3GPP TSG-RAN WG2 Meeting #109bis-e DRAFT\_ R2-2004131

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**Agenda item: 6.7.6**

**Source: Nokia, Nokia Shanghai Bell**

**Title: [AT109bis-e][031][IIOT] UE capabilities**

**WID/SID: NR\_IIOT - Release 16**

**Document for: Discussion and Decision**

# 1 Introduction

The open issues identified so far for UE capabilities of IIOT WI are summarized in [1] as follows:

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| --- |
| **Editor’s note / open issue** |
| FFS if data vs. data and SR vs. data prioritization are signalled as a single capability. |
| FFS whether signalling of maximum value of additional SPS periodicities and additional CG periodicities supported by a UE is required. |
| FFS what is the value range for maximum number of contexts signalled by the UE. |
| FFS whether to support allowing CG periodicities of multiple of 2/7 symbols as a separate capability with a cross-slot boundary capability as a pre-requisite. |
| FFS whether LCH based prioritization can be supported without PHY prioritization. It is expected this can be discussed once RAN1 has defined feature/capability related to PHY layer prioritization |

The current running CR for TS 38.306 can be found in [2] while running CR for TS 38.822 can be found in [3].

Section 2 of this document summarizes contributions submitted to Agenda Item 6.7.6 related to UE capabilities for IIOT WI while Section 3 gathers the proposals stemming from Section 2. Those sections are copied from [17] and are greyed out in this document to avoid confusion.

Subsequent sections (starting from Section 4) are used to progress the following e-mail discussion of RAN2#109bis-e meeting:

* [AT109bis-e][031][IIOT] UE capabilities (Nokia)

Scope: Treat topics in 6.7.6, based on R2-2003793 and comments.

Part 1: Determine which issues that need resolution, find agreeable proposals, can consider TP. Deadline: April 24 0700 UTC.

Part 2: Running CRs (for 38.306, 36.306, 38.822?)

# 2 Summary of Tdocs submitted to RAN2#109bis-e

## 2.1 Capability for LCH-based prioritization

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| --- | --- | --- |
| Company [Tdoc] | Proposal | Rationale from Tdoc |
| Samsung [4] | Proposal 1. A single capability reports both Data-Data and SR-Data prioritizations. | Regardless of whether data-data prioritization and SR-data prioritization can be configured separately or not, a single capability should be specified. |
| Ericsson [5] | Proposal 1 Data vs. data and SR vs. data prioritization are signalled as a single capability. | These two features both require another set of basic intra-UE feature such as PHY-priority index. If we define two separate capabilities, then, inevitably, more capability bits (such as PHY-priority index) are needed to properly capture the intended functionalities. |
| CATT [6] | Proposal 3: Support single capability for data vs. data and SR vs. data prioritization. | The prioritization of the data vs. data and SR vs. data prioritization relies on the same basic principles and functionality. Therefore, extra-complexity and specification effort is not justified to introduce independent prioritization configurations for data vs. data and SR vs data. |
| Qualcomm [7] | Proposal 1: SR-data and data-data prioritization at MAC layer should have separate UE capabilities. | SR vs grant prioritization is a feature distinct from and complementary to grant prioritization, and both can be useful on their own for URLLC traffic. Both features require different implementation on both UE and gNB sides. |
| CMCC [10] | Proposal 1: it is proposed to configure these capabilities of data vs. data and SR vs. data in a single signalling. | SR/data multiplexing is a subset scenario of data vs. data prioritization. Both prioritization mechanisms are based on comparison of priority derived from either the MAC PDU corresponding LCH or derived from the LCH which triggered an SR and both mechanisms are enhanced for URLLC service’s transmission in time. |
| Nokia [11] | Proposal 1: Confirm that Data vs. data and SR vs. data prioritization are signalled as a single capability. | Both prioritization mechanisms are based on comparison of LCH priority of either an LCH carried by a MAC PDU or of an LCH which triggered an SR and both are equally important when it comes to support of URLLC traffic. |

**Rapporteur summary and proposal:**

5 companies indicate that SR vs. data and data vs. data prioritization should be signalled as a single capability. The companies mainly indicate that the features are based on the same mechanism (i.e. LCH priority comparison) and that both mechanisms are needed to enhance URLLC traffic handling.

1 company proposes to specify separate capabilities and indicates that both features have distinct use cases and require different implementation on UE and gNB side.

**Proposal 1: Data vs. data and SR vs. data prioritization are signalled as a single capability.**

## 2.2 Additional SPS periodicities and additional CG periodicities signalling

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| --- | --- | --- |
| Company [Tdoc] | Proposal | Rationale |
| Samsung [4] | Proposal 2a. A capability bit indicating support of periodicityExt-r16 for DL SPS is required.  Proposal 2b. A capability bit indicating support of periodicityExt-r16 for UL CG is required. | New capabilities are required for finer granularity of SPS and CG periodicity. |
| Ericsson [5] | Proposal 3 Signalling of maximum value of Rel-16 SPS/CG periodicities supported is NOT needed. | There are no challenges to implement a large periodicity value at UE. It is sufficient to test several randomly chosen values and the details can be specified in RAN5. |
| CATT [6] | Proposal 1: It is not necessary to report the maximum value of the additional SPS/CG periodicities by a UE. | There is no evidence that all the parameters are needed to be tested and verified for the periodicities. The benefits of more granularities is unclear and it will introduce more complexity on signaling design. |
| CMCC [10] | Proposal 2: it is proposed to support signalling of maximum value of additional SPS periodicity and additional CG periodicity to enable such granularity. | Lower values of new SPS/CG periodicities (e.g., 0.5ms) are regarded as useful for TSN network, practical relevance of vast majority of new CG/SPS periodicities is unknown. More granularity in signalling of supported SPS/CG periodicities feature allows UE to save cost to just realize a partial CG/SPS periodicity. |
| Nokia [11] | Proposal 2: Do not introduce further fragmentation for “Additional DL SPS periodicities” and “Additional CG periodicities” features. | It is hard to predict which of the periodicities will be needed in real deployments. Having only a subset of periodicities would limit significantly the scheduling flexibility in the presence of multiple IIOT devices supporting multiple TSC flows. There is currently no dedicated solution for support of ‘non-integer’ TSC periodicities and the only solution is to use overprovisioning. |
| Intel [12] | Proposal 2: The maximum value of additional SPS periodicities and additional CG periodicities supported by a UE is signaled as capability.  Proposal 3: The following is signaled as the maximum value of additional SPS/CG periodicities: { ms10, ms20, ms40, ms80, ms160, ms320, ms640 }. | 1) Testing/verification of all new periodicities can be challenging; 2) While configurations with lower values of new SPS/CG periodicities (e.g., less than 10ms) are known to be useful, practical relevance of vast majority of new CG/SPS periodicities is unknown.  The gain of alignment between TSN periodicity and SPS/CG periodicity diminishes when the periodicity increases. |
| Huawei [16] | Proposal 4: Not to support the signalling of maximum value of additional SPS periodicities and additional CG periodicities supported by a UE. | It is difficult for the UE to predict which periodicities are really needed before IIoT services start, if a UE sets an additional limit on the maximum value of SPS/CG periodicities, it may restrict the benefits of the feature. |

**Rapporteur summary and proposal:**

5 companies (including Samsung who indicated the need for general capabilities only, without further granularity) indicate that signalling of maximum value of additional periodicities for SPS and CG is not required and indicate that there is no additional complexity related to that and that testing can be handled in a reasonable way by RAN5.

2 companies propose to introduce signalling of the maximum value of supported periodicities for SPS and CG indicating that the usefulness of higher values is unclear.

**Proposal 2: Do not introduce additional signalling for maximum value of supported periodicities for SPS/CG.**

## 2.3 Maximum number of contexts signalling

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| --- | --- | --- |
| Company [Tdoc] | Proposal | Rationale |
| Samsung [4] | Proposal 3. Exponentially increasing range of maximum number of EHC contexts is supported as in maxNumberROHC-ContextSessions: maxNumberEHC-ContextSessions ENUMERATED {cs2, cs4, cs8, cs12, cs16, cs24, cs32, cs48, cs64, cs128, cs256, cs512, cs1024, cs16384, spare2, spare1}, | Apply similar principle as for RoHC. |
| Ericsson [5] | Proposal 4 The support of one-byte header size is mandatory and the support of two-byte header size is optional with a capability indication.  Proposal 5 The maximum number of the supported EHC contexts is indicated by the support of the header size, i.e., it equals to the maximum number of contexts addressable in its supported header size. | There is no need for fine-granular signalling of the number of supported contexts and only supported header size indication is sufficient. |
| CATT [6] | Proposal 5: the maximum number of contexts signalled by the UE is 2^15, i.e. 32768; | EHC contexts correspond to unique combinations of Ethernet header fields: PCP/DEI/VID of one or multiple 802.1Q tags. Therefore, it may be not sufficient to apply the same value for the maximum context sessions as for ROHC, i.e. 16384. CID length allows for maximum of 32768. |
| Nokia [10] | Proposal 3: Maximum number of EHC context sessions signaled by the UE can be one of the following values: cs128, cs256, cs512, cs1024, cs8192, cs16384, cs32768.  Proposal 4: maxNumberEHC-ContextSessions parameter indicates the number of contexts supported by the UE’s compressor and decompressor separately, i.e. maxNumberEHC-ContextSessions can be established between the compressor in the UE and decompressor in the gNB and, simultaneously, maxNumberEHC-ContextSessions can be established between the compressor in the gNB and decompressor in the UE. | The minimum value can be aligned with what is available with 1-byte header, i.e. 128. THe maximum allowed by CID size is 32768.  Clarification is needed that maxNumberEHC-ContextSessions indicates the number of context session supported by the UE in downlink and uplink separately. |
| Intel [12] | Proposal 1: The signaled number of EHC context capability contains the following values {2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384, 32768}. | Adopt similar ranges as for ROHC, but consider that the maximum CID size is 15 bits (i.e. maximum 32768) contexts are possible. |
| Huawei [15] | Proposal 4: The maximum number of EHC contexts supported by a UE can take the value from {64, 128, 256, 512, 1024, 16384, 32768, 65536}.  Proposal 5: Introduce an indication parameter, e.g. maxNumberEHC-ContextsSN, in ConfigRestrictInfoSCG IE of CG-ConfigInfo Message, to indicate the maximum number of EHC contexts allowed to the SN terminated bearer.  Proposal 6: The indication parameter maxNumberEHC-ContextsSN can take a value from 0 to 65536. | The maximum number of supported EHC contexts supported by a UE can be integer multiples of 64 or 16384 (it is assumed that the number indicates sum of DL and UL contexts).  Coordination about the maximum number of EHC contexts supported by a UE can be needed, in order to guarantee the contexts configured by the MN and SN satisfy the UE’s capability constraint. |

**Rapporteur summary and proposal:**

Firstly, it is proposed to clarify whether the parameter *maxNumberEHC-Contexts* indicates the number of contexts supported by the UE’s compressor and decompressor separately (R2-2003171 [10]) or jointly (R2-2002718 [15]).

**Proposal 3: Clarify whether parameter *maxNumberEHC-Contexts* indicates the number of contexts supported by the UE’s compressor and decompressor separately or jointly.**

It should be noted that the number of maximum contexts supported by the UE depends on the outcome of discussion from Proposal 3 and the number of reserved bits, if any. However, based on the proposals above, it seems agreeable that the maximum value of supported context sessions is either 2^CID\_length or 2\*(2^CID\_length):

**Proposal 4: The maximum number of supported / signalled contexts for EHC is either 2^CID\_length or 2\*(2^CID\_length) (depending on the outcome of Proposal 3).**

There are different views on whether the minimum value can be set to 128 (e.g. proposed by Nokia and Ericsson) or whether it should be less than that, e.g. similar to what is defined for RoHC (e.g. Intel, Samsung). There is also a proposal to signal only the supported header size, which would translate into signalling of two possible values (128 and 32768). It is then proposed to discuss these aspects further:

**Proposal 5a: Decide on the minimum number of supported contexts by the UE.**

**Proposal 5b: Discuss whether the number of supported contexts can be derived based on supported header size signalling instead of direct number of contexts signalling.**

In [15], also the issue of MN/SN coordination for maximum number of contexts established at each Cell Group is raised. Even though the issue has not been discussed in other papers, the proposal seems non-controversial is proposed for agreement. The exact values for this signalling can be discussed later, based on the outcome of related discussions.

**Proposal 6: Introduce an indication parameter, e.g. maxNumberEHC-ContextsSN, in ConfigRestrictInfoSCG IE of CG-ConfigInfo Message, to indicate the maximum number of EHC contexts allowed to the SN terminated bearer.**

## 2.4 Relation between PHY-based prioritization and LCH-based prioritization

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| Company [Tdoc] | Proposal | Rationale |
| Samsung [4] | Proposal 4. LCH based prioritization can be supported without PHY prioritization. | Both mechanisms were discussed separately and can be preformed independently. |
| Ericsson [5] | Proposal 2 LCH based prioritization can be supported without PHY prioritization. | PHY layer prioritization is not always required in case a UE generates a single MAC PDU based on LCH-based prioritization. |
| CATT [6] | Proposal 4: LCH based prioritization is not supported without PHY prioritization. | Cancellation of on-going transmissions for intra-UE prioritization is part of the new Rel-16 features supported by PHY. And these are necessary to implement MAC-based prioritization when MAC delivers two PDUs. |
| Qualcomm [9] | Proposal 2: RAN2 should confirm that from purely technical feasibility perspective, MAC prioritization can be used at a UE that does not support PHY prioritization features.  Proposal 3: UE should be allowed to set capability to indicate support for MAC layer prioritization even when it does not support PHY layer prioritization. | There is no technical dependency between the two features and there are scenarios where significant performance benefits can be realized with only MAC layer prioritization, even without using PHY layer prioritization. |

**Rapporteur summary and proposal:**

Rapporteur would like to indicate that this aspect was supposed to be discussed once RAN1 has defined feature/capability related to PHY layer prioritization, which has not been done yet. However, it would be beneficial at least to clarify whether there is a technical dependency between the two features as this also affects whether one can be enabled without the other. In [5] and [6] it is indicated that there are cases where MAC provides two MAC PDUs associated to overlapping grants for transmission to PHY while [9] claims there is no technical dependency between the two features. In [5], it is proposed to address this by a note, similar to the one proposed in an e-mail discussion in [14], e.g.: “An uplink grant, which by PHY grant prioritization will not be transmitted due to overlapping with another ongoing transmission, is considered as a de-prioritized uplink grant.” However, it should be noted that this note refers to PHY grant prioritization, so does not address the case where the UE does not support PHY based prioritization. The rapporteur believes it has to be clarified whether LCH-based prioritization can be enabled without PHY based prioritization being enabled before deciding on the capability dependencies.

**Proposal 7: Discuss whether it is possible to enable LCH-based prioritization without enabling PHY based prioritization, e.g. how is it avoided that MAC provides overlapping grants to PHY layer.**

## 2.5 Other issues

**Number of supported DRBs**

The topic is raised by two companies as shown in the table below.

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| Company [Tdoc] | Proposal | Rationale |
| Apple [7], [8] | Proposal 1: Clarify the note for #DRB UE Capability Constraint to 8 per MAC entity with Release 15 duplication  Proposal 2: Add a note for #DRB UE Capability Constraint to 4 per MAC entity with Release 16 duplication | Since with Rel-16 duplication, each PDCP entity for a DRB can be associated up to 4 lower layer entities when PDCP Duplication is configured, existing note should be updated to capture Rel-15 limitation while a new note should capture Rel-16 limitation. |
| Nokia [11] | Proposal 5: Allow additional RLC entities to be configured for duplication/DAPS without impacting the maximum number of DRBs.  Proposal 6: Discuss the conditions allowing additional RLC entities to be configured (for duplication/DAPS) without impacting the maximum number of bearers that a UE can support. | The current limitation that each RLC entity configured for a DRB configured with duplication counts as a separate DRB leads to too much configuration restrictions and makes duplication and DAPS less useful while not being always justified, e.g. even not activated RLC entities reduce the number of DRBs supported by the UE. |

Rapporteur summary and proposal:

Since this is a new issue, not raised previously, it is proposed to further discuss the following proposal:

**Proposal 8: Discuss how RLC entities configured for Rel-16 PDCP duplication impact the number of the DRBs supported by the UE.**

**Simultaneous EHC and ROHC configuration**

In [15], it is proposed to introduce UE capability signalling to support RoHC and EHC simultaneously for a DRB in both NR and LTE specifications, with the argument that there is a high processing demand for UE to support ROHC and EHC at the same time for large packet size and high data rate.

**Proposal 9: RAN2 to discuss whether to introduce a UE capability signalling to indicate the simultaneous support of RoHC and EHC for a DRB in both NR and LTE specifications.**

**CG periodicities of multiple of 2/7 symbols**

In [6], it is proposed to support to report CG periodicities of multiple of 2/7 symbols with cross-slot boundary capability. In [12], the opposite view is provided. The rapporteur recommends to postpone the discussion on capabilities for this feature after the decision on the support is done to avoid duplication of discussions.

**EHC capabilities for LTE**

In [13], a draft CR introducing EHC related capabilities to 36.306 is provided. Rapporteur proposes to finalize the 38.306 for EHC and then create a CR towards 38.306 based on that.

# 3 Proposals based on Tdoc summary

The following easy proposals are identified:

**Proposal 1: Data vs. data and SR vs. data prioritization are signalled as a single capability.**

**Proposal 4: The maximum number of supported / signalled contexts for EHC is either 2^CID\_length or 2\*(2^CID\_length) (depending on the outcome of Proposal 3).**

**Proposal 6: Introduce an indication parameter, e.g. maxNumberEHC-ContextsSN, in ConfigRestrictInfoSCG IE of CG-ConfigInfo Message, to indicate the maximum number of EHC contexts allowed to the SN terminated bearer.**

The following proposal has no consensus, but there is a majority, so it is brought for agreement:

**Proposal 2: Do not introduce additional signalling for maximum value of supported periodicities for SPS/CG.**

The following proposals require further discussion:

**Proposal 3: Clarify whether parameter *maxNumberEHC-Contexts* indicates the number of contexts supported by the UE’s compressor and decompressor separately or jointly.**

**Proposal 5a: Decide on the minimum number of supported contexts by the UE.**

**Proposal 5b: Discuss whether the number of supported contexts can be derived based on supported header size signalling instead of direct number of contexts signalling.**

**Proposal 7: Discuss whether it is possible to enable LCH-based prioritization without enabling PHY based prioritization, e.g. how is it avoided that MAC provides overlapping grants to PHY layer.**

**Proposal 8: Discuss how RLC entities configured for Rel-16 PDCP duplication impact the number of the DRBs supported by the UE.**

**Proposal 9: RAN2 to discuss whether to introduce a UE capability signalling to indicate the simultaneous support of RoHC and EHC for a DRB in both NR and LTE specifications.**

# 4 [AT109bis-e][031][IIOT] UE capabilities – Phase 1

## 4.1 Potential easy agreements

The following agreements are proposed as potential easy agreements based on the summary in [17]

**Proposal 1: Data vs. data and SR vs. data prioritization are signalled as a single capability.**

**Proposal 2: Do not introduce additional signalling for maximum value of supported periodicities for SPS/CG.**

**Proposal 4: The maximum number of supported / signalled contexts for EHC is either 2^CID\_length or 2\*(2^CID\_length) (depending on the outcome of Proposal 3).**

**Proposal 6: Introduce an indication parameter, e.g. maxNumberEHC-ContextsSN, in ConfigRestrictInfoSCG IE of CG-ConfigInfo Message, to indicate the maximum number of EHC contexts allowed to the SN terminated bearer.**

Companies are requested to indicate in case they object to any of the above proposals

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| --- | --- | --- |
| **Company** | **Objected proposal** | **Comments / alternative proposal** |
| Ericsson | Proposal 4 | Proposal 4 needs to be revised.  Header compression is configured per DRB, and CID\_length is per DRB. Proposal 4 makes sense if the capability applies **per DRB**.  In ROHC, the capability is defined **per UE**. To align, we should think of a number that applies per UE, which should be a large number, not just 2^7 but at least 2^15. |
| LG | Proposal 4 | The maxNumberEHC-ContextSessions is defined per UE, and it indicates the UE memory that can be used for storing EHC contexts. The CID length has nothing to do with the maxNumberEHC-ContextSessions. |
| Huawei | Proposal 4 | Agree with Ericsson and LG on the “per UE” definition. As RAN2 hasn’t discussed explicitly the number EHC-enabled DRBs that UE can support, it might be tricky to agree on exact maximum number for “maxNumberEHC-Contexts”. We suggest to allow certain “spare values” as in [4], i.e. to change P4 to something like “maxNumberEHC-Context ENUMERATED {cs128, cs256, cs512, cs1024, cs16384, cs32768, spare2, spare1} |
| OPPO | Proposal 4 | We agree to have a ‘The maximum number of supported / signalled contexts’ parameter per UE. But, “maxNumberEHC-Contexts” could not be calculated by using CID because of its per DRB nature. |
| vivo | Proposal 4 | Agree with Ericsson and LG that this capability is per UE. Huawei’s change seems to be an acceptable example to us. |
| Intel | Proposal 4 | We also think the capability is per UE. We agree with the proposed values. |
| DOCOMO | Proposal 4 |  |

**Summary of discussion on potential easy agreements**

The following proposals did not receive any objection and are deemed agreeable:

**Proposal 1: Data vs. data and SR vs. data prioritization are signalled as a single capability.**

**Proposal 2: Do not introduce additional signalling for maximum value of supported periodicities for SPS/CG.**

**Proposal 6: Introduce an indication parameter, e.g. maxNumberEHC-ContextsSN, in ConfigRestrictInfoSCG IE of CG-ConfigInfo Message, to indicate the maximum number of EHC contexts allowed to the SN terminated bearer.**

Proposal 4 related to maximum value of maxNumberEHC-Contexts is not agreeable and the issue is summarized further in a summary of section 4.2.

## 4.2 EHC related capabiities

**Clarification of *maxNumberEHC-Contexts* meaning**

As indicated in section 2.3, two different interpretations of maxNumberEHC-Contexts were proposed. In [10] it is proposed to clarify that the parameter indicates the number of contexts supported by the UE’s compressor and decompressor separately while in [15], it is assumed they are indicated jointly.

**Question 1: Should *maxNumberEHC-Contexts* refer to the number of contexts supported by the UE’s compressor and decompressor separately or jointly?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| Ericsson | Jointly | Simpler and sufficient, e.g. UE memory consumption to maintain EHC contexts is similar in decompressor/compressor. |
| LG | Jointly | Both compressor and decompressor maintain the context, and the maxNumberEHC-ContextSessions indicates the UE memory that can be used for storing EHC contexts. |
| Huawei | Jointly | The number of contexts supported by the UE affects the management of “joint” space of memory to store the contexts. No necessity to support separate indications for compressor and decompressor. |
| CATT | Jointly | TSN traffic is symmetrical hence it does not make much sense that UE would have different capabilities for UL and DL. |
| OPPO | Jointly | Agree with Ericsson. It seems not necessary to support separate indications for compressor and decompressor. |
| vivo | Jointly | We see some benefit of using separate capability indications for allowing more flexible UE implementation, but it seems reserving equal memory for UL and DL could also be a reasonable UE implementation and simplifies the implementation and the signaling design. |
| Nokia | Separately | It is a bit late as companies have already provided their views, but our intentions were misunderstood it seems. We were not proposing to have separate indications, but to clarify whether the number refers to UL and DL separately or jointly. As an example, UE indicates maxNumberEHC-Contexts = 128   * If the number is joint, it means UE can support, e.g. 64 in DL and 64 in UL or 32 in DL and 96 in UL etc. * If the number is separate, it means UE can support 128 in DL and 128 in UL.   We think ‘separate’ interpretation is simpler and it is the one used in ROHC in our understanding, although it is not crystal clear from the specifications. The option that we choose impacts also the signaled values that should be considered. |
| Sony | Jointly |  |
| Intel | Jointly | Agree with Ericsson. |
| MediaTek | Jointly |  |
| DOCOMO | Jointly |  |

**Header size or CID signalling**

It was also argued in [5] that explicit signalling of the number of supported contexts is not needed and that the UE should signal the supported EHC header size instead (1-byte or 2-byte long).

**Question 2: Should the UE signal the number of supported EHC contexts explicitly or should it signal supported EHC header size only?**

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| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| Ericsson |  | Our assumption was proposal 4 applies per DRB. The maximum number supported per UE is the product of the maximum number per DRB and the maximum number of DRBs. Depending on the clarification of proposal 4, we can discuss this proposal further. |
| LG | Explicit signaling | The CID length has nothing to do with the maxNumberEHC-ContextSessions. |
| Huawei | Explicit signalling | Agree with LG |
| CATT | Explicit signalling | It is simple and aligns with ROHC. |
| OPPO | Explicit signalling | Similar as RoHC |
| vivo | Explicit signalling | Agree with LG. |
| Nokia | Explicit signalling | There is a relation between CID length and maxNumberEHC-ContextSessions, bcause the latter cannot be larger than what is allowed by CID length. In any case, the explicit signalling of maxNumberEHC-ContextSessions across all DRBs, as for ROHC, is OK to us. |
| Sony | Explicit signalling |  |
| Intel | Explicit signalling | Signalling supported EHC header size has too coarse granularity.  Our understanding for proposal 4 is per UE. Taking ROHC as an example. The capability *maxNumberROHC-ContextSessions* is per **UE**, and the maximum signalled value is 16384. In RRC configuration, *maxCID* is per **DRB**, and the maximum value is 16383. We think the same applies to EHC, i.e. the maximum number of EHC contexts can be configured can equal to the maximum numer of EHC contexts UE supports. Of course, in this case, there can be only one DRB configured with EHC. |
| MediaTek | Explicit signalling | Agree with Intel |
| DOCOMO | Explicit signalling |  |

**Minimum number of supported EHC contexts**

As can be seen in section 2.3, there were different proposals for the values which can be signalled as the supported number of EHC contexts. It is proposed to first agree on the minimum number that can be signalled and decide on other values when implementing the signalling. In case a company prefers header size signalling instead of explicit number, please indicate so also in the reply to question 3. The minimum number in this case is understood to be 2^CID\_length where CID\_length is the number of CID bits in the 1-byte header.

**Question 3: What is the minimum number of EHC contexts that a UE has to support when supporting EHC?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| Ericsson | 2 \* 2^7 | We also wonder if this applies per UE or per DRB.  To handle TSC services properly, at least 2^7 contexts (as in 1-byte header) should be supported for each link direction, i.e., each compressor and decompressor per DRB. Preferably, a higher number can be supported per UE. |
| LG | 1 | The number of EHC contexts that a UE has to support ranges from 1 to maximum value. The maximum value can be e.g. 65535. |
| Huawei | 2^6 or 2^7 | Depends on the minimal length of CID fields, i.e. 6bits or 7bits |
| CATT | 2\*2^7 | We share the same view as Ericsson |
| OPPO | 2 | Adopt similar ranges as for ROHC |
| vivo | 1 | This is to reduce the UE cost of memory allocation for certain IIOT device which only has one EHC flow. |
| Nokia | 2^7 or 2\*2^7 (depending on the decision for Question 1) | We think it would be good to always have a possibility to use the full space of CID given by 1-byte header. We do not think we can go as low as for RoHC where the minimum was 2. In case we go with ‘joint’ option in Question 1, then 1 s definitely not an option. It would not even allow to have 1 context per UL/DL direction. Please note that RoHC profiles were much more complicated and the main use case there was VoIP. For VoIP a single/two context sessions is sufficient, but for IIOT this is not enough. |
| Sony | 1 or 2 | TSN traffic may be symmetric but there may be unidirectional service as well. So no strong preference between 1 and 2. |
| Intel | 2 \* 2^7 | Although in our contribution, we proposal the minimum value of 2. We are OK to have 2 \* 2^7 as the minimum value. |
| MediaTek | 2 | The minimum number of EHC contexts should be similar to RoHC |
| DOCOMO | 1 or 2 | Agree with vivo. |

**Joint EHC and RoHC operation**

In [15], it was proposed to introduce UE capability signalling to support RoHC and EHC simultaneously for a DRB in both NR and LTE specifications, with the argument that there is a high processing demand for UE to support ROHC and EHC at the same time for large packet size and high data rate. Companies are invited to provide their views on this proposal

**Question 4: Do companies think that a UE capability indicating the simultaneous support of RoHC and EHC is needed?**

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| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| Ericsson | No | One bit for each RoHC and EHC is sufficient. Another bit to indicate joint support is not justified, as the operations are largely independent. In addition, in general, we should avoid feature-capability dependencies, |
| LG | No | Independent signaling is enough. |
| Huawei | Yes | As explained in our paper [15], for large packet size**/**high data rate, supporting RoHC and EHC simultaneously for a DRB may impact the UE processing load. Single bit indication for each compression scheme **independently** does not prevent the network to configure both ROHC and EHC simultaneously for a DRB. |
| CATT | Yes | We agree that simultaneously support both ROHC and EHC requires high demand on UE hardware. |
| OPPO | No | No need to introduce dependent capability. Independent indication for ROHC and EHC is enough. |
| vivo | Yes | As the memory could be shared between ROHC and EHC, if the UE indicates the support of ROHC and EHC, this does not mean the UE has sufficient memory for both. |
| Nokia | Slight preference for “No” | We prefer no additional capability for simplicity, but we are OK to have a separate capability considering the concerns over UE memory constraints. |
| Sony | Yes | Agree with the concern of UE memory sharing between ROHC and EHC |
| Intel | No | Our understanding is that EHC is mainly beneficial for small payload size, as captured in TR 38.825. Therefore there might be no concern regarding large payload size / high data rate. |
| MediaTek | Yes | Agree with Huawei’s reasoning |
| Apple | No |  |
| DOCOMO | Yes | Consider a case that only RoHC is configured in a DRB A to compress high data rate, while only EHC is configured in another DRB B to compress small packet. In this case, the UE must have the simultaneous compression implemented for the DRB A while this function is not used in the DRB A if the UE capability indicating the simultaneous support of RoHC and EHC is missing. This is excessive implementation. Therefore, we think the UE is distinguished whether it can compress packet with the EHC and the RoHC, or it can compress packet with them and can apply them in a DRB simultaneously. |

**Summary of EHC related discussions**

The following new proposals are identified as easy agreements due to having an overwhelming support (no more than one company with different preference):

**Proposal Ph1-1: UE signals the maximum number of supported EHC contexts across all DRBs using *maxNumberEHC-Contexts* parameter.**

**Proposal Ph1-2: *maxNumberEHC-Contexts* parameter indicates the number of EHC contexts supported by the UE’s compressor and decompressor jointly.**

Whenit comes to the values that *maxNumberEHC-Contexts* can take, there are different views. However, the maximum of 32768 seems to be sufficient at the moment and agreeable, higher values could be added in future, if needed.

**Proposal Ph1-3: Maximum value of *maxNumberEHC-Contexts* that can be signalled is 32768.**

The views about what the minimum value of *maxNumberEHC-Contexts* should be are almost evenly split between two options:

1. Minimum signaled value can be 2^6 or 2^7, depending on the reserved bits discussion outcome
2. Minimum signaled value can be 1 or 2

Considering that the contexts are much less complex in EHC than in RoHC and that the main application is also very different and may require significantly higher number of contexts, but recognizing the concerns about memory constraints, the rapporteur would like to propose the following compromise:

**Proposal Ph1-4: Minimum value of *maxNumberEHC-Contexts* that can be signalled is 32.**

Other values can be decided when updating RRC signalling as the rapporteur believes this will not be controversial discussion once the minimum and maximum values are established.

On whether a separate capability is needed to indicate joint operation of EHC and RoHC, the views are also evenly split. Since the main concern was about the memory constraints of the UE, there might be also other approaches, e.g. limiting the number of contexts that UE can have when operating both RoHC and EHC in parallel. It is proposed to discuss this issue further during the next meeting.

**Proposal Ph1-5: Postpone the discussion on whether additional capability or related signalling is needed for joint EHC and ROHC operation until the next meeting.**

## 4.3 Relation between LCH-based and PHY-based prioritization

The summary from section 2.4 is copied here for easy reference:

|  |
| --- |
| Rapporteur would like to indicate that this aspect was supposed to be discussed once RAN1 has defined feature/capability related to PHY layer prioritization, which has not been done yet. However, it would be beneficial at least to clarify whether there is a technical dependency between the two features as this also affects whether one can be enabled without the other. In [5] and [6] it is indicated that there are cases where MAC provides two MAC PDUs associated to overlapping grants for transmission to PHY while [9] claims there is no technical dependency between the two features. In [5], it is proposed to address this by a note, similar to the one proposed in an e-mail discussion in [14], e.g.: “An uplink grant, which by PHY grant prioritization will not be transmitted due to overlapping with another ongoing transmission, is considered as a de-prioritized uplink grant.” However, it should be noted that this note refers to PHY grant prioritization, so does not address the case where the UE does not support PHY based prioritization. The rapporteur believes it has to be clarified whether LCH-based prioritization can be enabled without PHY based prioritization being enabled before deciding on the capability dependencies. |

Hence, before discussing interrelation between UE capability to perform PHY-based prioritization and LCH-based prioritization, it is suggested to clarify whether there are some issues if one is enabled in the UE without the other. The view from most of the companies as summarized in section 2.4 is that such operation should be possible. However, as indicated e.g. in [5] or [6], this might require some modifications/clarifications to the specifications.

**Question 5: Do companies agree that LCH-based prioritization can be enabled in the UE without PHY-based prioritization?**

**NOTE: If you agree, please clarify whether you think any changes to current specifications are required to achieve that. In case you do not see any issue, please refer to the problems raised by other companies in the referred contributions or within this discussion, e.g. why do you think those are not relevant. If you disagree, please clarify what the blocking points are and why dependency exists in your opinion.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | Yes | Changes to current specifications are needed. Our proposal in [5] is to have a note in MAC and we agree with Rapporteur that the wording in that proposal is not precise. Another simplified version can be  An uplink grant, which will not be transmitted in PHY when overlapping with another ongoing transmission, is considered as a de-prioritized uplink grant.  How to correctly capture needs further discussion/confirmation. |
| LG | Yes | We don’t see any issue. |
| Huawei | No | We need to double-check. In case there are problems, we prefer to only configure both. |
| CATT | No | MAC-based prioritization requires that PHY is able to pre-empt a transmission by another. |
| OPPO | Yes | We think the note in [5] will require MAC to consider not only the logical channel priority but also the L1-based priority in deciding whether or not a specific MAC PDU is a prioritized MAC PDU, which will make MAC implementation too complexity. In addition, we have agreed to send a LS to RAN1 regarding the possibility of respecting the logical channel-based prioritization decision. So, we think so far it is too early to make such note in TS 38.321. Also, even though RAN1 decides to not make any changes after receiving the LS, we think that an indication regarding the unsuccessful transmission of the prioritized MAC PDU in PHY could be introduced. When it is sent by the PHY to MAC, MAC could make re-scheduling/autonomous transmission of the MAC PDU possible. This potential solution should be considered by RAN2 also. |
| vivo | Yes | We have not observed any issue so far. If companies provide some potential issues in the next meeting, we could also re-visit this. |
| Nokia | Yes | We think this should be allowed, but a clarification will be required how to avoid that MAC provides overlapping grants to PHY when it does not support PHY prioritization. Ericsson proposal can be used as a starting point, but we should probably clarify how MAC knows that a grant will not be transmitted by PHY. |
| SONY | No | We agree with CATT. As pointed out by Ericsson and Nokia, some new specification efforts will be needed, and we do not think there is enough time to do.  In any case, we also like to postpone this discussion until RAN1 give us response. |
| Intel | Yes | We agree with the analysis in [9] that in some scenarios, LCH-based prioritization can be configured without PHY-based prioritization. |
| MediaTek |  | It is unclear why we are having this discussion. We have defined a means of prioritisation in the UE jointly in RAN1 and RAN2, and have spent several meeting cycles discussing the inter-dependencies between the groups. These should not be seen as independent features, but jointly form the framework for prioritisation. |
| Apple | Yes |  |
| DOCOMO | Yes | Agree with Ericsson to have a Note in the MAC spec. Wording could be further discussed. |

**Question 6: Do companies agree that PHY-based prioritization can be enabled in the UE without LCH-based prioritization?**

**NOTE: If you agree, please clarify whether you think any changes to current specifications are required to achieve that. In case you do not see any issue, please refer to the problems raised by other companies in the referred contributions or within this discussion, e.g. why do you think those are not relevant. If you disagree, please clarify what the blocking points are and why dependency exists in your opinion.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | Yes | It can be enabled, but its usefulness depends on what is included in the PHY-based prioritization, which is pending RAN1 discussion.   1. If PHY-based prioritization includes also L1 control/control prioritizations and other control/data (in addition to SR/PUSCH), e.g., two different HARQ ACK/NACK and collision between HARQ ACK/NACK on PUSCH, then it can be enabled and might be useful. 2. If PHY-based prioritization includes only SR/PUSCH and PUSCH/PUSCH discussed in RAN2, it is of no use (although possible) due to the lack of LCH-based prioritization.   From the above analysis, regardless of which interpretation, we do not see any issue in RAN2 specifications. |
| LG | Yes | We don’t see any issue. |
| Huawei | No | We need to double-check. In case there are problems in either RAN1 or RAN2, we prefer to only configure both. |
| CATT | Yes | We agree with Ericsson |
| OPPO | Yes |  |
| vivo | Yes |  |
| Nokia | Yes | This seems to be possible, although, as pointed out by Ericsson, the usefulness of the feature will be very limited as only PHY layer control information prioritization will apply. For SR vs. PUSCH, always PUSCH will be prioritized regardless of its PHY priority. In PUSCH vs. PUSCH, always DG will be prioritized regardless of its priority. |
| SONY | We are not sure | We would prefer to postpone this discussion until RAN1 give us response. |
| Intel | Yes | We agree with Ericsson that some features in PHY-based prioritization can be configured without LCH-based prioritization. |
| MediaTek |  | Similar to Q5, it is unclear why we are having this discussion. We have defined a means of prioritisation in the UE jointly in RAN1 and RAN2, and have spent several meeting cycles discussing the inter-dependencies between the groups. These should not be seen as independent features, but jointly form the framework for prioritisation. |
| Apple | Yes |  |
| DOCOMO | Yes |  |

**Summary of the discussion on relation between PHY-based prioritization and LCH-based prioritization**

When it comes to PHY-based prioritization operating without LCH-based prioritization, almost all companies agree this is possible, although some companies indicate the usefulness of the feature would be limited. In any case, no technical feasibility concerns were raised.

As far as LCH-based prioritization operation without PHY-based prioritization is concerned, clear majority of companies indicate this is possible. On the other hand, one potential problem that has been raised is about the situation where MAC delivers two PDUs which relate to overlapping grants while PHY is not able to / not configured with PHY-based prioritization and is not able to prioritize between them. On the other hand, it was also mentioned that this may require just a small change to MAC specifications, similar to the one discussed for handling of grants with equal PHY priority. Since the decision on how to address the situation on overlapping grants with equal PHY priority is depending on RAN1 reply to RAN2 LS, it is proposed to resolve this issue after RAN1 reply is received. The following is then proposed:

**Proposal Ph1-6: PHY-based prioritization and LCH-based prioritization are configured independently and one can be configured without the other.**

**Proposal Ph1-7: Decide during the next meeting how to address the scenario where PHY layer of a UE which is not configured to perform PHY-based prioritization, receives from MAC layer two MAC PDUs related to overlapping grants.**

## 4.4 Minimum number of supported DRBs with PDCP duplication

[7] and [11] discuss the issue of the number of DRBs supported by a UE in case of the UE support enhanced PDCP duplication. Currently, TS 38.306 captures the following:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 8 UE Capability Constraints The following table lists constraints indicating the UE capabilities that the UE shall support.   | Parameter | Description | Value | | --- | --- | --- | | #DRBs | The number of DRBs that a UE shall support. | 16 per UE.  NOTE: 8 per MAC entity with duplication. | |

This means that a secondary RLC entity configured for a DRB with PDCP duplication, counts as a separate DRB as far as DRB limits are concerned. In [7], it is proposed that the same approach is applied to enhanced PDCP duplication with up to 4 RLC entities per DRB:

|  |
| --- |
| Proposal 1: Clarify the note for #DRB UE Capability Constraint to 8 per MAC entity with Release 15 duplication  Proposal 2: Add a note for #DRB UE Capability Constraint to 4 per MAC entity with Release 16 duplication |

In [11], it is indicated this is too restrictive and it is proposed to allow additional RLC entities to be configured for duplication without impacting the maximum number of DRBs UE can be configured with:

|  |
| --- |
| Proposal 5: Allow additional RLC entities to be configured for duplication/DAPS without impacting the maximum number of DRBs.  Proposal 6: Discuss the conditions allowing additional RLC entities to be configured (for duplication/DAPS) without impacting the maximum number of bearers that a UE can support. |

**Question 7: Companies are requested to express their views on the issue and on the proposals from [7] and [11] related to DRB limitations due to enhanced PDCP duplication.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We support proposal 5 from paper [11]. However, in addition to the Rel-16 TEI paper mentioned by Nokia, this similar issue for Rel-15 PDCP duplication is discussed in the Rel-15 UE capability, e.g., R2-2002571. Thus, we propose to postpone the discussion. |
| LG | We are ok to allow additional RLC entities to be configured for duplication/DAPS without impacting the maximum number of DRBs. |
| Huawei | We prefer to not use the reserved RLC entities for now, given that we have not seen a clear motivation to use so many DRBs with duplication. Without any change, we can rely upon the network to control the DRBs with duplication, under the current limitation of number of logical channels. |
| CATT | We agree that the issue exist and slightly prefer Nokia’s solution |
| OPPO | Proposals from [7] are acceptable, which makes UE implementation not too complicated. |
| vivo | We support proposal 1 and 2. If we do not change the number of supported DRB, then the UE would have to add more memories in order to add the extra RLC entities of the 4 leg duplication. |
| Nokia | As we mentioned in our Tdoc, it is too restrictive and not justified to always count each RLC entity for a DRB as a separate DRB, the deactivated RLC entities being the most clear example. Hence, we think we should discuss the conditions to allow RLC entities being configured and not counted towards the DRB limit of the UE.  When it comes to R2-2002571, we think it mainly provides a clarification on how to interpret the note in Rel-15, so the discussions can take place in parallel. |
| Intel | Agree that the discussion depends on the decision on Rel-15 CR R2-2002571, which specifies that the maximum number of RLC entities per UE is 16. If the CR is agreed, the number of DRBs configured with PDCP duplication of 4 RLC entities is then 4 per UE. We may consider to increase the number of supported RLC beareres without impacting the maximum number of DRBs, as in proposal 5 from paper [11]. |
| MediaTek | We support Proposals 1 and 2 from [7] |
| Apple | It would be preferable to clarify the note to avoid impacting the maximum number of DRB. The current note with 8 per MAC entity with duplication was added with 2 leg duplication in mind. However, with Release 16, 4 leg duplication is implemented and thereby the note would imply a number different than 16 per UE. |
| III | We slightly prefer to wait for the result of the discussion on Rel-15 UE capability before making decisions. |
| DOCOMO | Agree with Nokia’s solution. |

**Summary of discussion on DRB number limitations**

Both approaches, i.e. the one proposed in [7] and the one proposed in [11], gained some support among companies. It was also indicated that the clarification for the DRB number limitation with PDCP duplication for Rel-15 was raised, e.g. in R2-2002571. This contribution was treated as part of ” [AT109bis-e][014][NR15] UE Cap Miscellaneous I(Qualcomm, ZTE,Mediatek, Huawei)” and in the first phase of the discussion all participating companies were in favour of the proposed change. The exact wording will be discussed as part of Phase 2 of the e-mail discussion. It is proposed that the interested companies participate in this discussion as it could potentially be possible to develop a wording which is applicable to duplication regardless of the number of maximum allowable RLC entities per DRB. In addition to that, it is proposed to discuss how additional RLC entities can be configured for a UE without impacting the UE’s DRB limitation.

**Proposal Ph1-8: Revisit the discussion on the number of DRBs the UE shall support with Rel-16 PDCP duplication after the related issue for Rel-15 is clarified.**

**Proposal Ph1-9: Allow additional RLC entities to be configured for duplication without impacting the maximum number of DRBs. Discuss further the conditions for allowing additional RLC entities to be configured.**

## 4.5 Summary of Phase 1

The following proposals from Tdoc summary document in [17] did not receive any objection and are deemed agreeable:

|  |
| --- |
| **Proposal 1: Data vs. data and SR vs. data prioritization are signalled as a single capability.**  **Proposal 2: Do not introduce additional signalling for maximum value of supported periodicities for SPS/CG.**  **Proposal 6: Introduce an indication parameter, e.g. maxNumberEHC-ContextsSN, in ConfigRestrictInfoSCG IE of CG-ConfigInfo Message, to indicate the maximum number of EHC contexts allowed to the SN terminated bearer.** |

The following proposals are proposed for agreement based on Phase 1 of the discussion:

|  |
| --- |
| **Proposal Ph1-1: UE signals the maximum number of supported EHC contexts across all DRBs using *maxNumberEHC-Contexts* parameter.**  **Proposal Ph1-2: *maxNumberEHC-Contexts* parameter indicates the number of EHC contexts supported by the UE’s compressor and decompressor jointly.**  **Proposal Ph1-3: Maximum value of *maxNumberEHC-Contexts* that can be signalled is 32768.**  **Proposal Ph1-4: Minimum value of *maxNumberEHC-Contexts* that can be signalled is 32.**  **Proposal Ph1-5: Postpone the discussion on whether additional capability or related signalling is needed for joint EHC and ROHC operation until the next meeting.**  **Proposal Ph1-6: PHY-based prioritization and LCH-based prioritization are configured independently and one can be configured without the other.**  **Proposal Ph1-7: Decide during the next meeting how to address the scenario where PHY layer of a UE which is not configured to perform PHY-based prioritization, receives from MAC layer two MAC PDUs related to overlapping grants.**  **Proposal Ph1-8: Revisit the discussion on the number of DRBs the UE shall support with Rel-16 PDCP duplication after the related issue for Rel-15 is clarified.**  **Proposal Ph1-9: Allow additional RLC entities to be configured for duplication without impacting the maximum number of DRBs. Discuss further the conditions for allowing additional RLC entities to be configured.** |

# 5 [AT109bis-e][031][IIOT] UE capabilities – Phase 2

Companies are requested to indicate in case they object to any of the proposals resulting from Phase 1 of the discussion, i.e. any of the proposals Ph1-1 to Ph1-9.

|  |  |  |
| --- | --- | --- |
| **Company** | **Objected proposal** | **Comments / alternative proposal** |
|  |  |  |

# References

1. R2-2003166 *Summary of IIOT WI agreements and open issues*, Nokia, Nokia Shanghai Bell
2. R2-2003174 *UE radio access capabilities introduction for NR IIOT WI*, Nokia, Nokia Shanghai Bell
3. R2-2003175 *UE feature list introduction for NR IIOT WI*, Nokia, Nokia Shanghai Bell
4. R2-2002944 *UE Capability for IIOT*, Samsung
5. R2-2002713 *UE capability for IIoT*, Ericsson
6. R2-2002759 *Remaining issues for UE capabilities*, CATT
7. R2-2002815 *Discussion on DRBs Supported with Rel16 PDCP Duplication Enhancement*, Apple
8. R2-2002816 *DRBs Supported with Rel16 PDCP Duplication Enhancement*, Apple
9. R2-2003732 *Open issues in Intra-UE prioritization capability*, Qualcomm Incorporated
10. R2-2003503 *RRC Open Issues for UE capabilities*, CMCC
11. R2-2003173 *UE feature list and capabilities remaining issues*, Nokia, Nokia Shanghai Bell
12. R2-2003322 *Remaining issues in IIoT UE capability*, Intel Corporation
13. R2-2003315 *Draft CR on introduction of miscellaneous EHC capabilities in LTE*, Huawei, HiSilicon
14. R2-2003226 *Summary of e-mail discussion: [Post109e#50][IIOT] Remaining issues intra-UE prioritization*, Nokia, Nokia Shanghai Bell
15. R2-2002718 Discussion about remaining issues of EHC Huawei, HiSilicon
16. R2-2002663 Discussion about open issues for CG and SPS Huawei, HiSilicon
17. R2-2003793 Summary of 6.7.6 UE capabilities for IIOT Nokia, Nokia Shanghai Bell