**3GPP TSG-RAN2 #116bis-e R2-220xxxx**

**Electronic meeting, January 17th – 25th 12**

**Agenda item:**‎x.xx

**Source:** CATT

**Title:** Report of [Post116-e][088][UDC] UDC initial discussion (CATT)‎

**Document for:** Discussion and Decision

# 1 Introduction

This document is for the report of the following discussion

* [Post116-e][088][UDC] UDC initial discussion (CATT)

Scope: To align companies’ understanding regarding which parts of the UDC functionality directly follows LTE mechanism, which parts shall be adapted based on NR characteristics (if any), and what is the target of each such adaptation (if any). The discussion may include stage-3 examples to illustrate the points discussed.

Intended outcome: Report

Deadline: Long

The reminder of this contribution is organized as the following.

* Section 2 provides Rapporteur’s general analysis on NR UDC functionality including potential issues to be discussed due to NR characteristics. Section 3 provides specification impact analysis and modification examples may be provided in later phase. Section 4 contains the summary.

The discussions are planned in two phases:

* In Phase 1, companies’ views/comments are collected, on the generally analysis and potential open issues in section 2 (i.e., do they agree to those issues or do they see any other issues that need to be discussed) and also on spec impact analysis in section 3. The deadline for Phase 1 is end of Dec. 8th, 2021, UTC time.
* In Phase 2, companies’ views/comments are collected regarding how to address the issues that have been identified through Phase 1 discussions and how to modify the specifications. The deadline is end of Dec.16th, 2021, UTC time.

Participants are invited to leave their contact information in the table.

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# 2 General analysis on NR UDC Functionality

### Phase 1

The purpose of this section is to analyse from high level the NR UDC functionality, and identify

* which parts directly follow the LTE UDC mechanism, and
* which parts need further discussion and clarification.

The functionalities are divided as the following

1. PDCP aspects
2. UDC configuration
3. UDC operation in RRC re-establishment procedure
4. Release of UDC configuration in different cases
5. UDC operation in mobility procedure
6. Split Bearer
7. RAN3 impacts.
8. UE capability for UDC

In Table 1, some analysis in R2-2111067‎ is reused. In the table, the parts with TBD mean that some further discussions are needed (i.e. adaptation due to NR characteristics should be considered). Note that these points are not for the sake of optimization which does not belong to the WID scope, but it aims at clarification and easy inclusion of UDC to all the related NR specifications.

**Table 1 Functionality analysis**

|  |  |
| --- | --- |
| **parts of NR UDC functionality** | **Analysis** |
| PDCP aspects | * **UDC protocol**: defines the compression algorithm of UDC; * **Configuration of UDC**: defines the configuration procedure for UDC as well as the initialization of the dictionary buffer of UDC; * **UDC header**: defines the format of UDC header; * **Pre-defined dictionary**: in UDC, pre-defined dictionary can be applied to improve the compression efficiency; * **UDC buffer reset**: when the compression buffer and de-compression buffer are not synchronized, the compression buffer is reset for resynchronization; * **UDC feedback procedure**: the network can figure out whether UDC decompression succeeds or not by checking UDC checksum error. Hence, UDC feedback procedure enables feedback, i.e. UDC feedback packet, from the network in case of the out of synchronization happens to trigger UDC buffer reset procedure; * **UDC PDU format definitions**: defines the PDU format for UDC with 12 bits PDCP SN and 18 bits PDCP SN. In NR, SDAP is introduced for mapping between QoS flow and DRB. But it is TBD whether SDAP header and SDAP control PDU should be compressed by UDC; * **PDCP reordering**: gNB implementation ensures that UDC decompression is after PDCP reordering. * **UDC continuity** : whether support UDC continuity in NR which can follow ROHC continuity mechanism can be TBD. * **Relationship with ROHC and EHC:** UDC is not configured simultaneously with ROHC or EHC for the same radio bearer. |
| UDC configuration | * UDC only is configured when reconfiguration with sync or the first *RRCReconfiguration* message after RRC connection re-establishment. |
| UDC operation in RRC re-establishment procedure | * Reset compression buffer for UDC bearer. |
| Release of UDC configuration in different cases | * RRC reconfiguration with sync; * RRC reestablishment procedure; * Conditional reconfiguration with sync; * RRC resume procedure; |
| UDC operation in mobility procedure | * **UDC in DAPS** (**TBD**): whether UDC can be used during DAPS HO in NR should be clarified. In LTE UDC, it is not applied for DAPS. * **UDC in CHO:** UDC configuration is released when conditional reconfiguration with sync is executed. |
| Split bearer | * **UDC for split bearer** (**TBD**): it should be clarified whether UDC can be applied to split bearer. |
| RAN3 impacts | * **UDC impacts on E1** (**TBD**): if supporting CU-CP/UP splitting, E1 would be impacted to transmit UDC configuration from CP to UP. |
| UE capability for UDC | * Support UDC and pre-defined dictionary capabilities |

**Question 1-1: Do you agree the parts without TBD can easily follow the LTE mechanism?**

|  |  |  |
| --- | --- | --- |
| Company | Yes or No | Comments if any |
| LG | Comments | It is difficult to say whether we can easily follow the LTE mechanism or not. Each function should be carefully checked whether it is supported for NR. |
| CATT | Yes | Intention is to check from high level which functionalities can follow those of LTE UDC, e.g., compression algorithm, checksum, pre-defined dictionary, handling for failure etc.. Detailed specification changes can be discussed in a later stage, once views have been aligned from high level. |
| Mediatek | Yes | Except the aspects of TBD, we don't see any technical issue to follow the LTE mechanism. |
| Huawei, HiSilicon | Yes with some clarifications | For UDC configuration, we understand that the network can configure UDC for a new DRB and the network can configure UDC for existing DRBs only by some means. So the following description can be improved:  For existing DRBs, UDC only is configured when reconfiguration with sync or the first *RRCReconfiguration* message after RRC connection re-establishment.  For release of UDC after a successful CHO, we understand that the UE shall release UDC configuration when the UE perfroms a successful CHO (i.e. after CHO execution), so the bullet “Conditional reconfiguration with sync;” could be improved to: after UE applying Conditional reconfiguration with sync.  For UDC buffer reset, we think that when the compression buffer and de-compression buffer are not synchronized (indicated by gNB or identified by UE), the compression buffer is reset for resynchronization. This should be allowed by existing LTE UDC definition. |
| Apple | Yes | We think that we can follow the high-level UDC functionality of LTE as a baseline and we also agree on the TBD aspects, detailed changes can be discussed in subsequent steps. |
|  |  |  |

Some further clarifications on potential issues in table 1 (i.e. TBD) are discussed below.

**Issue 1: Whether UDC is applied to SDAP header and SDAP control PDU?**

In NR, SDAP has been introduced. There may be two types of SDAP PDUs, i.e. SDAP data PDU and SDAP Control PDU. It has specified that ciphering and header compression are not applied to SDAP header and SDAP control PDU (see TS 38.323). Whether UDC is applicable to SDAP header and SDAP control PDU should be discussed. If companies agree this is an issue to be discussed, two alternatives can be considered:

Alt 1: UDC is applicable to SDAP header and SDAP control PDU.

Alt 2: UDC is not applicable to SDAP header and SDAP control PDU.

The rapporteur prefers Alt2 which follow the existing mechanism that ciphering and header compression are not applied to SDAP header and SDAP control PDU.

**Question 1-2: Do you agree UDC is not applied to SDAP header and SDAP control PDU?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | New issues to be discussed if any |
| LG | Yes |  |
| CATT | Yes |  |
| Mediatek | Yes |  |
| Huawei, HiSilicon | Yes | We prefer alt2. At RAN2#107, we paper R2-1910523 discussed the issue. We think alt2 follows the principle of legacy ciphering and header compression definition, so the option should be easier than alt1. |
| Apple | Yes |  |
|  |  |  |

**Issue 2: UDC PDU format**

Since SDAP is introduced in NR, its header location should be decided, i.e. whether it is located before or after UDC header should be discussed. Two formats can be considered:

Option 1: the SDAP header is located after UDC header which is illustrated as following:



Option 2: the UDC header is located after SDAP header which is illustrated as following:



Note: this issue may be related to issue 3.3-1.

This issue is related to issue 1. If UDC is not applied to SDAP header, option 2 format can be used.

**Question 1-3: Do you agree option 2 is used as the UDC PDU format?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | New issues to be discussed if any |
| LG | Yes | Similar to ROHC and EHC header. |
| CATT | Yes |  |
| Mediatek | Yes |  |
| Huawei, HiSilicon | Yes | We prefer Option 2. At RAN2#107, we paper R2-1910523 discussed the issue, and Q1-3 is related to Q1-2. |
| Apple | Yes | Strongly prefer option 2. This also implies that the UDC header is ciphered as in LTE. In this case ciphering would apply to the UDC header, UDC data block, and MAC-I. And integrity protection would apply to PDCP header, SDAP header, UDC header, and UDC data block. |
|  |  |  |

**Issue 3: UDC continuity**

In NR Rel-15, it has been agreed to support ROHC continuity in case of resuming an RRC connection or reconfiguration with sync, when the PDCP termination point is not changed and the *fullConfig* is not indicated (see TS 38.331). This is helpful to reduce the radio resource consumption. Although LTE UDC does not support continuity, some companies see the benefits of UDC continuity in NR. So it is suggested to discuss whether we can follow ROHC mechanism in NR UDC.

**Question 1-4: Do you agree to support UDC continuity in NR which reuses ROHC continuity mechanism?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | New issues to be discussed if any |
| LG | No | We want to keep the UDC simple to be aligned with allocated TU. |
| CATT | Yes | In our view, UDC continuity is beneficial to improve the resource efficiency. Since we follow the similar mechanism of ROHC continuity, we believe the work load is quite limited.  We can check what the companies’ views are. |
| Mediatek | Yes | We also think it’s beneficial to support UDC continuity. There is no much effort to support this, just following the same principle of ROHC continuity. Since UDC continuity is configurable, if the network can’t support UDC continuity, it can choose not to set the indication. |
| Huawei, HiSilicon | Yes | We see the benefits of following RoHC continuity for NR UDC, and the specification impacts are limited, so we support it. |
| Apple | Yes | OK to reuse a mechanism similar to RoHC continuity for NR UDC. |
|  |  |  |

**Issue 4: Applicability of UDC in DAPS**

In LTE mobility enhancement WI, whether UDC is applied to DAPS was not discussed sufficiently but just shown hands to see companies’ views to save discussion time and suggested to consider it in NR UDC. So in LTE, UDC is not applied to DAPS. The simple way is follow LTE UDC that NR UDC is not applied to DAPS.

**Question 1-5: Do you agree NR UDC is not applied to DAPS like LTE UDC?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | New issues to be discussed if any |
| LG | Yes | We want to keep the UDC simple to be aligned with allocated TU. |
| CATT | Yes |  |
| Mediatek | No strong view | We don’t see the real technical issue to have it. But considering the time limitation, we are OK to leave it out. |
| Huawei, HiSilicon | Yes | In LTE, if a DRB is configured with UDC, it can not be configured with DAPS. We think the LTE definition can be applied for NR UDC. |
| Apple | Yes |  |
|  |  |  |

**Issue 5: Applicability of UDC to split DRB**

In LTE UDC, the impact to 37.340 is not discussed and considered. But in NR, it should be checked. In 37.340, for ROHC, there is one clarification “In MR-DC, ROHC (as described in TS 36.323 [15] and TS 38.323 [16]) can be configured for all the bearer types.” In LTE, ROHC is not applied to split DRB and UDC followed the same as ROHC although UDC can be applied to split DRB from technical point of view. But in NR, ROHC is extended to apply to all bearer types. For NR UDC, it also can follow ROHC, i.e. UDC is extended to apply to all bearer types. Since it follows ROHC mechanism which is different in NR and LTE, it can be discussed as one open issue which belongs to the part of adaptation due to NR characteristics. So it is proposed to discuss whether to apply NR UDC to split DRB.

**Question 1-6: Do you agree NR UDC can be applied to split DRB?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | New issues to be discussed if any |
| LG | No | We want to keep the UDC simple to be aligned with allocated TU. |
| CATT | Yes | We think it beneficial to apply UDC to the split bearer.  We can follow the mechanism of ROHC for split bearer. These might impact some specs but in our view the work load should be not too much.  We can check what the companies’ views are. |
| Mediatek | Yes | For spit bearer, we have the common PDCP, where UDC/ROHC is performed. There is no technical concern to support UDC for split bearer. Considering split bearer is very common in NR, it is beneficial to support it to improve the resource efficiency generally. |
| Huawei, HiSilicon | Yes | We see the benefits of allowing UDC for split DRB(s), and potential specifications impacts are:   * RRC configuration restriction, e.g. network does not configure UDC when outOfOrderDelivery is configured * Stage-2 impacts * UE capability co-ordinations between network nodes, e.g. MN sends max UDC DRB number to SN. For RoHC for split DRB(s), the field maxNumberROHC-ContextSessionsSN can be exchanged between MN and SN   Generally the impacts are limited. |
| Apple | Yes | We see some benefits in applying UDC to split bearer scenario, which is common in NR. PDCP handles the reordering in NR, and we think NR UDC can follow NR ROHC in that it can be configured for any bearer type. |
|  |  |  |

**Issue 6: CU-CP and CU-UP splitting**

E1AP provides the signalling between gNB-CU-CP and gNB-CU-UP. And the Bearer Context Setup procedure is used to allow the gNB-CU-CP to establish a bearer context in the gNB-CU-UP. In the procedure, the gNB-CU-CP sends the BEARER CONTEXT SETUP REQUEST message to the gNB-CU-UP. Introduction of UDC configuration may require changes to E1 as well. This may need RAN3 further work. If companies think the scenario should be supported, LS can be sent to RAN3 when we identify parameters of UDC configuration.

**Question 1-7: Do you agree NR UDC is also applied to the scenario of CU-CP and CU-UP splitting, i.e. E1 interface should be involved?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detailed comments |
| LG | No | We want to keep the UDC simple to be aligned with allocated TU. |
| CATT | Yes | CU-CP and CU-UP slitting scenario is one typical scenario in NR. Therefore, we think UDC should be supported in this scenario. We suggest to send LS to RAN3 after UDC configuration content is clear. |
| Mediatek | Yes | Agree with CATT. |
| Huawei, HiSilicon | Yes | We share similar views as CATT. |
| Apple | Yes | Agree with CATT. |
|  |  |  |

**Other issues**

**Question 1-8: Do you see any further issues to be discussed for NR UDC? Please explain more about the identified issues.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detailed comments |
| Apple | Yes | In LTE, UDC is not used for sidelink communication. RAN2 should discuss whether the same restriction can be carried forward to NR. |
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### Phase 2

TBD

# 3 Specification impacts analysis

The purpose of this section is to align from high level companies’ views regarding which specifications are impacted and how.

## 3.1 TS 38.300

### Phase 1

Table 2 provides some analysis on the potential specification impacts to TS 38.300.

**Table 2 Spec impact analysis for 38.300**

|  |  |  |
| --- | --- | --- |
| Specification | Parts that follow the LTE mechanism | Additional impacted parts due to NR |
| TS 38.300 | * + Adding abbreviation of UDC;   + Adding UDC function in PDCP;   + Changing the protocol figures to allow UDC in uplink compression. | N.A. |

With the analysis, Rapporteur hasn’t seen any further impacts due to NR UDC to TS 38.300.

**Question 1-9: Do you agree with spec impact analysis in Table 2? Do you see any other impacts to TS 38.300?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Additional impacts if any |
| LG | Yes |  |
| CATT | Yes |  |
| Mediatek | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Apple | Yes | TS 38.300 should be extended to specify how UDC is handled for DAPS handover, as well as for the sidelink (see our response in question 1-8). |
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### Phase 2

TBD

## 3.2 TS 38.306

### Phase 1

Table 3 provides some analysis on the potential specification impacts to TS 38.306.

**Table 3 Spec impact analysis for 38.306**

|  |  |  |
| --- | --- | --- |
| Specification | Parts that follow the LTE mechanism | Additional impacted parts due to NR |
| TS 38.306 | Adding UDC abbreviation and corresponding capability definition. | N.A. |

Rapporteur hasn’t seen any further impacts due to NR UDC to TS 38.306.

**Question 1-10: Do you agree with spec impact analysis in table 3? Do you see any other impacts to TS 38.306?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Additional impacts if any |
| LG | Yes |  |
| CATT | Yes |  |
| Mediatek | Yes |  |
| Huawei, HiSilicon | Yes | In LTE, the UE supporting UDC shall support up to 2 UDC DRBs, and it has been defined in TS 36.306.  In NR, the UE will be more powerful, and it may happen that more than 2 DRBs can benefit from UDC. So we think that the UE capability can be enhanced, e.g. the UE can indicate whether it supports at most 3/4 UDC DRBs to the network. |
| Apple | Yes |  |
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### Phase 2

TBD

## 3.3 TS 38.323

### Phase 1

Table 4 provides some analysis on the potential specification impacts to TS 38.323.

**Table 4 Spec impact analysis for 38.323**

|  |  |  |
| --- | --- | --- |
| Specification | Parts that follow the LTE mechanism | Additional impacted parts due to NR |
| TS 38.323 | Additions/changes related to the following   * + UDC protocol.   + Configuration of UDC   + UDC header.   + Pre-defined dictionary.   + UDC buffer reset.   + UDC feedback procedure   + UDC function in RRC re-establishment procedure: reset compression buffer for RLC AM mode;   + ~~Configuration with ROHC and EHC: limitation that UDC is not configured simultaneously with ROHC or EHC for the same radio bearer.‎~~   + Clarification, if necessary, that gNB implementation ensures that UDC decompression is after PDCP reordering. ‎ | * + Whether UDC is applied for SDAP header and SDAP control PDU   + UDC PDU format addressing SDAP header location   + UDC continuity if needed |

**Question 1-11: Do you agree with spec impact analysis in table 4? Do you see any other impacts to TS 38.323?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Additional impacts if any |
| LG | No | It is difficult to say whether we can easily follow the LTE mechanism or not. Each function should be carefully checked whether it is supported for NR.  In addition, we think following two bullets are not relevant for PDCP specification.  o Configuration with ROHC and EHC: limitation that UDC is not configured simultaneously with ROHC or EHC for the same radio bearer.‎ 🡪 The configuration limitation should be specified in RRC not in PDCP.  o Clarification, if necessary, that gNB implementation ensures that UDC decompression is after PDCP reordering. ‎🡪 Network implementation should not be specified in PDCP specification. |
| CATT | Yes, and see comments | Firstly, we agree with LG’s comment about the limitation on configuration with ROHC and EHC. We’ve updated this part, so that this bullet is now move to 38.331 section (see highlighted modifications in the tables).  Then, for LG’s comment on reordering related clarification, we can discuss if it is necessary to specify in the spec and if needed then consider where to capture it. |
| Mediatek | Yes | First of all, the intention is to clarify the difference between LTE and NR when UDC is supported. In LTE, PDCP reordering is optional. UDC still works even without it, since RLC can guarantee the in-sequence delivery. It’s network implementation to decide at which step to perform UDC decompression with/without PDCP reordering. But for NR, the case is different that PDCP reordering is mandatory. So network should perform UDC decompression after PDCP reordering.  We agree that network implementation is not specified, but it would be good that the difference can be clarified somewhere. |
| Huawei, HiSilicon | Yes |  |
| Apple | Yes | In addition to the changes in table 4, some general text may be needed to specify that operation with UDC is configurable for the PDCP entity (similar to what’s currently there in subclause 4.2.2 for RoHC/EHC).  Further, we agree with MediaTek and LG that it might be good to clarify the UDC decompression order somewhere. |
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### Phase 2

TBD

## 3.4 TS 38.331

### Phase 1

Table 5 provides some analysis on the potential specification impacts to TS 38.331.

**Table 5 Spec impact analysis for 38.331**

|  |  |  |
| --- | --- | --- |
| Specification | Parts that follow the LTE mechanism | Additional impacted parts due to NR |
| TS 38.331 | Additions/changes related to the following   * + UDC configuration;   + Release UDC configuration in: * RRC reconfiguration with sync; * RRC reestablishment procedure; * Conditional reconfiguration with sync; * RRC resume;   + Configuration with ROHC and EHC: limitation that UDC is not configured simultaneously with ROHC or EHC for the same radio bearer.‎ | Applicability of UDC in DAPS if needed  UDC continuity if needed |

**Question 1-12: Do you agree with spec impact analysis in table 5? Do you see any other impacts to TS 38.331?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Additional impacts if any |
| LG | Yes |  |
| CATT | Yes | Adding the limitation on configuration with ROHC and EHC in the table. |
| Mediatek | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Apple | Yes |  |
|  |  |  |

### Phase 2

TBD

## 3.5 TS 37.340

### Phase 1

Table 6 provides some analysis on the potential specification impacts to TS 37.340.

**Table 6 Spec impact analysis for 37.340**

|  |  |  |
| --- | --- | --- |
| Specification | Parts that follow the LTE mechanism | Additional impacted parts due to NR |
| TS 37.340 | N.A. | Applicability of UDC to split DRB if agreed |

**Question 1-13: Do you agree with spec impact analysis in table 6? Do you see any other impacts to TS 37.340?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Additional impacts if any |
| LG | No | We think UDC is not configured for split DRB. Then, there should be no specification impacts on 37.340. |
| CATT | Yes |  |
| Mediatek | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Apple | Yes | TS 37.340 should indicate the bearer types that can be supported with UDC (e.g., in section 6.3, regardless of whether or not the split bearer is included). |
|  |  |  |

### Phase 2

TBD

## 3.6 TS 38.463

### Phase 1

Table 7 provides some analysis on the potential specification impacts to TS 38.463.

**Table 7 Spec impact analysis for 38.463**

|  |  |  |
| --- | --- | --- |
| Specification | Parts that follow the LTE mechanism | Additional impacted parts due to NR |
| TS 38.463 | N.A. | Potential E1 impacts |

**Question ph1-14: Do you agree with spec impact analysis in table 7?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Additional impacts if any |
| LG | No | We think UDC is not configured for CP/UP split case. Then, there should be no specification impacts on 38.463. |
| CATT | Yes |  |
| Mediatek | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Apple | Yes |  |
|  |  |  |

### Phase 2

TBD

## 3.7 Other TS impacted?

### Phase 1

**Question ph1-15: Do you see any other specification impacted? If any, please provide more details.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Additional spec impacts if any |
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### Phase 2

TBD

# 4. Conclusions

TBD

# References

[1] RP-211203, Revised WID: NR Uplink Data Compression (UDC)‎

[2] R2-2111067, Discussion on introduction of NR UDC CATT, CMCC, Huawei, HiSilicon, MediaTek