN access. |
| Xiaomi | The soft TA procedure for GEO may be optionanl. |
| ZTE | Yes |
| NEC | Soft TA procedure: For GEO, UE may need to read multiple TAC per cell but no need to automatically check the TAC update, since TAC list is not supposed to change. We may need two different feature names. Yes for others  |
| OPPO | Yes |
| Nokia | Yes |

**Proposal 5: Support for discontinuous coverage, cell reselection based on Time and CHO for eMTC are optional control plane capabilities.**

**Q5. Do companies agree on P5 on optional control plane capabilities**

|  |  |
| --- | --- |
| Company  | Views (Yes/No/if no indicate specific capability to be excluded from the mandatory list) |
| Ericsson | Yes to cell reselection based on time.For discontinuous coverage we will have to discuss what this actually means. A start would be to at least support reading the discontinuous coverage-related information elements. For CHO we assume that it is not needed as there are already CHO capability bits and we have not discussed any NTN-specific changes. If we are to add this then we need to have a serious discussion on which one of the CHO capability bits (there are 4 currently) that should be applicable for eMTC and we think it is too late in this release to start this discussion. So our opinion is not to have capability for CHO for eMTC.  |
| MediaTek | Agree with Ericsson. For discontinuous coverage we need to complete discussion first. |
| Spreadtrum | The cell reselection based on time can be treated as optional capability.But for CHO, since it has no enhancement for CHO in Rel-17. Therefore, it is not necessary to have this capability. |
| Intel | “discontinuous coverage, cell reselection based on Time” are related to idle UE operations, it seems no UE capability bits need to be defined.Ok to consider CHO for eMTC as optional UE capability |
| Lenovo, Motorola Mobility | For discontinuous coverage we need to determine the solutions first. We would like to make decision on whether it is optional later. |
| Qualcomm | Yes for cell reselection. Ok to further discuss for discontinuous coverage. For CHO, it should be clarified whether it is supported in TN or not. If it is not applicable to TN for eMTC, then existing IE for LTE CHO can be used with clarification, otherwise we should introduce separate signaling for TN and NTN. |
| Xiaomi | Yes, all those features are optional. We can determine whether the optional discontinuous coverage capability bit needed or not when it finished. |
| ZTE | Yes. Among the features, “discontinuous coverage, cell reselection based on Time” are related to idle UE operations, they are optional features without capability report. |
| NEC | CHO: Agree with Ericsson that the legacy CHO capability bit may be enoughCell reselection based on Time: yes, optional and hence need capability bitdiscontinuous coverage: can wait  |
| OPPO | Yes |
| Nokia | Cell Reselection enhancements and discontinuous coverage can be new optional UE capabilities. For CHO existing capability can be reused |

[7] proposes to include location reporting as mandatory capability for IoT-NTN. In [3] specific features of location reporting should be considered as mandatory UE capability. As there are no specific views from other companies on this proposal, we propose to get further views on this capability through following question.

**Q6: Should location reporting mandatory capability for IoT-NTN ?**

|  |  |
| --- | --- |
| Company  | Views (Yes/No/Additional comments) |
| Ericsson | Yes. The details of the solution is currently being discussed. But we believe whatever solution is being introduced should be made mandatory.  |
| MediaTek | No. It is not even discussed yet. Discussions and agreements need to be completed before introducing capabilities. |
| Spreadtrum | No. Agree with MediaTek. |
| Intel | This can be postponed after we have concrete consensus. |
| Lenovo, Motorola Mobility | No. We think location reporting has many uncertain issues to be worked with SA3 or RAN3 and it is even not sure whether location reporting is allowed. We agree with MediaTek that discussions and agreements are needed first. |
| Qualcomm | No. We should wait for the conclusion in NR NTN. |
| Xiaomi | No. UE location reporting isn’t essential for IoT based on the current discussion. The CN can acquires the UE location based on the LCS procedure and GNSS capability is mandatory.  |
| ZTE | No. Agree with MediaTek. |
| NEC | We can wait  |
| OPPO | No. Agree with MediaTek. |
| Nokia | This can be decided later when the location reporting feature applicability and changes needed for NTT access are concluded. |

**Rapporteur Summary:**

7 companies out 9 respondents agreed to consider the features indicate P4 as mandatory control plane features for IoT-NTN access. 2 companies indicated that soft TA switching is only needed for LEO deployments.

Rapporteur view: As there is no indication from network via system information about LEO/GEO deployment, if the soft TA switching is not supported by UE camped onto LEO cell it will have impact on the idle mode functionality due to moving satellites.

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| **P3: General capability for IoT-NTN is introduced comprises of support for following control plane functionalities.*** Acquisition of new SIB for IoT-NTN access
* Support for soft TA switching procedure
* GNSS Support
 |

For the optional control plane capability discussions, most companies agreed to consider the cell reselection modification based on timer as optional UE capability. On CHO support most companies agreed to reuse the existing CHO capability bit as such. For discontinuous coverage related functionality some companies thinks that it is optional capability for idle mode so UE capability indication is not needed. Some companies thinks that decision on UE capability for discontinuous coverage support can wait for RAN2 conclusion on this topic.

**Draft Proposal for Agreement**

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|  **P4: Following can be agreed related to capability indication for optional features of control plane*** Capability bit is not needed for support of cell reselection based on timer functionality. UE not having this capability will follow legacy cell reselection behaviour.
* Existing CHO capability indication can be reused for IoT-NTN CHO also.
* Need for capability bit for support of discontinuous coverage can be postponed after RAN2 discussions on discontinuous coverage functionality are concluded.
 |

On the capability for location reporting most companies prefer to defer the discussion until finalisation of the required features for IoT-NTN.

**Draft Proposal for Agreement**

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| **P5: Discussion on Location reporting capability is postponed until the conclusion on required location reporting functionalities for IoT-NTN.**  |

## 2.3 Signalling message changes for IoT-NTN capabilities

**Single Capability for IoT-NTN mandatory Features**

General capability for IoT-NTN is introduced. If this capability is indicated the essential features of IoT-NTN are considered as supported. [6] [3] [1].

**Proposal 6: General capability for IoT-NTN is introduced comprising of all mandatory IoT-NTN UE capabilities discussed in P1,P2 and P4.**

**Q7: Do companies agree (P6) for single IoT-NTN capability for all mandatory IoT-NTN capabilities ?**

|  |  |
| --- | --- |
| Company  | Views (Yes/No/Additional comments) |
| Ericsson | Yes. We assume that this can be merged with the capability that RAN1 has introduced for IoT NTN support.  |
| MediaTek | Yes. |
| Spreadtrum | Yes. |
| Intel | Yes |
| Lenovo, Motorola Mobility | Yes |
| Qualcomm | This can be similar to NR NTN. Top level IoT NTN per-UE capability can implicitly indicate support of relevant conditionally mandatory IoT NTN features as discussed in earlier questions. Additionally, we think separate top level capabilities for GSO and NGSO support are preferable.  |
| Xiaomi | Yes |
| ZTE | No strong opinion, and think capability definition for essential features is not necessary. 1. As UE-specific TA pre-compensation is a new and mandatory function for IoT NTN UE, only the UE which supports IoT NTN technology can camp or access an IoT NTN cell. Therefore, if a UE can access the IoT NTN cell, the network can assume that it supports IoT NTN technology and can provide NTN corresponding radio configuration to it. For this aspect, no UE capability of supporting NTN needs to be reported to network. However, for the mobility scenario, UE capability of supporting NTN may be still needed. For NB-IoT, as HO is not supported, NTN capability report is not necessary. For eMTC, we assume NW can deduce the UE’s NTN capability based on the *supportedBandListEUTRA* IE. Then it may be also no need of explicit UE capability of supporting NTN.2. The essential features can be specified as an essential feature list for IoT NTN in TS36.331 as that for NB-IoT. E.g. it can be specified as following:*For UE in IoT NTN Network, the following features are supported:**...* |
| NEC | yes |
| OPPO | Yes |
| Nokia | Yes |

**New Parameter to indicate IoT Feature applicability for NTN**

In [2], it is proposed to introduce new EUTRA-IoT-NTN capability to indicate support of existing TN feature applicability for NTN. This new information element is beneficial for UE to indicate support level of basic IoT functionality for NTN connectivity seperately.

Analysis in [4] indicate that the UE knows whether it camp onto TN or NTN cell. Hence indicating capability seperately for IoT-NTN is not needed. The discussion on separate capability can be postponed until RAN4 definition for IoT-NTN operation.

We propose to get views of other companies on this issue in Q8.

**Q8: Do company see need for separate parameter to indicate applicability of existing IoT features for NTN connectivity?**

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| --- | --- |
| Company  | Views (Yes/No/Additional comments) |
| Ericsson | No. We would assume that if there are specific adaptations to features that are special to NTN, these would need a separate capability bit, for instance extension of pur-ResponseWindow as discussed above. We do not support creating separate NTN capabilities for all applicable IoT features.  |
| MediaTek | No |
| Spreadtrum | No |
| Intel | No |
| Lenovo, Motorola Mobility | No |
| Qualcomm | Yes. Reporting UE capability every time it accesses TN or NTN is not efficient. This will cause a lot of signaling overhead for UEs supporting both TN and NTN and mobility (IDLE/Connected mode) between them. The TN UE capabilities may not be supported in NTN, for example, PUR/WUS does work in TN but it may not work in NTN LEO but may work in NTN GEO. In short, the UE should be able to indicate to network whether it has implemented/tested PUR/WUS in NTN even if it indicates support in TN.In addition, RAN1 would have to check if the existing TN PHY layer parameters can work in NTN due to strict requirement on timing and frequency compensation. |
| Xiaomi | No. We assume the features introduced in TN which are not enhanced in IoT-NTN are applicable for IoT-NTN in default. If there are special cases, we can discuss case by case. |
| ZTE | No.We agree with Ericsson that it’s no need to create separate NTN capabilities for all applicable IoT features. Per our analysis, almost all TN capabilities (including some R17 features) can be reused in NTN (also after UE acquires that NW can support those features). One exceptional case is Rel-17 NB-IoT measurement before RLF. We think it’s no need to support this feature as discontinuous coverage may widely exist in IoT NTN. The simple way is just to indicate something in the capability description (e.g. the capability is only applied for UE in TN, and not applied for UE in NTN). |
| NEC | No, it would be too much to duplicate all IoT capability for NTN. But if we find any specific feature would be much different to support in NTN comparing with TN, we can then discuss if separate capability bit is needed or not  |
| OPPO | No. Share the same view as Ericsson. |
| Nokia | No. Current capability indications of IoT features can be reused. |

**Rapporteur Summary**

Most companies agreed to have single IoT-NTN capability indicating the support for mandatory control plane and user plane functionalities.For the proposal in [2] for introducing new parameter list to indicate support of every NB-IoT/eMTC feature applicability for NTN, all other respondents of this e-mail discussion did not see the need for same. Existing capability bits of IoT features can be used as such for IoT-NTN also.

**Draft Proposal for Agreement**

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| * **P6: Single Per UE capability for IoT-NTN support is introduced. This capability indication comprises of all RAN1 features needed for IoT-NTN and the mandatory user-plane and control-plane features agreed in this e-mail discussion.**
* **P7: Capability Indication of existing IoT-Features until Rel-16 are reused in NTN.**
 |

## **2.4 Others**

Following are the proposals which are related to additional aspects which are not directly related to the decision on the RAN2 feature set for IoT UE capabilities.

* Segment duration configuration for large repetition was agreed as RAN1 functionality for IoT-NTN. This should be considered as mandatory UE capability [4].
* Discuss whether CHO feature introduced for eMTC-NTN is applicable for TN also [6].

We propose to further discuss these proposals in online discussion as these proposals require further discussion.

# 3 Summary

Based on the views expressed in this e-mail discussion on the capability indication needed for IoT device for NTN access,

**Following are the potential proposals for agreement.**

* **Combined P1/P3/P6**
* IoT-NTN support is indicated by single per UE capability indication. This capability indication comprises of all RAN1 features needed for IoT-NTN and the following control plane and user plane functionalities of RAN2.
	+ TA Pre-compensation, RAR Window adjustments and MAC contention resolution Timer adjustments.
	+ Timer adjustments for PDCP/RLC/MAC for NTN operation.
	+ Acquisition of new SIB for IoT-NTN access
	+ Support for soft TA switching procedure
	+ GNSS Support.
* **P2:**

TA Reporting and PUR Timer modifications are optional UE capabilities with separate capability indication from UE.

* **P4: Following can be agreed related to capability indication for optional features of control plane**
	+ Capability bit is not needed for support of cell reselection based on timer functionality. UE not having this capability will follow legacy cell reselection behaviour.
	+ Existing CHO capability indication can be reused for IoT-NTN CHO also.
* **P7: Capability Indication of existing IoT-Features until Rel-16 are reused in NTN.**

**Proposals to be discussed after conclusion on related functionality within RAN2**

* Need for capability indication for support of discontinuous coverage can be postponed after RAN2 discussions on discontinuous coverage functionality are concluded.
* Discussion on Location reporting capability is postponed until the conclusion on required location reporting functionalities for IoT-NTN.

# Reference

[1] R2-2200255 Discussion on IoT NTN UE capabilities OPPO

[2] R2-2200443 Discussion on UE capabilities Qualcomm Incorporated

[3] R2-2200674 Analysis on IoT-NTN UE capability requirements Nokia, Nokia Shanghai Bells

[4] R2-2200702 Consideration on UE capability report for IoT NTN ZTE Corporation, Sanechips

[5] R2-2200875 RAN2 UE Feature List for IoT NTN CMCC

[6] R2-2201456 Discussion on UE capability Huawei, HiSilicon

[7] R2-2201601 IoT NTN capabilities Ericsson