**3GPP TSG-RAN WG2 Meeting #124 R2-23xxxxx**

**Chicago, USA, November 13-17, 2023**

**Source: Apple**

**Title:****Summary of [Post123bis][420][Relay] Rel-18 relay MAC identified open issues (Apple)**

**Agenda Item:** **7.9.1**

**Document for:** **Discussion and Decision**

# 1. Introduction

This is for the summary of the following email discussion:

* [Post123bis][420][Relay] Rel-18 relay MAC identified open issues (Apple)

Scope: Discuss the already identified open issues on MAC and attempt to converge.

Intended outcome: Report to next meeting and updated open issue list

Deadline: 23:59 UTC Friday, October 27, 2023

### 1.1 Contact Points

Respondents to this email discussion are kindly asked to fill in the following table for contact information.

|  |  |  |
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# 2. Discussion

The discussion in this email discussion is focused on the “Editor’s notes” included in [1]. Note that some minor issues such as definition and terminology alignments are not discussed here, which can be addressed in running CR drafting process.

### 2.1 Open Issues related to Multi-path relay

### 2.1.1 PDCP Duplication Scenarios

The first important open issue is to discuss the scenarios (e.g., how many legs) are to be supported in Rel-18 MP relay design, as related to the following EN in Section 5.10 of MAC running CR [1]:

*Editor’s Note: whether/ how Duplication RLC Activation/Deactivation MAC CE is used for the 2-leg/3-leg MP relay case is to be discussed.*

A collection of related proposed from the papers in RAN2#123bis meeting has been summarized in the table below:

|  |  |
| --- | --- |
| R2-2309615 | Proposal 20: For scenario 1 and scenario 2, if PDCP duplication is used, at most three duplication legs can be supported. |
| R2-2309682 | Proposal 1 Not support more than 2-leg MP relay case in this release. |
| R2-2309824 | Proposal 1 Only two duplication cases for multi-path Scenario-1 and Scenario-2 are supported:  - 2 legs: direct path and indirect path;  - 3 legs: two legs of CA duplication in direct path and one leg in indirect path. |
| R2-2310352 | Proposal 9 RAN2 to decide whether >2 legs for PDCP duplication (e.g., two in direct path and one in indirect path) needs to be supported in Rel-18 MP scenarios. |
| R2-2310876 | Proposal 7: Over direct path, there can be 3 RLC entities configured for duplication.  Proposal 8: In Rel-18, CA duplication over relay UE’s Uu link on the indirect path is not supported. |
| R2-2311109 | Proposal 1: RAN2 assumes CA duplication is neither applied to the direct path of the remote nor applied to the Uu link of the relay UE. Duplication with more than 2 legs is not supported in multi-path relaying scenarios. |

To facilitate the discussion, the rapporteur suggest to first discuss the number of legs in the indirect path. We need consider the following two main constraints related to this:

1. SL CA work in Rel-18 is for V2X use case only and not applicable to ProSe relay use case;
2. L2 Relay UE has no PDCP entity involved in end-to-end traffic, so RAN2 need solve the “lack of PDCP entity” problem that to support CA duplication for an RB over relay UE’s Uu link.

Given the above problems, the rapporteur think it is quite straight-forward to not consider this in Rel-18.

**Question 1-1:** Does your company agree that only 1 leg is allowed in the indirect path for MP duplication, i.e., CA duplication over relay UE’s Uu link the indirect path is not supported in Rel-18 MP Scenarios?

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| Apple | Yes |  |
| ASUSTeK | Yes |  |
| vivo | Yes |  |
| Samsung | Yes |  |
| Fujitsu | Yes |  |
| Nokia | Yes with comments | Relay UE may have its own traffic. So, CA duplication is not applied only to the relayed packets but CA duplication should still be possible for relay UE’s own packet. |

Then, assuming the duplicated leg in indirect path is only 1, the overall total number of legs depends on how many RLC entities are to be allowed in the direct path. if n RLC entities are allowed in the direct Uu path, then there will be n+1 legs in total. It is also worth noting that there cany be only up to 3 (secondary) RLC entities in the signaling format of Duplication RLC Activation/Deactivation MAC CE, so the total number of legs for MP PDCP duplication scenario cannot exceed 4-leg, as RAN2 has already agreed to reuse the legacy Duplication RLC Activation/Deactivation MAC CE.

The rapporteur also thinks there is no need to make separate designs for Scenario 1 and Scenario 2 for this issue, so it is suggested to check company views with the following question:

**Question 1-2:** Which duplication case(s) are to be supported for MP PDCP duplication (for both Scenario 1 and Scenario 2)?

a) 2-leg (1 RLC entity in direct path, 1 in indirect path)

b) 3-leg (2 RLC entity in direct path, 1 in indirect path)

c) 4-leg (3 RLC entity in direct path, 1 in indirect path)

d) Other, please specify

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Option(s)** | **Comments, if any** |
| OPPO | a | We have made the following agreement in R2 #119 meeting, which means we already agree on Option-a):  For a MP split bearer in scenario 1, one PDCP entity at the remote UE is configured with one direct Uu RLC channel and one indirect PC5 RLC channel.  - For upstream, a PDCP entity delivers to a Uu RLC entity and a PC5 RLC entity with SRAP entity in the remote UE side.  - For downstream, a PDCP entity receives from a Uu RLC entity and a PC5 RLC entity with SRAP entity in the remote UE side. |
| Xiaomi | A | Other options are out of scope |
| Apple | A, B | We have no strong view to support case b, can follow majority view. For case C, we think it is a corner case and no need to support. |
| ASUSTeK | a |  |
| vivo | A and B | We think both option A and B can be supported. But prefer to exclude option C since the legacy Uu interface to support the maximum 4 duplicated legs is introduced for IIOT feature which is not typical for MP operation. |
| Samsung | c | 4-leg is supported in legacy. The scenario for MP relay does not change the motivation of introducing 4-legs for PDCP duplication. Thus, we see no motivation to restrict 2-leg for MP relay. |
| Fujitsu | a | A is simple. |
| Nokia | A or C | If CA duplication is allowed for direct path, there is no technical reason to limit it to 2 RLC entities, so B shouldn’t be an option, and we can take C as in the legacy. |

### 2.1.2 How to Refer RLC entity for Scenario 2

For MP Scenario 2, there is no real “RLC entity” in non-3GPP link between the remote UE and relay UE. That is why there is the following EN in Section 5.10 of the MAC running CR [1]:

*Editor’s Note: whether/ how to describe MP Scenario 2 case when there is no “RLC entity” in the indirect path is FFS*

The rapporteur suggests using the word “ RLC-equivalent entity in N3C interface” to describe it. Alternatively, there is also suggestion from RAN2#E123bis contribution to use “Virtual RLCx” in R2-2309824 .

Let us check company view:

**Question 1-3:** Which way your company prefers to describe “RLC entity” in MP Scenario 2?

a) RLC-equivalent entity in N3C interface

b) Virtual RLC entity

c) Other, please specify

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Option(s)** | **Comments, if any** |
| OPPO | See comments | Maybe we need to discuss “whether” firstly then “how”. We understand this is not just terminology since the whole N3C is out of scope of 3GPP, and now we are trying to describe something out of 3GPP scope.  We should aim at a shape where the RLC related terms are avoided but just mention PDCP, for scenario-2, since we do not have RLC entity for scenario-2. |
| Xiaomi |  | Either is fine. We can go with majority. |
| Apple | a |  |
| vivo | See comments | At least separate descriptions for Scenario 1 and Scenario 2. Regarding the N3C interface, there is no RLC entity as shown in below Figure in the Stage 2 running CR, normative text as for Scenario 1 is not |
| Samsung | c | N3C is out of scope. So, it can be left to implementation. There is no need to create new concept. |
| Nokia | C | First we want to understand what the purpose of assuming lower layers of N3C interface as an RLC entity? |

### 2.1.3 Clarification on RLCi field in MAC CE

Then, regarding the following EN for Duplication RLC Activation/Deactivation MAC CE ,

*Editor’s Notes: Whether and how to number the PC5 RLC entity with SRAP entity within the ascending order of Uu LCID is to be further discussed, if PC5 RLC entity is not in the primary path.*

It is possible that a clarification of ranking of RLC entities is needed if more than 2 legs are supported for MP PDCP duplication (as asked in Q1-2). The rapporteur suggests to ordering the RLC entities in a consistent manner that always counting RLC entities in direct path before indirect path.

We consider the following two cases:

1. If the PC5 RLC entity (for Scenario 1) is in the primary path for a MP split DRB, then the existing legacy numbering scheme can work because all secondary RLC entities are in the same direct Uu path. No spec impact.
2. Otherwise, the proposed text to sort out the ranking of RLCi is “*or i is ascending order of logical channel ID of secondary RLC entities in the order of direct path and indirect path for the DRB in MP scenarios where primary RLC entity is in direct path*”

**Question 1-4:** Does your company agree that proposed RLCi field clarification in Duplication RLC Activation/Deactivation MAC CE by adding “*or i is ascending order of logical channel ID of secondary RLC entities in the order of direct path and indirect path for the DRB in MP scenarios where primary RLC entity is in direct path* “ in MP Scenario 1?

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| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | See comments | This related to whether we agree on more than 2-legs, if only 2-legs, we only have one secondary RLC entity, and we use R0 to indicate the only secondary RLC channel activation/de-activation as in legacy. |
| Xiaomi |  | Similar view as OPPO. If only 2 legs are supported, no need to specify such rule. |
| Apple | Yes |  |
| ASUSTeK |  | We share the same view with OPPO. |
| vivo | Yes | We don’t see technical movitation to supprot only 2 legs. Therefore, the clarification on the RLC entities order is needed. |
| Samsung | Yes | If 4-legs are agreed to be supported |
| Fujitsu |  | Agree with OPPO. |
| Nokia | See comments | If we agree that only 2 legs are supported, there is actually no need of using Duplication RLC A/D MAC CE. We already have a NOTE saying that “The Duplication Activation/Deactivation MAC CE is not used if a DRB is configured with more than two RLC entities, i.e. with moreThanTwoRLC-DRB”. |

For MP Scenario 2, the rapporteur thinks the same principle “ranking in the order of direct path and indirect path” can be applied.

**Question 1-5:** Does your company agree that the same ordering principle of RLCi for MP Scenario 1 can be also applied to MP Scenario 2?

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| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | See comments | See our reply in Q1-3 |
| Xiaomi |  | Same as above |
| Apple | Yes |  |
| vivo | See comments | Same reply in Q1-3. |
| Samsung | Yes |  |
| Nokia | See comments | If we agree that only 2 legs are supported, there is actually no need of using Duplication RLC A/D MAC CE. We already have a NOTE saying that “The Duplication Activation/Deactivation MAC CE is not used if a DRB is configured with more than two RLC entities, i.e. with moreThanTwoRLC-DRB”. |

Note that RAN2 already agreed that both of direct and indirect path belong to MCG together. There is a potential scenario that a SCG is also involved in PDCP duplication scenario (e.g., DC+MP duplication), which will further complicate the determination of RLCi. The rapporteur suggests to not consider the SCG case in Rel-18.

**Question 1-6:** Does your company agree that the only PDCP duplication in MCG is considered for Rel-18 Multi-path, i.e., no SCG involvement is supported in Rel-18?

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | Yes |  |
| Xiaomi | Yes | We agreed both paths are on MCG. |
| Apple | Yes | We think considering SCG may make the potential number of legs per DRB become larger than 4. |
| ASUSTeK | Yes |  |
| vivo | Yes | Given RAN2 agreement “For Scenario-1/2, MP remote UE is configured with a single cell group, i.e., MCG, for the direct path, and SL configuration, for the indirect path.”, it’s clear that SCG is not involved with MP operation. |
| Samsung | Yes |  |
| Fujitsu | Yes |  |
| Nokia | Yes | It means that PDCP duplication with MP is considered/modelled as CA duplication. |

### 2.1.4 UL BSR enhancements for Multi-path

There is an EN for Duplication RLC Activation/Deactivation MAC CE in the MAC running CR ,

*Editor’s Note: FFS whether any change/clarification needed for Buffer Size report for UL data via both direct path and indirect path*

A collection of related proposals from the papers in RAN2#123bis meeting has been summarized in the table below:

|  |  |
| --- | --- |
| R2-2309682 | Proposal 3 Uu BSR and SL BSR operate independently for Uu and SL traffic as in legacy.  Proposal 4 No change is needed for the Buffer Size report for UL data via both direct path and indirect path. |
| R2-2309756 | Proposal 7.4a: Uu BSR is used to report buffer size only for direct bearers and split bearers, not for indirect bearers.  Proposal 7.4b: When SL BSR is configured for SL mode 1, only PDCP buffer and UL RLC buffer are considered in data volume calculation of Uu BSR for split bearers as well as direct bearers.  Proposal 7.4c: Even when SL BSR is not configured i.e. for SL mode 2, only PDCP buffer and UL RLC buffer are considered in data volume calculation of Uu BSR for split bearers as well as direct bearers.  Proposal 7.4d: When SL BSR is not configured i.e. for SL mode 2, UE reports buffer size only for split bearers and direct bearers, not for indirect bearers. |
| R2-2309804 | Proposal 14: No change to the BSR procedure. |
| R2-2309824 | Proposal 5 Uu BSR MAC CE and potential SL BSR MAC CE for remote UE with SL mode 1 configuration can be supported only via direct path.  Proposal 6 Buffer size calculation for Uu BSR and SL BSR should reuse legacy DC rules, e.g. PDCP data volume pending for initial transmission of a split bearer is taken into account for both Uu BSR and SL BSR when the total buffer size of this bearer is equal or higher than a configured threshold. |
| R2-2310013 | Proposal 3: For scenario 1, if both Uu BSR and SL BSR are triggered and if one of the BSRs only contain(s) the information about the amount of data for split RBs, only the other BSR is sent. |
| R2-2310160 | Proposal 8: Split bearer data can be reported in only one of the Uu or SL BSR to the cell on the direct path. Whether to use SL BSR or Uu BSR can be left to UE implementation. |
| R2-2310169 | Proposal 1: A Mode 1 remote UE in multi-path scenario 1 reports buffer status for direct Uu bearers using Uu BSR and reports buffer status for indirect bearers using SL BSR.  Proposal 2: A Mode 1 remote UE in multi-path scenario 1 reports buffer status for split bearers using only one of Uu or SL BSR. FFS which BSR is used.  Proposal 3: A Mode 1 remote UE in multi-path scenario 2 reports buffer status for direct bearers and buffer status of split bearers using Uu BSR. FFS whether to report buffer status associated with indirect path also.  Proposal 4: A Mode 2 remote UE in multi-path scenario 1 reports buffer status of the direct bearers and buffer status of split bearers using Uu BSR. FFS whether to report buffer status associated with indirect path also. |
| R2-2310488 | Proposal 3: To avoid the duplicated BSR, a PDCP data split ratio can be configured and remote UE calculates the PDCP data volume delivered over direct path and indirect path according to this split ratio. |
| R2-2310772 | Proposal 3: A relay UE is configured to allow to inflate its BSR in order to accommodate the expected UL data transmission scheduled via the sidelink. |
| R2-2311109 | Proposal 5: For the remote UE in multi-path operation, Uu BSR reporting is used for direct bearer data, and SL BSR reporting is used for indirect bearer data and SL only data.  Proposal 6: For the BSR reporting of split bearer data in multi-path operation, RAN2 further discusses whether one BSR or multiple BSRs could be used. |

For UL BSR, the data volume calculation includes the data volume at RLC layer and the data volume at PDCP layer. First, there is some ambiguity on whether the SL traffic in mode 1 or mode 2 (buffered in PC5 RLC entity) shall be counted now in Uu BSR reporting fro MP case. The rapporteur think SL BSR and Uu BSR can still work independently. Any traffic destinated to U2N relay UE shall be still counted as SL traffic and reported in SL BSR. No need to involve novel scheme or optimization for this.

Let us check company view.

**Question 1-7:** Should the remote UEreport any traffic in SL RLC buffer in Uu BSR in MP Scenarios?

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Please specify the condition, if any** |
| OPPO | No | We understand there is no ambiguity on data volume calculation, and agree with Rapp that SL BSR and Uu BSR can work independently. |
| Xiaomi | No | Current BSR procedure can work. |
| Apple | No |  |
| ASUSTeK | No |  |
| vivo | No |  |
| Samsung | No |  |
| Fujitsu | No |  |
| Nokia | No |  |

Then, for data volume in PDCP layer, PDCP data volume are supported to be reported in MAC entities associated in both primary RLC entity and secondary RLC entity respectively for a split bearer. The rapporteur understands different from DC scenario, both SL BSR and Uu BSR are sent in the same PCell for a MP split bearer. Also, under the “Single MAC entity” modelling, those BSRs are triggered by the same MAC entity in the remote UE. Regarding those differences, some company suggest still following the legacy procedure even though some duplication may occur, some company suggest to enhance this by only allowing the PDCP data volume to be reported only in one of the BSRs, but can left to UE implementation to decide which BSR is used (R2-2310160, R2-2310169). Also, there is a proposal to introduce PDCP data split ratio and remote UE calculates the PDCP data volume delivered over direct path and indirect path according to this split ratio (R2-310488).

Let us check company view on those suggestions:

**Question 1-8:** Which option your company prefers to address “duplicated PDCP volume” reported in BSRs for a MP split bearer?

a) No spec change is needed (follow legacy)

b) Only to be counted in one of the BSR. Up to UE implementation to decide whether UL BSR or SL BSR is used.

c) Introduce a new PDCP split ratio to configure buffer reporting split in Uu BSR and SL BSR

d) Other, please specify

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| --- | --- | --- |
| **Company’s name** | **Option(s)** | **Comments, if any** |
| OPPO | a | We fall to understand “following the legacy procedure even though some duplication may occur” why following legacy procedure will cause duplication since the two BSR (UL-BSR and SL-BSR) would anyway be separated, and the volume would be calculated separately. |
| Xiaomi | a | Current BSR procedure can work. |
| Apple | a | We understand according to section 5.6 of TS 38.323, PDCP data volume will be reported to the MAC entities of both primary RLC and split secondary RLC, if data split threshold is exceeded. In MP case, the is the same MAC entity which would calculate PDCP data volume twice for BSR(s) of a split bearer by following this legacy procedure. But we think this is a minor issue as volume in RLC buffers are still calculated separately. Probably no need to change the spec to deal with this problem. |
| ASUSTeK | a | We share the same view as Apple. |
| vivo | a | We think the buffer size calculation for Uu BSR and SL BSR should reuse legacy DC rules, e.g. PDCP data volume pending for initial transmission of a split bearer is taken into account for both Uu BSR and SL BSR when the total buffer size of this bearer is equal or higher than a configured threshold. |
| Samsung | a |  |
| Fujitsu | a |  |
| Nokia | A |  |

### 2.1.5 SL BSR enhancements for Multi-path

Then, regarding the following EN for SL BSR in section 6.1.3.33:

*Editor’s Notes: FFS whether the SL-BSR also reports Uu path traffic buffer.*

The rapporteur believes SL BSR remains only to be reported for traffic to be transported in PC5 interface (SL RLC buffer and PDCP data volume) for mode 1 MP remote UE. Note that the duplicated PDCP volume issue is discussed in 2.1.4 and that may impact PDCP spec or UL BSR procedure, but not in this section. The buffer size definition below in 6.1.3.33 is still valid.

Buffer Size: The Buffer Size field identifies the total amount of data available according to the data volume calculation procedure in TSs 38.322 [3] and 38.323 [4] across all logical channels of a logical channel group of a destination after the MAC PDU has been built (i.e. after the logical channel prioritization procedure, which may result the value of the Buffer Size field to zero). The amount of data is indicated in number of bytes. The size of the RLC headers and MAC subheaders are not considered in the buffer size computation. The length of this field is 8 bits. The values for the Buffer Size field are shown in Table 6.1.3.1-2, respectively. For the Truncated SL-BSR format the number of Buffer Size fields included is maximised, while not exceeding the number of padding bits.

Hence, the rapporteur thinks no change is foreseen for section in 6.1.3.33 regarding the split bearer issue.

**Question 1-9:** Does your company agree to remove the above EN “*FFS whether the SL-BSR also reports Uu path traffic buffer*“ in 6.1.3.33 (i.e., no spec impact in 6.1.3.33 foreseen for MP split-bearer case) ?

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| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| Apple | Yes |  |
| ASUSTeK | Yes |  |
| vivo | Yes |  |
| Samsung | Yes |  |
| Fujitsu | Yes |  |
| Nokia | Yes |  |

### 2.2 Open Issues related to UE-to-UE relay

### 2.2.1 LCID for PC5 Relay RLC channel(s) for U2U

In section 6.2.4, there is the following EN:

*Editor’s Notes: how to add LCID(s) specified for PC5 Relay RLC channel((s) for U2U relay is FFS..*

The rapporteur suggests using a single new LCID 55 for “SCCH carrying end-to-end SL-SRB0/1/2/3 messages delivered via SL-U2U-RLC0 as specified in TS 38.331 [5]”

condition. Thus, the following question is to check company view:

**Question 2-1:** Does your company agree to only use a single new LCID (e.g., LCID 55) for SCCH carrying end-to-end SL-SRB0/1/2/3 messages?

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| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | See comments | We prefer to use separate channels since it seems clearer, but we can follow majority view on this. |
| Xiaomi | Yes |  |
| Apple | Yes |  |
| vivo | Yes | In our understanding, since RAN2 has agreed that all E2E SL-SRBs transmission occurs after local UE ID allocation for SRAP header, E2E SL-SRB 0/1/2/3 can be aggregated into one PC5 RLC Channel, e.g., RLC AM and with a specified LCID 55, which is simplest and feasible. |
| Samsung | Yes |  |
| Fujitsu | Yes |  |
| Nokia | Yes | We can follow majority view. |

### 2.3 Any Other Open Issue?

**If you think there are other essential issue(s) related to MAC running CR to be discussed, please add them below and companies can provide feedback/comment:**

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Issue** | **Suggested solution** |
| ASUSTeK | According to the User plane protocol stack for L2 Multi-path Relay using non-3GPP link (i.e. Figure 16.x.2-3) in the current Stage 2 specification, **an indirect bearer in MP Scenario 2 is associated with a PDCP entity in the remote UE and an RLC entity in the relay UE**. Since the legacy Uu radio bearer is associated with a PDCP entity and an RLC entity in the same UE, the mapping structure of the indirect bearer in MP Scenario 2 is new. Thus, we think there is a need to discuss how to report the data volume of the PDCP entity in the remote UE and the data volume of the RLC entity in the relay UE for an indirect bearer in MP Scenario 2. | Potential solutions may include the following:  Option 1: The remote UE reports the data volume of the PDCP entity in the remote UE and the data volume of the RLC entity in the relay UE.  Option 2: The relay UE reports the data volume of the PDCP entity in the remote UE and the data volume of the RLC entity in the relay UE.  Option 3: The remote UE reports the data volume of the PDCP entity in the remote UE and the relay UE reports the data volume of the RLC entity in the relay UE.  In case of Options 1 and 2, data volume provision between the remote UE and the relay UE can be up to UE implementation.  We think all these 3 options are feasible and simple. Suggest RAN2 to select from one of them.  [Rapp] The option 1 and option 3 are designed to use remote UE’s Uu BSR procedure to help gNB scheduling relay UE’s Uu traffic. This is an optimization not needed. For option 2, SL relay UE just send Uu BSR by following legacy procedure. One implementation could be that traffic from remote UE’s non-3GPP link will be automatically buffered in RLC entity of the one-to-one mapped Uu bearer, so there is even no “data volume of the PDCP entity in the remote UE” to be distinguished in the relay UE. Thus, there is no need to specify anything new for MP scenario 2. |
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# 3 Conclusion

TBD

# Reference

[1] R2-2311559 MAC Running CR for R18 SL relay endorsed in RAN2#123bis meeting