3GPP TSG-RAN WG2 Meeting #109e R2-200xxxx

Elbonia, Online, 24 February – 6 March 2020

**Agenda item: 6.7.1**

**Source: Nokia, Nokia Shanghai Bell**

**Title: [AT109e][031][IIOT] IIOT UE capabilities**

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

**Document for: Discussion and Decision**

# Introduction

The following open issues for UE features and capabilities were identified during the related e-mail discussion prior to RAN2#109-e meeting [1]:

* Ethernet header compression

The need for Ethernet padding removal and Ethernet padding addition features is to be confirmed during RAN2#109.

It is FFS whether Ethernet padding removal capability is needed (if its support is confirmed).

It is FFS whether a capability for EHC context continuation and *maxNumberEHC-ContextSessions-r16* are needed (pending the discussion on remaining aspects of EHC).

* TSC scheduling

It is FFS whether “Additional DL SPS periodicities” and “Additional CG periodicities” features require the signalling of maximum value of N supported by the UE.

It is FFS whether a UE supporting [multipleCG-Configs-r16] shall also support lch-ToConfiguredGrantMapping-r16.

* Intra-UE prioritization

It is FFS whether LCH priority-based prioritization covers both data/data prioritization and SR/data prioritization or if separate features are needed.

* PDCP duplication

It is FFS whether “PDCP duplication with more than two RLC entities” feature needs to be separate for UM and AM RLC modes.

Section 2 contains summary of UE capabilities related discussions based on contributions from companies. Section 3 summarizes the proposals while in Section 4 companies are requested to provide their views on the issues. In addition to the aspects originally summarized in [12], also capability related aspects of Ethernet Header compression, as summarized in [13] are considered.

# 2 Accurate reference timing summary

## 2.1 Ethernet Header Compression

The related proposals were summarized as part of Summary on EHC and are not discussed here.

## 2.2 TSC scheduling

### 2.2.1 CG and SPS periodicities

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| Company (Tdoc) | Proposals | Rationale |
| Qualcomm (R2-2001290) | Proposal 1: Support signalling of maximum value of additional SPS periodicity and additional CG periodicity supported by a UE. | Large number of new CG/SPS periodicities (>9000) are supported in Rel-16. Testing/verification of all new periodicities can be challenging. 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. |
| Nokia, Nokia Shanghai Bell(R2-2001049) | Proposal 3: Support CG periodicities of multiple of 2/7 symbols as a separate capability with a cross-slot boundary capability as a pre-requisite. | The main argument against supporting CG periodicities of multiple of 2/7 symbols were potential issues with resource allocations across the slot boundary and the proposal addresses this issue. |
| Nokia, Nokia Shanghai Bell(R2-2001052) | Proposal 4: Do not introduce further fragmentation for “Additional DL SPS periodicities” and “Additional CG periodicities” features. | In our opinion, it will be very hard for implementers to predict which of the periodicities will be needed in real deployments. In addition, it would limit significantly the scheduling flexibility in the presence of multiple IIOT devices supporting multiple TSC flows. Also, there is currently no dedicated solution for support of ‘non-integer’ TSC periodicities and the only solution is to use overprovisioning. With limited periodicities support at the UE, this task would be very hard. |

Summary:

Considering that only two companies expressed their view on the issue, it is proposed to discuss it further:

**Proposal 1: Discuss whether signalling of maximum value of additional SPS periodicities and additional CG periodicities supported by a UE is required.**

**Proposal 2: Discuss whether to support CG periodicities of multiple of 2/7 symbols as a separate capability with a cross-slot boundary capability as a pre-requisite.**

### 2.2.2 Relation between multipleCG-Configs and lch-ToConfiguredGrantMapping-r16 capabilities

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| Company (Tdoc) | Proposals | Rationale |
| Ericsson(R2-2000789) | Proposal 1 UE supporting multipleCG-Configs shall also support lch-ToConfiguredGrantMapping. | No separate capabilities are required in this case as multiple CG configurations and LCH to CG mapping would typically be used together anyway. Multiple CG were introduced to handle TSC flows better, for which also the LCH to CG mapping should be used to schedule resources for certain TSC flows deterministically. |
| Nokia, Nokia Shanghai Bell(R2-2001052) | Proposal 6: Keep the requirement that UE supporting multipleCG-Configs should also support lch-ToConfiguredGrantMapping. | It is very important to keep those two features together as otherwise the management of multiple LCHs which are provided with their dedicated CG configuration becomes very cumbersome. It may often be very challenging or even impossible for the network to achieve the intended mapping only by using legacy LCP restrictions. |
| Qualcomm(R2-2001290) | Proposal 2: A UE supporting multiple CG configurations feature need not support LCH-to-CG mapping restriction. | A UE could support multiple CGs without LCP restrictions (e.g., if associated traffic flows have non-overlapping arrivals) or use other LCP restrictions to restrict LCHs using the CGs. |

Summary:

Two companies indicated that UE supporting multipleCG-Configs should also support lch-ToConfiguredGrantMapping while one company has the opposite view. The following proposal is made:

**Proposal 3: FFS if the UE supporting multipleCG-Configs shall also support lch-ToConfiguredGrantMapping.**

## 2.3 Intra-UE prioritization

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| Company (Tdoc) | Proposals | Rationale |
| CATT(R2-2000115) | Proposal 5: It is not necessary to introduce one new parameter for SR/data prioritization. | Separating the features will also add extra-complexity and specification effort, so it is preferred to keep it a one overall functionality configured with a single parameter. |
| Ericsson(R2-2000797) | Proposal 5 SR/data prioritization is separate configurable feature from data/data prioritization feature. | While similarities and overlap in functionality of these features exist, their purpose and impact on UE MAC multiplexing as well as scheduling and gNB UL reception are quite different, e.g. it is not necessary or even not wanted in some implementations that UE prioritized between potentially overlapping grants for data/data. |
| Qualcomm(R2-2001289) | Proposal 1: SR and data prioritization each have separate RRC configuration parameters and 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. |
| Proposal 6: Once RAN1 has defined feature/capability related to PHY layer prioritization, RAN2 should discuss whether LCH based prioritization can be supported without PHY prioritization. | RAN2 should discuss whether LCH based prioritization can be implemented without PHY prioritization before introducing any such dependence between the two. For instance, PDU suppression of LCH based prioritization can be used without any PHY-layer actions like pre-emption provided Rel-15 timelines for associated grants are followed by the scheduler. |
| Samsung(R2-2001497) | Proposal 3. A single configuration lch-basedPrioritization is used for both 1) Data-Data prioritization and 2) SR Data prioritization. | Both prioritization between grants and a grant and SR are based on the priority value of the logical channels, so we can say that they have a commonality and are similar to each other.  |
| Nokia, Nokia Shanghai Bell(R2-2001052) | Proposal 3: Confirm that lch-PriorityBasedPrioritization-r16 covers both data vs. data and SR vs. data prioritization. | 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. At the same time, both of these are equally important when it comes to support of URLLC traffic. In order to avoid too extensive capability fragmentation and specifications complexity, it is proposed to keep those two together. |

Summary:

Some companies seem to mix the issue of separate configurability of data vs. data and SR vs. data prioritization with a capability signalling for those. Two companies (CATT, Samsung) indicate that a single configuration parameter is used, which automatically means these are both a single capability. One company (Ericsson) speaks of separate configurability, but does not refer to capability signalling. Once company (Qualcomm) mentions that both configurability and capability signalling should be separate. One company (Nokia) indicates that these two should be a single capability, but does not mention configurability.

In attempt to reach a common ground, it is proposed to agree on the following proposals:

**Proposal 4: Data vs. data and SR vs. data prioritization are configured separately.**

**Proposal 5: Data vs. data and SR vs. data prioritization are signalled as a single capability.**

It has been also raised by one company that we should wait to see the RAN1 definition of feature/capability for intra-UE prioritization to see whether they should be coupled. It is proposed to keep the current definition as in the current 38.306 CR in [2] and re-discuss after receiving feature descriptions from RAN1.

**Proposal 6: Once RAN1 has defined feature/capability related to PHY layer prioritization, discuss whether LCH based prioritization can be supported without PHY prioritization.**

## 2.4 PDCP duplication

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| Company (Tdoc) | Proposals | Rationale |
| Qualcomm (R2-2001288) | Proposal 1: PDCP duplication enhancements (support for up to 4 RLC entities, dynamic leg selection, resource efficient PDCP duplication) with RLC entities in mode AM should either- not be supported, or- should be configured for a UE based on a capability signalled by the UE. | PDCP duplication enhancements (support for up to 4 RLC entities, dynamic leg selection, resource efficient PDCP duplication) in scope of this WI are primarily to enhance reliability for use cases requiring low latency and RLC AM mode is not useful for such use cases. Given PDCP duplication enhancements with RLC entities in mode AM don’t add much value, it should be configured for a UE based on a capability to avoid test cases for configurations with limited practical use. |
| Nokia, Nokia Shanghai Bell(R2-2001052) | Proposal 5: Capability of PDCP duplication with more than two RLC entities is common for RLC AM and RLC UM mode. | For two-leg duplication AM and UM modes are not separated and there seems to be no additional complexity of supporting PDCP duplication over RLC AM mode as compared to RLC UM mode. |

Summary:

Only two companies expressed their view and had opposite views.

**Proposal 7: Discuss whether separate capabilities are needed for PDCP duplication with more than two RLC entities for RLC AM and RLC UM mode.**

# 3 Proposals based on Tdoc summary

Based on the summary in section 2, the following proposals are made:

**Proposal 1: Discuss whether signalling of maximum value of additional SPS periodicities and additional CG periodicities supported by a UE is required.**

**Proposal 2: Discuss whether to support CG periodicities of multiple of 2/7 symbols as a separate capability with a cross-slot boundary capability as a pre-requisite.**

**Proposal 3: FFS if the UE supporting multipleCG-Configs shall also support lch-ToConfiguredGrantMapping.**

**Proposal 4: Data vs. data and SR vs. data prioritization are configured separately.**

**Proposal 5: Data vs. data and SR vs. data prioritization are signalled as a single capability.**

**Proposal 6: Once RAN1 has defined feature/capability related to PHY layer prioritization, discuss whether LCH based prioritization can be supported without PHY prioritization.**

**Proposal 7: Discuss whether separate capabilities are needed for PDCP duplication with more than two RLC entities for RLC AM and RLC UM mode.**

# 4 [AT109e][031][IIOT] IIOT UE capabilities

**Question 1: Do you think signalling of maximum value of additional SPS periodicities and additional CG periodicities supported by a UE is required?**

|  |  |  |
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| **Company** | **Yes / No** | **Rationale** |
| Qualcomm | Yes | Large number of new CG/SPS periodicities (>9000) are supported in Rel-16. Testing/verification of all new periodicities can be challenging. 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.More granularity in signalling of supported SPS/CG periodicities feature allows UE implementations to focus better on practically relevant use cases, while also leaving the option to support more periodicities. Allowing signalling of maximum value of SPS periodicity and CG periodicity provides one way to introduce such granularity. |
| OPPO | Yes |  |
| Ericsson | No | One capability indication is preferred. We don’t see any challenges to implement a large periodicity value at UE. We also wonder if it is true that the testing/verification needs to do for all periodicity values or a test on several random chosen values is sufficient.  |
| Intel | Yes | Agree with Qualcomm’s view. |

**Question 2: Do you support allowing CG periodicities of multiple of 2/7 symbols as a separate capability with a cross-slot boundary capability as a pre-requisite?**

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| --- | --- | --- |
| **Company** | **Yes / No** | **Rationale** |
| Qualcomm | No | For more flexible CG periodicity, RAN2#107bis already agreed to support CG periodicities of any integer-multiple of one slot. We recommend that this topic is not considered further in Rel-16. This has been discussed several times including at least once online, in an email discussion and a RAN2#108 offline. |
| OPPO | No |  |
| Ericsson |  | We wonder if this is a capability discussion, since we haven’t agreed to support this feature yet. |
| Intel | No | Agree with Qualcomm. |

**Question 3: Shall the UE supporting multipleCG-Configs also support lch-ToConfiguredGrantMapping**

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| --- | --- | --- |
| **Company** | **Yes / No** | **Rationale** |
| Qualcomm | No | We don’t see the need to couple together multi-CG feature and LCH-to-CG mapping feature. A UE could use multiple CGs without LCP restrictions associated traffic flows have non-overlapping arrivals. Note that for many TSC traffic flows IEEE 802.1Qbv, there may be no jitter in expected arrival times. For such cases, there is no need to use LCP restrictions. |
| OPPO | No | We think multiCG-Config feature could work on the basis of current R-15 LCP restriction. |
| Ericsson | Yes | We believe that no separate capabilities are required in this case as multiple CG configurations and LCH to CG mapping would typically be used together anyway. Multiple CG were introduced to handle TSC flows better, for which also the LCH to CG mapping should be used to schedule resources for certain TSC flows deterministically. |
| Intel | Yes | Agree with Ericsson. |

**Question 4: Do you agree that data vs. data and SR vs. data prioritization can be configured separately?**

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| --- | --- | --- |
| **Company** | **Yes / No** | **Rationale** |
| Qualcomm | Yes | See rationale below. |
| Ericsson | Yes | While similarities and overlap in functionality of these features exist, their purpose and impact on UE MAC multiplexing as well as scheduling and gNB UL reception are quite different, e.g. it is not necessary or even not wanted in some implementations that UE prioritized between potentially overlapping grants for data/data. |
| Intel | No | We prefer that they are configured by the single parameter *lch-basedPrioritization*. |

**Question 5: Do you agree that data vs. data and SR vs. data prioritization are signalled as a single capability?**

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| --- | --- | --- |
| **Company** | **Yes / No** | **Rationale** |
| Qualcomm | No | SR vs grant prioritization is clearly a feature distinct from and complementary to grant prioritization, and hence should be a separate feature. For instance, SR vs grant prioritization can be used for infrequent aperiodic uplink URLLC traffic flow to prioritize associated SRs over lower priority traffic to ensure low latency delivery of uplink data. An *alternative complementary solution* involves use of configured grant to carry the aperiodic infrequent URLLC traffic and using data/data prioritization to prioritize the configured grant when the URLLC traffic is available.  |
| OPPO | Yes | Both of SR vs grant and grant vs grant employ the logical channel priority for intra-UE prioritization.  |
| Ericsson | Yes | We think some PHY prioritization features are designed together for both cases and one-bit indication is simpler.  |
| Intel | Yes | We prefer a single capability for MAC based prioritization. |

**Question 6: Do you think separate capabilities are needed for PDCP duplication with more than two RLC entities for RLC AM and RLC UM mode?**

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| --- | --- | --- |
| **Company** | **Yes / No** | **Rationale** |
| Qualcomm | Yes | Support for RLC AM will involve more effort than just supporting RLC UM. Further, we don’t expect RLC AM to be common in practise since:* RLC retransmissions are not needed for meeting reliability requirements for industrial use cases when PDCP duplication is used.
* PDCP duplication with RLC entities in mode AM is not needed for use cases requiring low latency. PDCP duplication with RLC entities in mode UM can be used for use cases requiring low latency.
 |
| OPPO | YES | Retransmission of PDU in RLC AM mode seems not workable for IIOT use cases requiring low-latency data transmission services.  |
| Ericsson | No | While the number of RLC entities involved can be up to 4, their internal functionality is not changed/increased. So no more need to differentiate between UM and AM in Rel-16 than in Rel-15. |
| Intel | No | In Rel-15, we don’t have separate capabilities for AM and UM regarding PDCP duplication. Same principle applies to Rel-16. |

The following issue is proposed to be postponed until RAN1 provides the description of L1 features:

1. **Whether LCH based prioritization can be supported without PHY prioritization.**

The discussion on whether maximum CID value should be configurable took place during the online session and it summary from chairman notes is copied here:

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| R2-2000175 Report of email discussion [108#53] [IIOT] EHC remaining issues Huawei, HiSilicon discussion Rel-16 NR\_IIOT-CoreP3- Chair wonder if we should discuss CID- LG think we need to decide fixed or variable size. - Chair wonders if the overhead is very significant. CATT think yes, and think we could go for small fixed size. QC support CATTs view. Samsung agree with CATT as well. - MTK think that in addition to small fixed size it could be useful to have a second size. - Oppo are ok with fixed size but think “large” size is needed. Think that in ROHC size is 14 or 17.- Docomo think that SA hasn’t concluded how many devices are connected to a UE so > 1 octet CID may be needed. - Intel think CID size need to be “large”. - Nokia could be ok to compromise and have two sizes.- ZTE think the no of devices doesn’t relate to - LG cannot agree to 2 sizes. * FFS if we have 1 CID size or 2 CID sizes: one byte, two bytes, Configured by RRC
 |

There were concerns for any of the options that has been brought. The main issue with fixed short (1 byte) header was that companies were unsure whether it would allow for sufficient number of contexts. The main issue with fixed long (2 byte) header was the additional overhead. There was also different understanding about whether the CID limitation is per DRB or per UE and it should be noted that if the limitation is per DRB, then the number of contexts a UE can support is increased to potentially sufficient level. It is proposed to consider the following options:

**Option 1: Both 1-byte header and 2-bytes header is supported and the choice depends on RRC configuration.**

**Option 2: Only 1-byte header is supported. EHC compressor/decompressor maintains contexts per DRB, which allows to support additional contexts by configuring additional DRBs.**

**Option 3: Both 1-byte header and 2-bytes header is supported and which one is used depends on the first bit of the CID field, e.g.**

* **If first bit == 0, CID = short (only 1 byte header)**
* **If first bit == 1, CID = long (2 byte header)**

**Option 4: Only 2-byte header is supported.**

It is noted that option 3 was not put on the table previously but is derived from ROHC behaviour. It is put on the table as it does not require additional configurability, which may address the concerns from some companies.

**Question 7: Please indicate your preferred option from the ones mentioned above.**

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| **Company** | **Preferred option** | **Rationale** |
| Qualcomm | 2 or 1 (less preferred) | Simple and flexible enoughWe believe option 3 has significant disadvantage because it introduces variable length headers that cause additional receiver complexity for URLLC traffic. |
| OPPO | Option 1 | Avoid unnecessary complexity |
| Ericsson |  | This is still FFS and should be part of the EHC email discussion.  |
| Intel | 4 or 1 (less preferred) | Agree with Ericsson that it might be better to discuss this issue in other email discussions. Nevertheless we provide our views as follows.We add option 4 as our understanding is that the option is not excluded from the online discussion.Our understanding is that since context ID can represent unique combinations of Ethernet header fields: destination address, source address, type/length, and 802.1Q tags, 1 byte header (up to 255 context IDs) is not sufficient. In addition, EHC operation (maintenance of mapping relationship between context ID to Ethernet header fields) is relatively simple compared to ROHC, therefore supporting larger number (i.e. 32767) of EHC contexts does not have much impact to UE complexity.As a compromise, we can also accept option 1, where the header length is configured by RRC instead of dynamic indication (option 3). We share the same view as Qualcomm regarding the complexity of option 3. |

**Question 8: Do you think it is required for the UE to signal the maximum supported number of EHC contexts? (it may depend on the outcome of Q7 as well)**

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| --- | --- | --- |
| **Company** | **Yes/ No** | **Rationale** |
| Qualcomm | Yes if option 2 in Q7 selected | If only one byte EHC header is supported, then the capability need not be signalled.If both one and two byte EHC headers are supported, some form of capability signalling becomes important due to the very large number of CIDs accommodated by the two byte option. |
| Ericsson | Yes  | Agree with Qualcomm that if two bytes are supported, some form of capability signalling is needed due to large memory at UE to accommodate large CID space. |
| Intel | Neutral | Given the relatively simple operation of EHC, we don’t think signalling of the maximum number of supported EHC context is necessary. But we don’t have strong opinion on this topic. |

In EHC e-mail discussion the following proposals are mentioned as potentially easy agreements:

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| **Proposal 31: Configuration of a parameters (e.g. drb-ContinueEHC) indicates whether or not EHC is reset at PDCP re-establishment.****Proposal 32: EHC context continue function can be indicted separately for UL and DL, through configuration of parameters, e.g. ul-drb-ContinueEHC and dl-drb-ContinueEHC.** |

**Question 9: Assuming EHC continue function is agreed, do you think we need to specify a capability bit for the support of EHC context continuation upon PDCP re-establishment?**

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| **Company** | **Yes/ No** | **Rationale** |
| Qualcomm | Yes |  |
| Ericsson | No |  |
| Intel | Yes |  |

Intel’s comment on UE capability *ehc-Profiles-r16* in the draft running CR R2-2001054 (for 38.306) and R2-2001055 (for 38.822). Currently *ehc-Profiles-r16* has the description of “*Indicates that the UE supports Ethernet header compression and decompression according to the indicated profile(s), as specified in TS 38.323 [16].*” Concerns were raised on the mentioning of profiles in email discussion “[108#47][IIOT] UE feature list” (R2-2001053). In the endorsed PDCP running CR for IIoT (R2-2001281), profile for EHC was removed (clause 5.X.1). To avoid inconsistency, it is suggested to rename the capability to *ehc-r16*¸with the description as “*Indicates that the UE supports Ethernet header compression and decompression as specified in TS 38.323 [16].*”

# List of referenced documents

1. R2-2001053 Summary of e-mail discussion: [108#47][IIOT] UE feature list, Nokia, Nokia Shanghai Bell
2. R2-2001054 UE radio access capabilities introduction for NR IIOT WI Nokia, Nokia Shanghai Bell
3. R2-2001290 Open issues in Scheduling Enhancements Qualcomm Incorporated
4. R2-2001049 Remaining issues on TSC scheduling Nokia, Nokia Shanghai Bell
5. R2-2001052 UE feature list and capabilities remaining issues Nokia, Nokia Shanghai Bell
6. R2-2000789 SPS and CG remaining MAC aspects Ericsson
7. R2-2000115 Remaining issues for intra-UE multiplexing and prioritization CATT
8. R2-2000797 Remaining details of intra-UE prioritization Ericsson
9. R2-2001289 Open issues in Intra-UE prioritization Qualcomm Incorporated
10. R2-2001497 Prioritization of SR Transmission Samsung
11. R2-2001288 Open issues in PDCP duplication enhancements Qualcomm Incorporated
12. R2-2002072 Summary on UE features and capabilities Nokia, Nokia Shanghai Bell
13. R2-2002020 Summary on Ethernet Header Compression MediaTek Inc.