**3GPP TSG-RAN WG2 Meeting #129bis R2-25xxxxx**

**Wuhan, China, 7th – 11th April 2025**

**Agenda Item: 8.13.3**

**Source: Apple, Ericsson**

**Title: [Draft] Report of [POST129][402][Relay] Control plane approach 2 impact (Apple/Ericsson)**

**Document for: Discussion and Decision**

# 1 Introduction

This contribution gives the discussion summary of following post email discussion.

* [POST129][402][Relay] Control plane approach 2 impact (Apple/Ericsson)

Scope: Scope the spec impact of control plane approach 2, considering aspects already discussed (e.g., local ID allocation, QoS split, SRAP and RLC channel configurations), authorization, and service continuity impact. Assume for this discussion that the plenary will approve extension to two additional hops.

Intended outcome:

Deadline: Long

## Contact information

|  |  |
| --- | --- |
| **Company** | **Name (Email)** |
| Apple (Rapporteur) | Zhibin Wu (zhibin\_wu@apple.com) |
| OPPO | Bingxue Leng (lengbingxue@oppo.com) |
| ZTE | Weiqiang Du(du.weiqiang2@zte.com.cn) |
| Kyocera | Henry Chang (henry.chang@kyocera.com) |
| Sharp | Takuma Kawano (kawano.takuma@mail.sharp) |
| Ericsson | Min Wang (min.w.wang@ericsson.com) |
| LG | Seoyoung Back (seoyoung.back@lge.com) |
| InterDigital | Martino Freda (martino.freda@interdigital.com) |
| Huawei, HiSilicon | Jagdeep Singh (jagdeep.singh6@huawei.com) |
| vivo | Jing LIANG (liangjing@vivo.com) |
|  |  |
|  |  |
|  |  |

# 2 Discussion

In RAN2#128 meeting [1], Approach 2 has been defined as the case that “*Intermediate Relay UEs (other than the Last Relay UE) can be in any RRC state when the U2N remote UE is in RRC\_CONNECTED*. “ Also, in Approach 2, any intermediate relay UE which happens to be in RRC\_CONNECTED towards the last relay UE’s serving gNB and is operating as a remote UE is assumed to obtain its relaying configuration (RLC channel configuration, SRAP configuration, etc.) in dedicated signaling from the last relay UE’s serving gNB via the U2N connection. Therefore, we can assume RRC\_CONNECTED intermediate relay UE(s) in approach 2 will have the same behavior as Approach 1 (or the baseline procedure), and share the same specification impact as baseline procedure. Note that the either Approach 1 or Approach 2 could work with the same SI and Paging forwarding solution (as agreed in RAN2#129 [5]), which can also be regarded as part of the baseline.

Therefore in this email discussion, we just evaluate the specification impact of support IDLE/INACTIVE/OOC intermediate relay UE in Approach 2, by highlighting the necessary differences from the baseline procedure.

Note that the email discussion is not to be used to evaluate the performance aspects (e.g., latency, reliability) of Approach 2. This email discussion is to focus on identifying the specification impact of the (potential) solutions involved in Approach 2.

Please also note that if both Approach 1& Approach 2 to be supported in Rel-19, it might be necessary to branch certain procedure descriptions with “if conditions” like below:

|  |
| --- |
| *1>if (*Approach 1):  2> procedure text for approach 1   1. *else* (i.e., Approach 2)   2> procedure text for approach 2 |

In this email discussion, we do not need to detail the trivial specification changes as above, but focus on the key specifications changes justified by the technical points. Also, all the TPs included in this paper are mere examples and can be further improved (e.g., in Stage-3, if Approach 2 is agreed), please focus on pointing out major specification impact(s) which are missing instead of minor enhancements of the TP examples.

The discussion will focus on the “specification impact” of the following aspects of Approach 2 of CP design:

* Remote UE’s RRC message forwarding w/o local ID assigned
* Local ID allocation and forwarding Remote UE RRC message with assigned local ID
* QoS Split for PC5 hops among relay UE(s) and remote UE
* SRAP and PC5 Relay RLC Channel configuration derivation in Intermediate relay
* L2 relay authorization for Intermediate relay UE
* Service continuity

In the following sections, we scope the specification impact for each of the above aspects respectively.

## 2.1 Remote UE’s RRC Message forwarding w/o assigned local ID

The key to Approach 2 is the support of IDLE/INACTIVE Intermediate Relay UE, which means those UEs will not enter RRC\_CONNECTED state while the remote UE (and the last relay UE, if not yet in CONNECTED) attempts to enter RRC\_CONNECTED. Hence, for Remote UE entering RRC\_CONNECTED, its first RRC message (e. g., *RRCSetupReq*) must be forwarded by the intermediate relay UE staying in IDLE/INACTIVE state. As intermediate relay UE does not get dedicated RRC configuration in IDLE/INACTIVE state directly from the gNB, the intermediate relay UE forwarding will be done w/o assigned local ID (at least at the very beginning), and the most plausible solution is to reuse the specified SL-RLC0 channel to relay this SRB0 message.

In Legacy Layer-2 UE-to-NW relay design and the proposed baseline procedure, each intermediate relay UE (acting as a remote UE) will use SL-RLC0 only to send its own Uu SRB0 message to its next-hop relay UE. In Approach 2, each intermediate relay UE does not generate its own Uu SRB0 message as no RRC state transition is triggered. Therefore, the procedure text changes in TS 38.351 as below is needed to allow SL-RLC0 forwarding from an ingress PC5 RLC channel to an egress PC5 RLC channel in Approach 2. The example below assumes a new section 5.4 could be added for intermediate relay UE operation in TS 38.351 (as the intermediate relay UE operation are quite symmetry in UL/DL, thereby no need to be split into two different sections (i.e., clause 5.2 and clause 5.3)). But similar changes can also be done in 5.2 & 5.3 if SRAP specification does not introduce a new dedicated section for intermediate relay UE.

|  |
| --- |
| 5.4 Forwarding operation of Intermediate U2N Relay UE <For Approach 2>  The SRAP entity shall:  If Intermediate U2N Relay UE is not in CONNECTED state  If the SRAP Data PDU is received from SL-RLC0 of child UE:  - Determine the egress link as the PC5 link to its parent relay as specified in TS 38.331 [3];  - Determine the egress RLC channel as SL-RLC0;  If the SRAP Data PDU is received from SL-RLC0 of parent relay UE:  - Determine the egress link as the PC5 link to its child as specified in TS 38.331 [3];  - Determine the egress RLC channel as SL-RLC0;  - Submit this SRAP Data PDU to the determined egress RLC channel of the determined egress link. |

**Figure 1: TP to 38.351 to allow SL-RLC0 forwarding via Intermediate relay UE (example)**

For RRC specification, as the intermediate relay UE will not conduct RRC state change by forwarding *RRCSetupReq*, there is no specification impact (other than the trivial impact to branch the Approach 1 procedure text to allow Approach 2 to happen). Also, please note that some additional specification changes in regards of “local ID and remote UE L2 ID” linkage are discussed in Section 2.2, not here.

Question 1.1: Do you agree that forwarding Remote UE’s RRC message from ingress SL-RLC0 to egress SL-RLC0 (w/o assigned local ID) has procedure impact (e. g. as shown in Figure 1) to TS 38.351 , for the UL delivery for the first RRC message?

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No** | **Comments** |
| OPPO | No | It is not clear to us how the Remote UE’s RRC message is forwarded w/o assigned local ID:   * We understand “Determine the egress link as the PC5 link to its child” doesn’t give UE instruction on how the determine egress link, i.e., this sentence seems mean nothing. * In legacy, the egress link determination is done at SRAP layer, now the egress link determination is moved to RRC layer, which to us is not motivated since this relates to UP handling.   Our understanding is the provided TP seems not work.  [Rapp: I understand this concern is mainly about the DL forwarding of SRB0 message where the intermediate relay UE need determine its child based on UE ID  For the UL part, each relay UE knows its parent relay, no ambiguity of egress link] |
| ZTE | Yes with comments | Egress link determination maybe following, if L2 ID is used in SRAP header:  - Determine the egress link corresponding to *L2 ID in SRAP header* as the PC5 link to its child as specified in TS 38.331 [3];  [Rapp: Thanks for the comment. Yes, for DL forwarding of SRB0, this somehow related to L2 ID- local ID linkage issue in Section 2.2, which would be more clear if companies check section 2.2] |
| Kyocera | Yes | Further discussion will likely be needed for the appropriate text to be added. |
| Sharp | Yes | Related change is needed for TS38.331 if this procedure is adopted. |
| Ericsson | Yes | Agree with Rapp that each intermediate relay UE in UL knows its parent relay, the proposed TP for UL SRB0 message is fine. |
| LG | No | We think about the steps of approach 2, and have a concern of each step. We know the association between L2 ID of the Remote UE and local ID is handled in the session 2.2. However, we think its related to the last Relay UE in RRC\_CONNECTED. The below issue is related to when the intermediate Relay UE in RRC\_IDLE/RRC\_INACTIVE to become RRC\_COMMECTED.  Step 1) Remote UE sends RRCSetupRequest message via intermediate(/last) Relay UE. The intermediate Relay UE forwards it toward gNB. Due to the tree link topology, the intermediate Relay UE in IDLE/INACTIVE can decide the egress link of its parent Relay UE. If the intermediate Relay UE uses only specified SL-RLC0 for forwarding, the gNB cannot know about the L2 ID of the Remote UE and which intermediate Relay UE is related to the Remote UE. In this situation, when the intermediate Relay UE becomes RRC\_CONNECTED from RRC\_IDLE, the gNB may not know whether the intermediate Relay UE is for the Remote UE. How can gNB know the intermediate Relay UE is related to the CONNECTED Remote UE, when the intermediate Relay UE changes to CONNECTED from IDLE?  Step 2) gNB sends RRCSetup message towards Remote UE. Each intermediate/last Relay UE have to decide which egress link is the proper link toward the right Remote UE. How does the intermediate Relay UE decide the egress link toward the right Remote UE? Especially, if multiple Remote UE sent RRCSetupRequest message via one intermediate Relay UE simultaneously, the intermediate Relay UE has to identify which RRCSetup message from gNB is for which Remote UE. How can the intermediate Relay UE identify which egress link is for the received RRCSetup message?  For the ZTE’s comment (i.e., the linkage L2 ID and local ID), we don’t understand well. We think it’s not clear. If the approach 2 means the intermediate Relay UE is in RRC\_IDLE/INACTIVE, how the intermediate Relay UE can be configured the L2 ID-local ID association. Is there any method to make the linkage between L2 ID and local ID without configuration from gNB? Or the intermediate Relay UE makes the linkage by itself? |
| NEC | Yes | Agree with Rapp that for each intermediate relay UE, there is only one single parent relay node in UL.  The proposed TP for UL SRB0 message is fine. |
| InterDigital | Yes | Agree with Rapp that the proposed TP should be clear enough. |
| Huawei, HiSilicon | No | Similar view as Oppo and LG what they have pointed out - it is unclear how the Remote UE’s RRC message can be forwarded without an assigned local ID. There are several concerns regarding this approach:  1) How will the messages from different remote UEs be distinguished by the intermediate relay UE?  2) The intermediate relay UE may have multiple egress links. It will need to select one based on the remote UE’s link to the network.  3) Determining the mapping between the L2 ID and the egress link seems problematic, as the intermediate relay UE could have multiple links associated with different UEs.  4) Egress link determination should not be handled at the RRC layer, as this is part of SRAP functionality and should remain within that layer  5) For approach 2, restricting the tree like link topology will be a problem. How the IDLE/INACTIVE intermediate relay UE would know the tree root, i.e., the gNB of the remote UEs  6) When the intermediate Relay UE transitions for RRC\_ IDLE to RRC\_CONNECTED, whether and how the gNB can know about the configuration on the intermediate relay UE for relaying, which is configured in IDLE/INACTIVE  All these aspects need to be addressed in detail before considering Approach 2. |
| Qualomm | Yes | Agree with Rapp. |
| vivo | See comments | Basically, we have some sympathy for that if we adopt the tree-like topology for approach 2, it is simple that the IDLE/INACTIVE intermediate relay UE can forward the UL message of the first RRC message based on its parent relay UE.  But for the whole procedure to work, the spec impact as shown in Figure 1 is not so clear to us as this egress link determination was in SRAP layer so we think the exact spec impact should be further discussed. |

Question 1.2: Any other specification impact to allow IDLE/INACTIVE intermediate relay UE to forward the RRC message (e.g., *RRCSetupRequest*) of remote UE w/o assigned local ID?

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| OPPO | As in legacy, for each SRAP PDU forwarding, there are 2 essential steps:   * Egress link determination (in case there are multiple egress links), the UE needs to identify the packet based on the information in SRAP header, and based on the configuration (link/L2 ID to local ID mapping) to determine the intended link. Therefore, w/o any local ID in SRAP header, we understand this doesn’t work. [Rapp, I think this works for UL, but not for DL direction] * Egress RLC channel determination, the UE determine specific RLC channel for each bearer based on configuration (either default or dedicated configured), this configuration should be aligned between the transmitting side and reception side. The receiving side should be able to aware of how to handle the packet based on the ingress RLC channel. If intermediate relay use the same SL-RLC0 to deliver the SRB0 of the remote UE and its own SRB0, different parent UE behavior needs to be discussed upon data reception from SL-RLC0 since it may be not from its child UE (but grandchild). [Rapp: based on the follow-up discussion in section 2.2, this two different SRB0 traffic will use different SRAP formats]   In summary, the impacts are much more complex. |
| ZTE | We also observe following spec impact:  1. SRAP entity will determine whether the received message needs to be discarded. The discard operation is based on SRAP configuration and SRAP header information configured by gNB. When intermediate UE is in IDLE or inactive state, how does intermediate relay UE discard the packet is FFS and I believe this has spec impact.  [Rapp: I agree not all sepc impacts are captured in TP, erroneous/failure case are not discussed]  2. Approach2 allows SOME intermediate relay UEs to be in RRC IDLE/INACTIVE, which means some other intermediate relay UEs can be in RRC connected. For intermediate mediate relay UE in RRC connected, it can obtain the local ID from network. This discussion paper seems focus on all intermediate relay UEs are in RRC IDLE/INACTIEV. So, “not all intermediate relay UEs are in RRC IDLE/INACTIVE” is a FFS issue which may have spec impact. {Rapp, wouldn’t CONNECTED intermediate relay UE just act as same as Approach 1[  ZTE: Taking following intermediate relay as an example.  Remote===Inter-1===Inter-2===Last===gNB  if inter-1 is in connected state, it can obtain the local ID for remote UE and may construct SRAP header having local ID. But for inter-2, it can not obtain the local ID of remote UE, so it may be use SRAP header having L2 ID. Another alternatives for inter-2 in this case is that inter-2 does not construct a new SRAP header, just forward the message received from inter-1, in which case inter-2 will use SRAP header having local ID.  But if inter-1 is also in IDLE state, both inter-1 and inter-2 can only use SRAP header having L2 ID.  Therefore the type of UE ID included in SRAP header used by inter-2 depends on the RRC state of inter-1, this is the case which may need further discussion.  Ericsson-> ZTE’s point is good. So what format of SRAP header would depend on the RRC state of the first relay UE. So, the TP in the above can be slightly updated if other companies also agree with this way forward. |
| LG | We still don’t understand how approach 2 can work without the mapping configuration between local ID and egress link. When intermediate Relay UE receives RRC message (e.g., RRCsetup message from gNB), the intermediate Relay should forward it toward the right Remote UE. We wonder how the intermediate Relay UE makes the decision which egress link (SL-RLC0) is for the right Remote UE. We think the intermediate Relay UE has to know the linkage between L2 ID of the Remote UE and local ID at least. To do this, if the intermediate Relay UE has to make the linkage by itself, how to make the linkage by itself could be a new spec impact.  And also, if the SRAP header structures for the intermediate Relay UE in RRC\_CONNECTED and for the intermediate Relay UE in RRC\_IDLE/INACTIVE are different (e.g., if L2 ID of the remote UE includes in SRAP header for the only one case), we wouldn’t like to agree with that. As the ZTE mentioned, if some intermediate Relay UEs are in RRC\_CONNECTED and some intermediate Relay UEs are in RR\_IDLE/INACTIVE, the header structure will be complicated. We have concern that this kind of approach will cause a new spec impact. And also, it’s not still clear what’s the benefit of taking on the complex spec change. |
| Huawei, HiSilicon | In fact, the implementation of Approach 2 will be quite complex, as we need to account for factors such as the RRC states of the intermediate relay UEs, the combination of RRC states for these UEs, how intermediate relay UEs controlled by different gNBs will be managed in Approach 2, ensuring the uniqueness of the Local ID, and the additional error handling that will need to be incorporated into the specification for Approach 2. These are not considered here.  Furthermore the key issue is how to distinguish the SRB0 message from different remote UE which is still unclear.  Additionally if we agree to Approach 2 the way it is described it would mean that there is no unified solution for IDLE/INATCIVE and CONNECTED states hence this will be complex. Moreover other point which is unclear is what if the relay transitions from IDLE to CONNECTED or vice verse, how the SRAP handling will be performed?. |

## 2.2 Forwarding Remote UE RRC message with assigned local ID

When the first RRC message of the remote UE reaches the last relay UE, the last relay UE needs to forward the first RRC message of remote UE via Uu hop to gNB. In order to do this, the baseline procedure or legacy L2 U2N procedure mandates the last U2N relay UE to enter RRC\_CONNECTED, then to follow dedicated SRAP configuration by using a configured Uu Relay RLC Channel (mapped for SRB0) to send a SRAP PDU containing the first RRC message. In baseline procedure, the SRAP header of incoming SRAP PDU is already prepared by the child relay UE (i.e., an intermediate relay UE) based on NW configuration for the child relay UE. But for Approach 2, this is not possible because the intermediate relay UE(s) are in IDLE/INACTIVE state and will have no NW configuration of any local ID and SRAP mapping. Therefore, the incoming SRAP PDU (containing SRB0 message)’s UE ID field is absent. Hence, the last relay UE, once in CONNECTED state, must generate proper SRAP header with assigned local ID, append it to the incoming SRAP SDU and forward it to gNB, according to the dedicated NW configuration. Note that the same SRAP header is also needed for DL SRB0 message, so that the *RRCSetup* can be routed to the correct remote UE.

For gNB to establish the remote UE context and to generate dedicated NW configuration to last relay UE (e.g., to handle the remote UE’s Uu SRB0, including allocating local ID for remote UE and setting up SRAP configurations for SRB0), the gNB relies on the last relay UE’s SUI reporting in UL RRC. For single-hop case in Rel-17, the remote UE’s L2 ID is known by the L2 U2N relay UE via the PC5 link between remote UE and relay UE. For Approach 1 of MH relay, the remote UE’s L2 ID is reported to gNB by the first intermediate relay UE’s SUI message. However, for Approach 2, only the last relay UE is in CONNECTED state at this stage and only it can report the remote UE’s Source Layer-2 ID to gNB so that the local ID can be assigned and associated to the “origin” of the SRB0 message (i.e., remote UE), instead of the child relay UE of the last relay. Hence, there is a need to modify SUI signaling to enable this for Approach 2.

The scope of specification impact to enable this would include the following:

1. SUI procedure and SUI signaling in TS 38.331 to report L2 ID of remote UE and solicit local ID allocation
2. The mechanism to enable the last relay UE to know the Src L2 ID of the remote UE originating SRB0 message.
3. SRAP procedure change to determine correct UE ID field value for forwarding SRB0 via Uu hop

For the first part, SUI procedure text change could be done as the example below:

|  |
| --- |
| 5.8.3.3 Actions related to transmission of *SidelinkUEInformationNR* message <text omitted>  3> if *SIB12* includes *sl-L2U2N-Relay* or *sl-L2U2N-MH-relay* and if configured by upper layers to transmit NR sidelink L2 U2N relay communication and the UE is acting as L2 U2N Relay UE:  4> include *sl-TxResourceReqL2U2N-Relay* in *sl-TxResourceReqListCommRelay* and set its fields (if needed) as follows for each destination for which it requests network to assign NR sidelink L2 U2N relay communication resource:  5> set *sl-DestinationIdentityL2U2N* to the destination identity configured by upper layer for NR sidelink L2 U2N relay communication transmission;  5> set *sl-TxInterestedFreqListL2U2N* to indicate the frequency of the associated destination for NR sidelink L2 U2N relay communication transmission;  5> set *sl-TypeTxSyncListL2U2N* to the current synchronization reference type used on the associated *sl-TxInterestedFreqListL2U2N* for NR sidelink L2 U2N relay communication transmission;  5> set *sl-MultiHopLocalIDReqList* to the L2 ID(s) of the L2 U2N Remote UE(s) if the L2 U2N relay UE is serving one or more remote UE(s) via multi-hop L2 U2N path(s);  5> set *sl-LocalID-Request* to request local ID for L2 U2N Remote UE transiting to RRC\_CONNECTED or in RRC\_CONNECTED state;  5> set *sl-PagingIdentityRemoteUE* to the paging UE ID received from peer L2 U2N Remote UE, if it is not released as in 5.8.9.8.3;  5> set *sl-CapabilityInformationSidelink* to include *UECapabilityInformationSidelink* message, if any, received from peer UE; |

And in ASN.1 for *SidelinkUEInformatonNR*

|  |
| --- |
| SL-TxResourceReqL2U2N-Relay-r17 ::= SEQUENCE {  sl-DestinationIdentityL2U2N-r17 SL-DestinationIdentity-r16 OPTIONAL,  sl-TxInterestedFreqListL2U2N-r17 SL-TxInterestedFreqList-r16,  sl-TypeTxSyncListL2U2N-r17 SEQUENCE (SIZE (1..maxNrofFreqSL-r16)) OF SL-TypeTxSync-r16,  sl-LocalID-Request-r17 ENUMERATED {true} OPTIONAL,  sl-PagingIdentityRemoteUE-r17 SL-PagingIdentityRemoteUE-r17 OPTIONAL,  sl-CapabilityInformationSidelink-r17 OCTET STRING OPTIONAL,  ...  [[  sl-MultiHopLocalIDReqList-r19 SEQUENCE (SIZE (1..maxNrofSL-Dest-r16)) SL-DestinationIdentity-r16 OPTIONAL,  ]]  }  <corresponding field description change omitted> |

**Figure 2: TP to 38.331 to include Remote UE L2 ID in SUI message (example)**

To ensure the L2 ID is known by the last relay UE, this L2 ID needs to be shared to the last relay UE crossing multiple PC5 hops. In the baseline approach, the L2 ID of remote UE is only known by the first relay UE. Hence, L2 ID has to be shared by either the first relay UE or the remote UE along the upstream path to the last relay UE, probably along with the first RRC message. If the intermediate relay UE send this information separately with another signalling, then it may be difficult for the last relay UE to correlate the L2 ID received in this signalling with the Remote UE’s Uu SRB0 message, especially in case of concurrent connection establishment requests from different remote UEs.

One possible way to enable this is to introduce a variant of SRAP header format by introducing “Remote UE L2 ID” field in the SRAP header, as implied in [2], to replace the replacing the “UE ID” field. This header format is only used when local ID is not yet assigned. This format may be added in a new section 6.2.x in TS 38.351 (The detailed changes in section 6.2 are not shown, but should be similar to the illustrated figure below). Note that a new “F” bit can be used to indicate a variant of SRAP PDU format vs. normal format, if needed.

A screenshot of a computer screen

AI-generated content may be incorrect.

**Figure 3: SRAP PDU formats variants of SRAP header for MH U2N Relay (Example)  
The left figure replace the UE ID filed with L2 ID field. The right figure adds L2 ID as an additional field**

Besides the illustration of the new format, there should be some additional change in 38.351 procedure to explain the usage of this new SRAP header format, which includes:

1) The procedure for remote UE for constructing the new SRAP header is to be added in section 5.3.1

2) The new parameter(s) are to be defined in 6.3

3) the SRAP procedure needs to be updated to allow the creation of correct SRAP header to be associated with the “bare” SL-RLC0 message to use the assigned local ID corresponding to the remote UE, not the last-hop relay UE.

The example TP for the above are provided in Figure 4:

|  |
| --- |
| =================================== <First change>=================================== 5.3.1 Transmitting operation of U2N Remote UE The transmitting part of the SRAP entity on the PC5 interface of U2N Remote UE can receive SRAP SDU from upper layer and constructs SRAP Data PDU.  Upon receiving an SRAP SDU from upper layer, the transmitting part of the SRAP entity on the PC5 interface shall:  - If the SRAP SDU is not for SRB0:  - Determine the UE ID field and BEARER ID field in accordance with clause 5.3.1.1;  - Construct an SRAP Data PDU with SRAP header, where the UE ID field and BEARER ID field are set to the determined values, in accordance with clause 6.2.2;  - Else if SRAP SDU is for SRB0 and the U2N remote UE is using a multi-hop path:  - Constructs an SRAP Data PDU with SRAP header in accordance with clause 6.2.x  - Else:  - Construct an SRAP Data PDU without SRAP header in accordance with clause 6.2.2.  - Determine the egress RLC channel in accordance with clause 5.3.1.2;  - Submit this SRAP Data PDU to the determined egress RLC channel.  ================================ <Next change>============================= 6.3 Parameters .<text omitted> 6.3.x F Length: 1 bit  This field indicates whether the corresponding SRAP header use the UE ID or Layer-2 ID to identify the U2N remote UE. When the bit is set to 1, Layer-2 ID field is used as specified in 6.2.x. Otherwise, UE ID field is used as specified in 6.2.2. 6.3.x Layer-2 ID Length: 24 bits  This field indicates the Source L2 ID used by the L2 Remote UE for L2 U2N Relay communication.  ================================ <Next change>============================= 5.3.3 Transmitting operation of U2N Relay UE (or last Relay UE) The transmitting part of the SRAP entity on the Uu interface of U2N Relay UE can receive SRAP data packets from the receiving part of the SRAP entity on the PC5 interface of the same U2N Relay UE, and construct SRAP Data PDUs as needed (see clause 4.2.2).  When the transmitting part of the SRAP entity on the Uu interface has an SRAP Data PDU to transmit, the transmitting part of the SRAP entity on the Uu interface shall:  - If the SRAP Data PDU is received from SL-RLC0 as specified in TS 38.331 [3]:  - Determine the UE ID field and BEARER ID field in accordance with clause 5.3.3.1;  - Construct an SRAP Data PDU with SRAP header, where the UE ID field and BEARER ID field are set to the determined values, in accordance with clause 6.2.2;  - Determine the egress RLC channel in accordance with clause 5.3.3.2;  - Submit this SRAP Data PDU to the determined egress RLC channel. 5.3.3.1 UE ID field and BEARER ID field determination For an SRAP Data PDU received from SL-RLC0 as specified in TS 38.331 [3], the SRAP entity shall:  - If there is an entry in *sl-RemoteUE-ToAddModList*, whose *sl-L2IdentityRemote* matches the Layer-2 ID of the remote UE from which the SRAP Data PDU is received, or the Layer-2 ID included in the “Layer2 ID” field of the incoming SRAP Data PDU:  - Determine the UE ID field corresponding to *sl-LocalIdentity* configured for the concerned *sl-L2IdentityRemote* as specified in TS 38.331 [3];  - Determine the BEARER ID field as 0 (i.e., set BEARER ID field as 0). |

**Figure 4: TP for 38.351 Procedure text to use the new SRAP header (example)**

Finally, we also need to enable the forwarding operation via default SL-RLC1 for any intermediate relay UE. This is because even though local ID is assigned and included in SRAP header, and the intermediate relay UE has neither dedicated SRAP mapping nor QoS requirements for SRB1, it is natural to just use SL-RLC1 for any remote UE’s SRB1 traffic.

|  |
| --- |
| 5.4 Forwarding operation of Intermediate U2N Relay UE <For Approach 2>  The SRAP entity shall:  If Intermediate U2N Relay UE is not in CONNECTED state  If the SRAP Data PDU is received from child UE and BEARER ID indicated as SRB1:  - Determine the egress link as the PC5 link to its parent relay as specified in TS 38.331 [3];  - Determine the egress RLC channel as SL-RLC1;  If the SRAP Data PDU is received from parent relay UE and BEARER ID indicated as SRB1:  - Determine the egress link as the PC5 link to its child as specified in TS 38.331 [3];  - Determine the egress RLC channel as SL-RLC1;  - Submit this SRAP Data PDU to the determined egress RLC channel of the determined egress link. |

**Figure 5: TP for 38.351 Procedure text to use the new SRAP header (example)**

Based on the above analysis and example TP shown in Figure 2,3,4 and 5, we collect company view on the specification impact regarding this aspect.

Question 2.1: Do you agree that forwarding Remote UE’s RRC message with assigned local ID would have the following spec impact on TS 38.331 and TS 38.351:

1. SUI procedure and SUI message change to add L2 ID of remote UE (impact to TS 38.331)
2. SRAP format design change to include L2 ID of remote UE in SRAP PDU (TS 38.351)
3. SRAP procedure changes to enable the usage of new SRAP header and “L2 ID - local ID” linkage in the last relay UE & intermediate relay UE in UL & DL handling (TS 38.351)
4. SRAP procedure changes to enable SL-RLC1 to be used for forwarding Remote UE Uu SRB1 message. (TS 38.351)

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No** | **Comments** |
| OPPO | See comment | 1. The SUI impact is not just add L2 ID of remote UE, since there maybe intermediate relay who needs to RRC connection establishment as well. And in that case, the impact will be complex. [Rapp, if intermediate relay UE sends its own SRB0 message to the last relay UE via SL-RLC0, the last relay UE will just include this information in legacy SUI message and solicit a local ID for this intermediate relay UE. Is there any more complex behavior needed?] 2. Same as the comment to SRB0, the procedure doesn’t specify clear UE behavior. [Rapp: I think the egress link part can be determined based on local ID – L2 ID linkage either implicit or explicit indication. If we support concurrent remote UE requests, then the first DL SRB0 message would carry a SRAP header to map local ID and the earlier L2 ID, so the egress link is clear for each intermediate relay UE. If no concurrency supported, then each intermediate relay UE has only received SRB0 from one child relay UE, then the egress link is also clear. |
| ZTE | No for a)  FFS for d)  Yes for others | For a), my understanding is last relay UE can re-use single hop relay SUI message to request local ID for multi-hop remote UE. What’s the purpose to crease a new local ID request indication for multi-hop remote UE? Maybe something is needed to indicate this remote UE is a multi-hop remote UE, but such indication is not used for local ID request and Approach1 may also need this indication. So, at least for “last relay UE to obtain the local ID, SRAP config, Uu RLC channel config”, we do not see the need to change SUI message.[Rapp: I assume the legacy SUI format is always used to carry the adjacent downstream node’s L2 ID (which acting as a remote UE towards the last relay UE), as needed for Approach 1]. So, for Approach 2, some other indication is needed to solicit local ID for the end L2 remote UE.  ZTE: my understanding is that, for approach1, the DST L2 ID in SUI message is it’s adjacent child UE(a intermediate relay UE). For approach2, the DST L2 ID in SUI message is the end L2 Remote UE, last relay UE can put end L2 Remote UE’s L2 ID into *sl-DestinationIdentityL2U2N-r17*. Maybe rapper needs to clarify the motivation of introducing other indication, from local ID request perspective.   |  | | --- | | SL-TxResourceReqL2U2N-Relay-r17 ::= SEQUENCE {  sl-DestinationIdentityL2U2N-r17 SL-DestinationIdentity-r16 OPTIONAL,  sl-TxInterestedFreqListL2U2N-r17 SL-TxInterestedFreqList-r16,  sl-TypeTxSyncListL2U2N-r17 SEQUENCE (SIZE (1..maxNrofFreqSL-r16)) OF SL-TypeTxSync-r16,  sl-LocalID-Request-r17 ENUMERATED {true} OPTIONAL,  sl-PagingIdentityRemoteUE-r17 SL-PagingIdentityRemoteUE-r17 OPTIONAL,  sl-CapabilityInformationSidelink-r17 OCTET STRING OPTIONAL,  ...  } |   For d), we have not discussed yet whether remote UE’s SRB1 message is allowed to be forwarded when intermediate relay is in RRC INACTIVE/IDLE state. So, FFS for d) [Rapp: here we just scope spec impact. I understand if RAN2 decide not to support some feature of approach 2, then the spec impact of such a feature will not be need in stage 3 work]  ZTE: Yes, my motivation is to clarify that d is optionally supported if we agree DRB traffic is allowed to be forwarded by IDLE/INACTIVE inter relay UE. The clarification of prerequisite is important to identify the mandatory feature in approach2, so that we can minimize the spec impact if RAN2 agree to support approach2. |
| Kyocera | Yes for a) – c) | We are ok with the intention of steps a), b) and c), but would like to further consider the details of the Stage 3 text. We would like further discussion on the need for d) for SL-RLC1. |
| Sharp | No. Further impact should be expected. | For a), last relay UE should recognize remote UE L2 ID and indicate it to gNB before remote UE transmits the SL-RLC0 data. To enable this, hop-by-hop PC5-RRC message or upper layer message to indicate remote UE L2 ID is needed. And RRC layer receiving the information should indicate it to the SRAP layer. It should be spec impact.  For b), the intermediate relay UE only can understand L2 IDs of neighbour UEs in legacy. L2 ID for discovery and L2 ID for communication have different values. Therefore, if L2 ID of remote UE is used, intermediate relay UE should always transfer a SL-RLC0 data associated with unknown L2 ID. It seems serious issue from security point of view.  For c), it should be RRC impact instead of SRAP impact because the local ID is sent via (PC5-) RRC message. Otherwise, SRAP CPDU to associate/allocate between L2 ID and local ID is needed as mentioned in impact (c). |
| Ericsson | Yes | ZTE comments for a) is reasonable to further reduce the change on SUI, however, some additional indicator indicating the concerned remote UE is a multi-hop rather single hop relay is anyway needed. |
| LG | See comment | a) To do this, we think the last Relay UE should report the L2 IDs of the whole path. If the intermediate Relay UE in RRC\_IDLE/INACTIVE becomes RRC\_CONNECTED, the intermediate Relay UE need to get a configuration for the Remote UE. In this case, how can the gNB ensure the intermediate Relay UE is belonged the path for the Remote UE? When the intermediate in RRC\_IDLE/INACTIVE becomes RRC\_CONNECTED, does the intermediate Relay UE report the L2 ID of the Remote UE? Then how does the intermediate Relay UE knows the L2 ID of the Remote UE?  b) According to the description of the approach 2, two types of SRAP header structure are required. However, as long as the benefits of the approach 2 are not clear, we don’t understand why we have to apply this complicated procedure for multi-hop. The benefits of approach 2 needs to be clarified.  c/d) All the intermediate relay UE has to decide the egress RLC channel by using the linkage of a local ID, L2 ID of the remote UE and end-to-end bearer ID. We wonder how the intermediate relay UE decides the egress RLC channel without any configuration. Does the intermediate Relay UE configures it by its implementation? Then, this means the intermediate Relay UE stores the information of which link is toward which remote UE when initial RRC connection procedure? It seems increase the complexity/latency of the intermediate Relay UE. |
| InterDigital | Yes | Agree to the changes suggested by rapporteur, with possible enhancements to the signaling of the L2 ID suggested by ZTE. As for d), we think DRB traffic forwarding should be part of approach 2. |
| Huawei, HiSilicon | See comment | Generally, through this solution, SRB0 and SRB1 messages can be forwarded even when the intermediate relay UE is in IDLE/INACTIVE state. However, we still face a significant delay before the local ID is assigned, which impacts data transmission.  If we consider user plane latency as the time taken to transmit the first user plane packet and compare it with Approach 1, we don’t observe a significant advantage in terms of user plane latency for Approach 2, even with the support for IDLE/INACTIVE relay UEs. In this sense, Approach 2 complicates the control plane procedure without offering any substantial benefits  For Approach 2 there are some specific questions/concerns that still needs to be answered/addressed   1. The main change for SUI procedure is who will report the SUI message. If the last relay UE report the SUI. the content in the SUI message can be the same as legacy. 2. How the last relay UE can determine the L2ID of the remote UE? 3. How for the intermediate relay UE can determine the linkage, particularly for the IDLE/INACTIVE relay UEs? 4. How the RRC State transition of Intermediate Relay UE handled? 5. RRC State dependent SRAP Header usage will complicate both the RRC and SRAP specs and force to have cross layer interaction between the protocol layers which is not needed in Approach 1 |
| Qualcomm | No for a  Yes for others | For a, I assume hop number should also be included in SUI for gNB QoS spliting, then gNB should know the Remote UE L2 ID is multi-hop relay. |
| vivo | See comments | We some how share the view from Huawei that Approach 2 that there are a bunch of problems to be solved for forwarding Remote UE’s RRC message with assigned local ID.  Although this question is to know the spec impact, we think the technical discussion about how approach 2 works seems immature.  Besides, for a)-d), we think at least ‘no’ for a), as we would like to reuse legacy SUI as much as possible. |
|  |  |  |

Question 2.2: Any other specification impact to enable remote UE local ID allocation and allow the last relay UE and IDLE/INACTIVE intermediate relay UE(s) forwarding the RRC message of remote UE with the assigned local ID?

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| OPPO | The intermediate relay UE’s behavior on how to handle the SRAP PDU w/ L2 ID is missing, i.e.,   * How to identify the packet (in case it is not the first relay, and it doesn’t know the L2 ID); [Rapp: For UL, this would be the SRB message destinated to gNB, so it will just forward to parent relay node. For DL, the egress link part can be determined based on local ID – L2 ID linkage either implicit or explicit indication. If we support concurrent remote UE requests, then the first DL SRB0 message could carry a SRAP header to map local ID and the earlier L2 ID, so the egress link is clear for each intermediate relay UE. If no concurrency supported, then each intermediate relay UE has only received SRB0 from one child relay UE, then the egress link is also clear * How to do egress link determination w/o local ID configuration. [Rapp, as explained above] |
| ZTE | For DL SRB0 message, last relay UE need to remove the SRAP header, as shown in below. So for approach2, whether last or intermediate relay UE need to remove the SRAP header may have spec impact   |  | | --- | | - If the SRAP Data PDU is for SRB0 (the BEARER ID field is 0, and the bearer is identified as SRB based on *sl-RemoteUE-RB-Identity* associated with the entry containing the *sl-EgressRLC-ChannelUu* which matches the LCID of the Uu Relay RLC Channel from which the SRAP Data PDU is received):  - Remove the SRAP header from the SRAP Data PDU; | |
| LG | Based on our understanding until now, all the intermediate relay UE should store the information which link is associated with which remote UE when receiving the initial RRC message including L2 ID of the remote UE. This information is needed when the intermediate relay UE receives a SRAP header including local ID and L2 ID of the remote UE. The procedure that intermediate relay UE decodes the L2 ID of the Remote UE included in the initial RRC message and then stores it in is needed.  In addition, for the security issue, the L2 ID of Remote UE can be changed frequently. In his case, it’s not clear how the intermediate Relay UE can make the linkage between the L2 ID and local ID for the Remote UE. Because, the linkage between L2 ID and local ID at the IDLE/INACTIVE intermediate Relay UE is made by using the information from the initial UL/DL SRAP header. So, it not clear how the intermediate Relay UE makes the linkage between local ID and L2 ID when the L2 ID of the Remote UE is changed.  Also, we wonder when the intermediate Relay UE in RRC\_IDLE/INACTIVE releases the mapping between L2 ID and local ID. If the Remote UE become RRC state transition from RRC\_CONNECTED to RRC\_IDLE/INACTIVE, the intermediate Relay UE should release the mapping. Then how does the intermediate Relay UE get a report whether the RRC state of the Remote UE is changed? |
| Huawei, HiSilicon | As indicated above the implementation of Approach 2 will be quite complex, as we need to account for factors such as the RRC states of the intermediate relay UEs and the handling during state transition, the combination of RRC states for these UEs, how intermediate relay UEs controlled by different gNBs will be managed in Approach 2, ensuring the uniqueness of the Local ID, and the additional error handling that will need to be incorporated into the specification for Approach 2.  Furthermore there are unclear points on Approach 2   1. In addition to SRB0, configured relay RLC channels maybe used to carry the SRB messages, e.g., SRB1 and SRB2. For the first SRB1 message, how to determine the egress relay RLC channel? |

## 2.3 QoS Split

For e2e traffic between remote UE and gNB, the QoS split can be still done by gNB based on NW implementation on a per-DRB level, as gNB implementation can aggregate the results for each e2e QoS flow and determine the per-DRB level QoS requirements. The major specification impact of QoS split in Approach 2 is about how to deliver the QoS (e.g. PDB) for PC5 hops where the intermediated Relay UE is the TX node, given the fact that this cannot be delivered directly via dedicated RRC message and must be delivered in an alternative way. So far, there are two options proposed in [3]:

- *Option 1*: SRAP Control PDU

- *Option 2*: RRC message (for both Uu and PC5)

### 2.3.1 Using SRAP control PDU to deliver QoS Split

**The first option (Option 1)** would limit the major impact to TS 38.351 with a new SRAP Control PDU design. In the SRAP control PDU approach, for each e2e DRB, gNB conducts the UL and DL QoS split, and include the QoS split results for each intermediate relay UE (i.e., PDB for the Tx UE to determine the required SL transmission latency) in this SRAP Control PDU. Note that this SRAP control PDU is a special control signaling for a corresponding Uu radio bearer, but not carry any traffic “belonging to” the Uu radio bearer.

An example design of Option 1 SRAP Control PDU format is provided in Figure 6 below.

A screenshot of a phone

AI-generated content may be incorrect.

**Figure 6: SRAP Control PDU for Split PDB delivery (Example)**

Such new format would have impact on the section 6.2 in TS 38.351, e.g., with a new section 6.2.x to describe the SRAP Control PDU format and its corresponding fields in section 6.3. For SRAP specification, an example TP is also provided for reference as shown in Figure 7 below:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ====================================<First change>================================= 5.4.x Handling of SRAP control PDU in Intermediate U2N Relay UE The SRAP entity shall:  If Intermediate U2N Relay UE is not in CONNECTED state  If the SRAP Control PDU is received from the parent relay UE:  - obtain the PDB value for PC5 hop between the intermediate relay of the SRAP entity and its child UE to be used for the end-to-end bearer identified in BEARER ID field;  - Determine the egress link as the PC5 link to its child intermediate relay UE as specified in TS 38.331 [3];  - Derive the egress RLC channel as specified in section 5.8.9.7.0 in TS 38.331;  - if there exists a child intermediate relay UE for the remote UE identified in UE ID field:  - Submit this SRAP Control PDU to the determined egress RLC channel of the determined egress link.  ==================================<next change>================================= 5.2.1 Receiving operation of U2N Relay UE (or last relay) Upon receiving an SRAP Data PDU or SRAP control PDU from lower layer, the receiving part of the SRAP entity on the Uu interface of U2N Relay UE shall:  - Deliver the SRAP data packet or SRAP control PDU to the transmitting part of the collocated SRAP entity on the PC5 interface. 5.2.2 Transmitting operation of U2N Relay UE (or last relay)5.2.2.0 General The transmitting part of the SRAP entity on the PC5 interface of U2N Relay UE receives SRAP data packets or SRAP control PDU from the receiving part of the SRAP entity on the Uu interface of the same U2N Relay UE, and construct SRAP Data PDUs as needed (see clause 4.2.2) or forward SRAP control PDU as it is.  When the transmitting part of the SRAP entity on the PC5 interface has an SRAP Data PDU or SRAP control PDU to transmit, the transmitting part of the SRAP entity on the PC5 interface shall:  - Determine the egress link in accordance with clause 5.2.2.1;  - Determine the egress RLC channel in accordance with clause 5.2.2.2;  - If the SRAP Data PDU is for SRB0 (the BEARER ID field is 0, and the bearer is identified as SRB based on *sl-RemoteUE-RB-Identity* associated with the entry containing the *sl-EgressRLC-ChannelUu* which matches the LCID of the Uu Relay RLC Channel from which the SRAP Data PDU is received):  - Remove the SRAP header from the SRAP Data PDU;  - Submit this SRAP Data PDU or SRAP control PDU to the determined egress RLC channel of the determined egress link 5.2.2.1 Egress link determination For a SRAP Data PDU or SRAP control PDU to be transmitted, SRAP entity shall:  - If there is an entry in *sl-RemoteUE-ToAddModList*, whose *sl-LocalIdentity* included in *sl-SRAP-ConfigRelay* matches the UE ID field in SRAP Data PDU or SRAP control PDU:  - Determine the egress link on PC5 interface corresponding to *sl-L2IdentityRemote* configured for the concerned *sl-LocalIdentity* as specified in TS 38.331 [3]. 5.2.2.2 Egress RLC channel determination For a SRAP Data PDU to be transmitted, the SRAP entity shall:  - If the SRAP Data PDU is for SRB0 (the BEARER ID field is 0 and the bearer is identified as SRB based on *sl-RemoteUE-RB-Identity* associated with the entry containing the *sl-EgressRLC-ChannelUu* which matches the LCID of the Uu Relay RLC Channel from which the SRAP Data PDU is received):  - Determine the egress PC5 Relay RLC channel in the determined egress link corresponding to *logicalChannelIdentity* for SL-RLC0 as specified in TS 38.331 [3].  - Else if there is an entry in *sl-RemoteUE-ToAddModList*, whose *sl-LocalIdentity* included in *sl-SRAP-ConfigRelay* matches the UE ID field in SRAP Data PDU, which includes an *sl-RemoteUE-RB-Identity* that matches the SRB identityor DRB identityof the SRAP Data PDU determined by the BEARER ID field (For the BEARER ID shared by both SRB and DRB, SRB and DRB are differentiated based on *sl-RemoteUE-RB-Identity* associated with the entry containing the *sl-EgressRLC-ChannelUu* which matches the LCID of the Uu Relay RLC Channel from which the SRAP Data PDU is received, and for DRB, the DRB identity is BEARER ID plus 1):  - If the SRAP Data PDU is for SRB1 but the corresponding *sl-EgressRLC-ChannelPC5* is absent in *sl-SRAP-ConfigRelay*:  - Determine the egress PC5 Relay RLC channel in the determined egress link corresponding to *logicalChannelIdentity* for SL-RLC1 as specified in TS 38.331 [3].  - Else:  - Determine the egress PC5 Relay RLC channel in the determined egress link corresponding to *sl-EgressRLC-ChannelPC5* configured for the concerned *sl-LocalIdentity* and concerned *sl-RemoteUE-RB-Identity* as specified in TS 38.331 [3].  For a SRAP Control PDU to be transmitted, the SRAP entity shall:  - if there is an entry in *sl-RemoteUE-ToAddModList*, whose *sl-LocalIdentity* included in *sl-SRAP-ConfigRelay* matches the UE ID field in SRAP Control PDU, which includes an *sl-RemoteUE-RB-Identity* that matches the DRB identityof the SRAP Control PDU determined by the BEARER ID field:  - Determine the egress PC5 Relay RLC channel in the determined egress link corresponding to *sl-EgressRLC-ChannelPC5* configured for the concerned *sl-LocalIdentity* and BEARER ID field indicate for the end-to-end DRB, as specified in TS 38.331 [3].  ================================<next change>===================================== 6.3 Parameters <text omitted> 6.3.6 D/C Length: 1 bit  This field indicates whether the corresponding SRAP PDU is an SRAP Data PDU or an SRAP Control PDU (not used in this release).  Table 6.3.6-1: D/C field   |  |  | | --- | --- | | Bit | Description | | 0 | SRAP Data PDU | | 1 | SRAP Control PDU |  6.3.x Number of Intermediate Relays Length: 8 bit  This field indicates the number of intermediate relays used to support the end-to-end bearer (e.g., DRB) 6.3.x DL PDB for Intermediate relay Length: 8 bits  This field indicates the intermediate relay UE’s packet delay budget in milliseconds for the PC5 transmission in DL path of Multi-hop L2 U2N relay. The first PDB value is for the first intermediate relay UE in the DL/downstream direction, the 2nd PDB value is for the second intermediate relay UE in the DL/downstream direction, and so on. 6.3.x UL PDB for Intermediate relay Length: 8 bits  This field indicates the intermediate relay UE’s packet delay budget in milliseconds for the PC5 transmission in UL path of Multi-hop L2 U2N relay. The first PDB value is for the first intermediate relay UE in the UL/upstream direction, the 2nd PDB value is for the second intermediate relay UE in the UL/upstream direction, and so on. |

**Figure 7: TP to support SRAP Control PDU Procedure (example)**

Note that for a relay UE to derive the RLC channel configuration, only a PDB value is insufficient. The relay UE needs a full SL QoS profile, which can be mapped to a SLRB configuration or default SLRB provided in SIB12 or Pre-configuration. In order to solve this issue, we assume a default “*SL-QoS-Profile*” can be provided in SIB12 or Pre-configuration. The exact TP change (for SIB12 or pre-configuration in TS 38.331) is omitted here.

### 2.3.2 Using RRC messages to deliver QoS Split

**The second option (Option 2)** of using RRC signaling involves changes in TS 38.331. Frist, there should be enhancement in Uu message (*RRCReconfiguration*) to include an extensive list of QoS split results determined by NW towards the relay(s). Then, based on the RRC configuration from gNB, the last relay UE is triggered to initiate a hop-by-hop PC5-RRC signaling procedure to deliver the QoS split results along the multi-hop path. As a result, each intermediate relay UE should be triggered in turn to process the incoming PC5-RRC message and to generate its own next-hop PC5-RRC signaling to deliver the QoS split results downstream. Thus, Option 1 would need message formats changes in both Uu RRC (i.e., *RRCReconfiguration* and PC5-RRC (e.g., a new PC5-RRC Message *QoSTransferSidelink*) for split QoS delivery) and PC5-RRC procedures to handle the reception of *QoSTransferSidelink*)from the parent relay node and re-generate the *QoSTransferSidelink*) towards its child relay(s).

Necessary ASN.1 changes are explained below in Figure 8 as reference for Option 2. In the signalling design below, the NW provides the UL and DL split per each DRB per reach remote UE in RRC signalling in ASN.1 formats. In addition, a default *sl-default-PC5QoS* is provided per DRB to characterize the overall SL QoS requirements (except PDB) for PC5 hop(s) so that the IDLE/INACTVE intermediate relay UE can derive the PC5 RLC channel configuration with a PC5 QoS profile including the split PDB. This parameter can be omitted if a similar parameter is provided in SIB12 or Pre-configuration, as done in Option 1 in clause 2.3.1.

The PC5-RRC procedure text changes for *QoSTransferSidelink* would be quite similar to what the baseline procedure specified for paging and SI forwarding in regards of the handling/forwarding of *UuMessageTransferSidelink.* So, we omitted the TP changes for RRC procedures here. But please note that there will be extra TP changes needed in TS 38.331 to handle the signalling.

|  |
| --- |
| ================================ <First change>============================= – *RRCReconfiguration* <Text Omitted>  RRCReconfiguration-v1900-IEs ::= SEQUENCE {  sl-MHRelayQoSSplitList-r19 SEQUENCE (SIZE (1.. maxNrofMHPaths-r19)) OF SL-QoSSplit-Info-r19} OPTIONAL, -- Need M  nonCriticalExtension RRCReconfiguration-v1900-IEs OPTIONAL  }  <Text Omitted>  SL-SplitQoS-Info-r19 ::= SEQUENCE {  sl-DestinationIdentityRemoteUE-r19 SL-DestinationIdentity-r16,  sl-E2E-UuDRB-Index-r19 INTEGER (1..maxDRB)  sl-default-PC5QoS-r19 SL-QoS-Profile-r16 OPTIONAL, -- Need N  sl-DLDRBSplitQoSList-r19. SEQUENCE (SIZE (1.. maxNrofHops-r19)) OF SL-PDBSplit-r19 OPTIONAL, -- Need N  sl-ULDRBSplitQoSList-r19. SEQUENCE (SIZE (1.. maxNrofHops-r19)) OF SL-PDBSplit-r19 OPTIONAL, -- Need N  }  SL-PDBSplit-r19 = INTEGER (0..255)  <corresponding field description change omitted>  ================================ <Next change>============================= – *QoSTransferSidelink* The *QoSTransferSidelink* message is used for the sidelink transfer of QoS split results from a parent relay to child relay(s) in Multi-hop Layer-2 UE-to-NW relay.  Signalling radio bearer: SL-SRB3  RLC-SAP: AM  Logical channel: SCCH  Direction: L2 U2N Relay UE to L2 U2N Relay UE  *QoSTransferSidelink* message  -- ASN1START  -- TAG-QOSTRANSFERSIDELINK-START  QoSTransferSidelink-r17 ::= SEQUENCE {  criticalExtensions CHOICE {  qosTransferSidelink-r17 QoSTransferSidelink-r19-IEs,  criticalExtensionsFuture SEQUENCE {}  }  }  QoSTransferSidelink-r19-IEs ::= SEQUENCE {  sl-SplitQoS-InfoList-r19 SEQUENCE (SIZE (1.. maxNrofMHPaths-r19)) OF SL-SplitQoS-Info-r19 OPTIONAL, -- Need N  lateNonCriticalExtension OCTET STRING OPTIONAL,  nonCriticalExtension SEQUENCE {} OPTIONAL  }  -- TAG-QOSTRANSFERSIDELINK-STOP  -- ASN1STOP  <corresponding field description change omitted> |
|  |

**Figure 8: ASN.1 change to enhancements to Uu RRC and PC5-RRC to distribute QoS split results (example)**

### 2.3.3 Common change for both Options

To allow the gNB to properly split the e2e QoS requirements into per-hop PDB (e.g., based on the number of hops), the remote UE need to report the number of hops in its own SUI message. This is commonly needed for either Option 1 or Option 2. In order to implement this, the example TP to TS 38.331 is shown as below:

|  |
| --- |
| 5.8.3.3 Actions related to transmission of *SidelinkUEInformationNR* message <text omitted>  3> if *SIB12* includes *sl-L2U2N-MH-Relay* and the UE is acting as L2 U2N Remote UE using a multi-hop path:  4> include *sl-TxResourceReqL2U2N-Remote* and set its fields as follows:  5> set *sl-remoteUEIdentity* to the Layer 2 ID configured by upper layer for remote UE to conduct multi-hop L2 U2N relay communication transmission;  5> set *sl-extraNumHopsinMHRelay* to indicate the extra number of hops used in remote UE’s path towards the gNB; |

And in ASN.1 for *SidelinkUEInformatonNR*

|  |
| --- |
| <text omitted>  SidelinkUEInformationNR-v1900-IEs ::= SEQUENCE {  sl-TxResourceReqL2U2N-Remote-r19 SL-TxResourceReqL2U2N-Remote-r19 OPTIONAL,  nonCriticalExtension SEQUENCE {} OPTIONAL  }  <text omitted>  SL-TxResourceReqL2U2N-Remote-r19 ::= SEQUENCE {  sl-remoteUEIdentity-r19 SL-DestinationIdentity-r16,  sl-extraNumHopsinMHRelay-r19 ENUMERATED {one, two}  ...  }  <Corresponding field description change omitted> |

**Figure 9: TP to 38.331 to enable remote UE to report the number of extra hops in the MH path (example)**

Based on the above analysis and example TPs shown in Figure 6, 7, 8 and 9, we collect company view on the overall specification impact regarding this aspect.

Question 3.1: Do you agree that for the support of gNB configuration of QoS split of IDLE/INACTIVE intermediate relay UE(s), the spec impact include either “a+b” (SRAP approach) or “a+c” (RRC approach) :

1. SUI procedure to indicate the number of (extra) hops in SUI to gNB (impact to TS 38.331)
2. SRAP control PDU to convey PDB split results per e2e DRB (impact to TS 38.351 SRAP format and procedure text)
3. Uu RRC & PC5-RRC procedure changes and ASN.1 changes to deliver QoS split results from gNB to relays via RRC signalling (impact to TS 38.331 ASN.1 and procedure text)

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No** | **Comments** |
| OPPO | See comment | We are not sure the proposed options work:   * For option-1, only indicate split-PDB cannot work. In R17 U2N, only PDB is provided because the RLC channel configuration is provided by NW, PDB is only used for mode-2 resource selection. In R18 U2U, to support UE derive RLC channel configuration itself, all the QoS information is provided, together with the QoS to bearer mapping, which is not realistic to be carried in control PDU. * For option-2, a default QoS profile will be used for all QoS flows, it means all the bearers have the same QoS requirement besides PDB, i.e., the RLC channel derivation will only be based on PDB, which to us is not correct.   [Rapp: To be fair, for the option-2, we can also include the QoS profile in each PC5-RRC message. with some additional ASN.1 change to *QoSTransferSidelink*  For the common part, we understand we have agreed to design solutions which should not be impacted by hop number, the new SUI report seems against this principle?  [Rapp: I think the proposed design is not against the principle, No matter how many hops are involved, the remote UE always reports hop number in Approach 2, so there is no design dependency on hop number.  Besides, we understand both options have signalling overhead issue, and requires each intermediate relay UE to process the hop-by-hop QoS split procedure, which increases latency as well. |
| ZTE | See comments | First share same concern with OPPO that the proposed changes have large spec impact, which should be avoided. Since approach1 has been taken as baseline procedure and we still have lots of FFS issues for approach1. So, if we will support approach2 as an optional feature, considering the limited time budget, the proposed solution having large spec impact should not be adopted.  Secondly, before discussing the QoS split, we should first clarify the intermediate relay UE’s serving cell is which cell(last relay UE’s cell or it’s own serving cell)? Then, we should discuss which gNB will determine the PC5 RLC channel configuration and QoS split. Furthermore, the PC5 RLC channel is configured in what kind of granularity is also not clear. The discussion on detailed QoS split function should be postponed.  Thirdly, QoS split is designed for user plane traffic. So, we should first clarify whether remote UE’s DRB traffic is allowed to be forwarded by intermediate relay UE in RRC IDLE/INACTIVE state. If the motivation of approach2 is to decrease the remote UE delay during RRC connection phase in approach1, we do not think we need to discuss this case.  [Rapp: I understand UP operation with Approach 2 may not be agreed. The rapporteur just provide input for potential specification impacts w/o assuming this must be supported. Whether this is to be adopted or not is not going to be decided in the email discussion]  ZTE: Same comments as in Q2.1. |
| Kyocera | Yes | We agree that either can work, although we prefer to go with a) the SUI approach. |
| Sharp | No. Further impact should be expected. | To enable appropriate QoS split, not only number of hops information, but hop-by-hop link quality and load information in each hop are needed. In approach 1, it can be achieved by each measurement report and SUI. However, in approach 2, the information is not indicated to gNB. Therefore, to indicate the link and load information, enhanced measurement report and SUI message are needed. Otherwise, E2E PDB should be split equally by UEs.  Furthermore, to indicate number of hops information, remote UE AS layer should be indicated the information by the upper layer.  In order to correctly know which PDB information received in the SRAP CPDU, the UE needs to be notified UE-located hop number information from higher layers. Otherwise, a mechanism that allows UE to do it without knowing the information is needed. |
| Ericsson | Yes |  |
| LG | See Comment | First of all, we agree with OPPO’s view. The procedure looks a spec change burden. We wonder how each intermediate Relay UE can know the split QoS from gNB is belong to itself. The intermediate Relay UE has to know the mapping local ID and L2 ID of the Remote UE. However, how the intermediate Relay UE can know the mapping?  Secondly, the intermediate Relay UE of approach 1 just do follows what the gNB has ordered. But the intermediate Relay UE of approach 2 needs to perform some works more by itself than the intermediate Relay UE of approach 1. It looks increasing the complexity of the intermediate Relay UE to support relay operation |
| InterDigital | Yes | Both options can work with the indicated specification impact. Between the two, we think RRC is preferrable because the specification impact is minimal, and because we think QoS split is more related to control plane signaling. PC5-RRC container to carry Uu RRC is a more scalable solution. |
| Huawei, HiSilicon | See Comments | We share the same concerns as Oppo , ZTE and LG. It is unclear that if the RRC state of the intermediate relay UE changes, does the QoS split mechanism needed to be changed with Approach 2?  Additionally, since the intermediate relay UE can be in IDLE/INACTIVE state or in a cell managed by a different gNB, this further complicates the procedures. There is no central node to manage QoS splitting for each hop, which could impact RAN 3, and we want to avoid this, especially with only two more meetings left to finalize the R19 work items.  In contrast, local ID allocation, QoS splitting, and SRAP configuration for Approach 1 are straightforward and do not require any complex procedures. Approach 1 is a natural extension of R17 U2N Relay and can support all of these functions without added complexity |
| Qualcomm | Yes for a, c | For a, yes, it is needed.  Agree with Interdigital than RRC based solution is more preferable since QoS forwarding and splitting is always control plane issue. |
| vivo | See comments | For the question itself we understand the spec impact is identified rightly and we understand the option-1 may have less impact? However, we shared the concerns from companies that the QoS split solutions for Approach 2 is quite complexed, so we should be careful about this aspect, otherwise we may not solve all remaining issues to enable approach 2 to be workable. |

Question 3.2: Any other specification impact to enable gNB configuration of QoS split for IDLE/INACTIVE intermediate relay UE?

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| OPPO | We are not sure whether NW can do the split properly only based on hop number, since for connected case, NW has measurement result as well as reference.  [Rapp: performance discussion is not in the scope of this email discussion. If you have identified some missing spec impact, we can add to the discussion] |
| ZTE | As clarified in Q3.1 ,following issues need to discussed first, which will have large spec impact:  1.Clarify the intermediate relay UE’s serving cell is which cell(last relay UE’s cell or it’s own serving cell)?  2. Which gNB will determine the PC5 RLC channel configuration and QoS split?  [Rapp; for both 1&2, I think this is the serving cell/gNB of the last relay UE]  3. The PC5 RLC channel is configured in what kind of granularity？  [Rapp: This is configured per e2e DRB, on demand if needed (e.g, if QoS is different and justify a new PC5 RLC channel)]  ZTE:Response to 2&3, this is just an alternative. This email discussion is to scope the spec impact, so I just think 2&3 are essential questions, RAN2 needs to spend time to to discuss different alternatives and corresponding spec impact. |
| LG | We have a concern about whether the NW can perform proper QoS split without measurement report from the RRC\_IDLE/INACTIVE intermediate Relay UE. If all the intermediate Relay UEs are in RRC\_IDLE/INACTIVE state, the gNB performs QoS split based on the Uu link quality and just hop count. Then what’s the difference of L3 Relay UE? We think one of the reasons we use L2 Relay operation is for dedicated and delicate control for supporting service quality. We think measurement based QoS split is an important factor that cannot be ignored in multi-hop L2 Relay comparing to multi-hop L3 Relay. |
| Huawei, HiSilicon | Agree with Oppo. ZTE and LG; there are many aspects to consider apart from the ones listed here.  One key question is: What would be the behavior of the intermediate relay UE before and after it performs RRC connection establishment through a cell controlled by a different gNB —one that the UE was camped on or uses for its own traffic transfer—while it is simultaneously forwarding traffic for the remote UE? |

## 2.4 Derivation of SRAP and PC5 Relay RLC channel configuration in IDLE/INACTIVE intermediate relay UE(s)

In Approach 2, the derivation of PC5 Relay RLC channel configuration and SRAP mapping for IDLE/INACTIVE intermediate U2N relay UE is based on SIB12 or pre-configuration, as similar to Rel-18 Layer 2 U2U relay UE case. Basically, for each end-to-end Uu DRB, the Tx UE in each PC5 hop will check the QoS requirements for this PC5 hop and attempts to map the e2e bearer to an existing PC5 Relay RLC channel. If not possible, it then derives a new PC5 Relay RLC channel configuration and map the end-to-end DRB automatically to this derived egress PC5 Relay RLC channel. The PC5-RRC procedure to establish the PC5 Relay RLC channel will be triggered based on the legacy Rel-18 procedure in section 5.8.9.7 of TS 38.331.

An example TP is provided as in Figure 9 below:

|  |
| --- |
| ================================<First change>===================================== 5.8.9.7.0 Deriviation of PC5 Relay RLC channel configuration An L2 U2U Remote UE/L2 U2U Relay UE or L2 U2N Intermediate Relay UE in RRC\_IDLE or in RRC\_INACTIVE or out of coverage shall derive PC5 Relay RLC channel configuration based on the per-hop QoS requirements. The update of the PC5 Relay RLC channel configuration can be triggered upon reception of the *UEInformationRequestSidelink* or *UEInformationResponseSidelink* due to the update of the per-hop QoS requirements, as described in clause 5.8.9.11.3 and 5.8.9.11.4. The update of the PC5 Relay RLC channel configuration for L2 U2N intermediate relay UE can be triggered by SRAP control PDU which includes the per-hop QoS requirements, as described in TS 38.351. The UE shall perform PC5 Relay RLC channel release/addition/modification procedure when the corresponding PC5 Relay RLC channel configuration is released/added/modified.  The source L2 U2U Remote UE and L2 U2U Relay UE derive the configuration for the corresponding PC5 Relay RLC channel based on *SIB12*/Preconfiguration, as follows:  - The source L2 U2U Remote UE derives the configuration for the PC5 Relay RLC channel(s) between the source L2 U2U Remote UE and L2 U2U Relay UE (i.e. the first hop PC5 Relay RLC channel(s)), by aggregating the QoS profile(s) of the QoS flow(s) with split QoS information on the first hop into a per-SLRB level QoS profile for each end-to-end sidelink DRB as described in clause 5.8.9.11.4, and considering the *SL-RLC-BearerConfig* in either *sl-RLC-BearerConfigList* or *sl-RLC-BearerPreConfigList* (linked to the *SL-RadioBearerConfig* which matches the per-SLRB level QoS profile) as the first hop PC5 Relay RLC channel configuration.  - The L2 U2U Relay UE derives the configuration for the PC5 Relay RLC channel(s) between L2 U2U Relay UE and the target L2 U2U Remote UE (i.e. the second hop PC5 Relay RLC channel(s)), by aggregating the QoS profile(s) of the QoS flow(s) with split QoS information on the second hop into a per-SLRB level QoS profile for each end-to-end sidelink DRB as described in clause 5.8.9.11.3, and considering the *SL-RLC-BearerConfig* in either *sl-RLC-BearerConfigList* or *sl-RLC-BearerPreConfigList* (linked to the *SL-RadioBearerConfig* which matches the per-SLRB level QoS profile) as the second hop PC5 Relay RLC channel configuration.  The L2 U2N intermediate relay derives the configuration for the corresponding PC5 Relay RLC channel based on *SIB12*/Pre-configuration, for each end-to-end Uu DRB, as follows:  - For an end-to-end Uu DRB, the L2 U2N Intermediate Relay UE check if the QoS profile (e.g., split PDB provided in SRAP control PDU) for the PC5 hop can be supported by an existing PC5 Relay RLC channel between this UE and its UL or DL next-hop neighbor. If not, it derives the configuration for the PC5 Relay RLC channel(s) between the intermediate Relay UE and its UL or DL neighbor based on per-DRB level QoS profile for an end-to-end Uu DRB, and considering the *SL-RLC-BearerConfig* in either *sl-RLC-BearerConfigList* or *sl-RLC-BearerPreConfigList* (linked to the *SL-RadioBearerConfig* which matches the per-SLRB level QoS profile) as the first hop PC5 Relay RLC channel configuration.  - The SRAP entity of intermediate relay UE is updated with the mapping of this end-to-end Uu DRB to the corresponding PC5 Relay RLC channel.  ================================<next change>===================================== 5.8.9.7.2 PC5 Relay RLC channel addition/modification Upon PC5-RRC connection establishment between the L2 U2N Relay UE and L2 U2N Remote UE or between two Intermediate relay UEs, the L2 U2N Relay UE or Intermediate Relay UE shall:  1> establish a SRAP entity as specified in TS 38.351 [66], if no SRAP entity has been established;  1> apply RLC specified configuration of SL-RLC0 as specified in clause 9.1.1.4:  1> apply RLC default configuration of SL-RLC1 as defined in clause 9.2.4 if the L2 U2N Relay UE or Intermediate Relay UE is in RRC\_IDLE/INACTIVE state;  Upon PC5-RRC connection establishment between two UEs for L2 U2U relay operation, the L2 U2U Relay UE and the L2 U2U Remote UE shall:  1> establish a SRAP entity as specified in TS 38.351 [66], if no SRAP entity has been established;  1> apply RLC specified configuration of SL-U2U-RLC as specified in clause 9.1.1.4;  The UE shall:  1> if the PC5 Relay RLC channel addition/modification was triggered due to the reception of the *RRCReconfigurationSidelink* message; or  1> after receiving the *RRCReconfigurationCompleteSidelink* message, if the PC5 Relay RLC channel addition/modification was triggered due to the configuration received within the *sl-ConfigDedicatedNR*; or  1> after receiving the *RRCReconfigurationCompleteSidelink* message, if the PC5 Relay RLC channel addition/modification was triggered based on the derivation of PC5 Relay RLC channel configuration(s) for end-to-end sidelink DRB(s) or end-to-end Uu DRB as specified in 5.8.9.7.0:  2> if the current configuration contains a PC5 Relay RLC channel with the received *sl-RLC-ChannelID* or *sl-RLC-ChannelID-PC5*; or  2> if the configuration in *SIB12* or *SidelinkPreconfigNR* has updated, based on which the PC5 Relay RLC channel is derived:  3> reconfigure the sidelink RLC entity in accordance with the received *sl-RLC-Config* or *sl-RLC-ConfigPC5*;  3> reconfigure the sidelink MAC entity with a logical channel in accordance with the received *sl-MAC-LogicalChannelConfig* or *sl-MAC-LogicalChannelConfigPC5*;  2> else (a PC5 Relay RLC channel with the received *sl-RLC-ChannelID* or *sl-RLC-ChannelID-PC5* was not configured before):  3> establish a sidelink RLC entity in accordance with the received *sl-RLC-Config* (in *sl-ConfigDedicatedNR*, or *SIB12*, or *SidelinkPreconfigNR*) or *sl-RLC-ConfigPC5*;  3> configure the sidelink MAC entity with a logical channel in accordance with the received *sl-MAC-LogicalChannelConfig* or *sl-MAC-LogicalChannelConfigPC5*. |

**Figure 10: TP to 38.331 to enable Intermediate Relay UE derivation of PC5 Relay RLC channel and SRAP configuration (example)**

Note that if RAN2 agrees that intermediate relay UE in IDLE/INACTIVE shall only follow the SIB12 forwarded by the last relay UE of last relay’s serving cell (after the completion of SI forwarding in the baseline procedure), then SL preconfiguration will not be used and the above TP can be further modified to remove the pre-configuration case.

Based on the above analysis and example TP shown in Figure 10 , we collect company view on the specification impact regarding this aspect.

Question 4.1: Do you agree that PC5 RLC channel configuration and SRAP mapping has the impact on TS 38.331 (e.g., deriving configuration based on SIB and Pre-configuration as similar to L2 U2U relay)?

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No** | **Comments** |
| OPPO | See comments | The impact is more complex since:   * The QoS split in U2U is done by the relay UE, and it has only 2 hops. But for multi-hop U2N Relay, it has more than 2 hops and the QoS split is done by gNB; * Ericsson-> not sure how this would affect the TPs which are covered in this paper. Please to be more specific on the issues. * When intermediate relay trigger its own RRC connection, how to handle the RLC channel configuration/on going remote UE’s data needs to be discussed. This is not discussed in U2U Relay since there is no service continuity requirement for U2U Relay. * Ericsson-> for approach 2, if intermediate relay UE has to need to go to RRC\_CONNECTED, the intermediate relay UE can trigger its own RRC connection establishment when receiving remote UE’s SRB0 message, it is not restricted. If the intermediate relay UE chooses to not go to RRC\_CONNECTED when receiving remote UE’s SRB0 message, it must be due to that the intermediate relay UE has no need. We don’t see the scenario where the intermediate relay UE triggers to switch to RRC\_CONNECTED while serving remote UE’s relay session is a valid scenario. * When any of the QoS information is updated, the relay UE needs to process the whole QoS split procedure again and the update RLC channel accordingly. And how to perform QoS/BEARER/RLC channel addition/release/modification needs to be further discussed. * Ericsson-> the proposed TP already covers triggering due to any change of QoS split. There is no additional spec changes foreseen |
| ZTE | See comments | The proposed solution seems mimic U2U relay’s principle, which is totally different from approach1. Since approach1 has been agreed as a baseline procedure, we can not accept approach2 having such proposed spec impact. |
| Kyocera | Yes | We do agree that Intermediate relay UEs in IDLE/INACTIVE should only follow the SIB12 from the last relay UE. This would mean the pre-configuration should not be applied in case the Intermediate relay UE is in coverage of a cell different from the last relay UE’s serving cell. |
| Sharp | Yes, with comment | If it is needed, U2U relay mechanism should be baseline. |
| Ericsson | Yes | The proposed changes to allow reusing of the existing U2U framework without affecting U2N framework baseline approach. the proposed TPs are reasonable from limiting spec changes perspective. |
| LG | See comments | We have similar concern as OPPO and ZTE. The legacy U2U relay operation considered only two hops and didn’t consider service continuity. Approach 2 is totally different from the approach 1 and legacy U2U operation. Considering time budget for Rel-19 U2N WID and the spec impact of the approach 2, we wouldn’t like to agree to keep proceeding the approach 2. |
| InterDigital | Yes | We agree with specification impact presented. Discussion and specification impact of this would be minimized considering the same has already been discussed in U2U. |
| Huawei, HiSilicon | See Comments | Similar concerns as Oppo, ZTE and LG  If we mimic the U2N principle for multi-hop relays, the remote UE would connect to the last relay UE using a mechanism similar to the U2U relay. If there is only one relay UE between the remote UE and the last relay UE, the U2U relay mechanism can be reused. However, to support two or more additional hops, RAN2 will need to discuss multi-hop U2U relays first, which is outside the scope of the current WID.  We cannot accept mixing elements of both U2U and U2N principles to design multi-hop relays, as these two mechanisms are very different and it would introduce unnecessary complexity.  Furthermore, we need to consider the behavior of the intermediate relay UE before and after it establishes an RRC connection through a cell controlled by a different gNB—one that the UE was camped on or uses for its own traffic transfer. Additionally, we must address how RLC channel configuration should be handled before and after the RRC connection |
| Qualcomm | Yes | Generally agree with the spec impact, but need to further clarify which cell’s SIB is used. |
| vivo | Yes with comments | We agree with the principle that if we go for approach 2 we can use the U2U principle as baseline to minimize the spec impact.  From this point of view the spec impact seems fine but the only question is whether it is enough to make approach 2 workable, and we have similar concern on this as raise by OPPO. |

Question 4.2: Any other specification impact to enable intermediate relay UE to determine its own PC5 Relay RLC channel configuration?

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| OPPO | See above reply |
| ZTE | Same comments for Q3.2 |
| LG | See the above comment. |
| Huawei, HiSilcon | See reply above |

## 2.5 Authorization of IDLE/INACTIVE intermediate relay UE(s)

In [3], it is manifested that RRC\_INACTIVE state intermediate Relay UE should be allowed to operate based on prior authorization. It is feasible to have an intermediate UE staying in RRC\_INACTIVE for Approach 2. The UE can be authorized when the intermediate UE was in RRC\_CONNECTED (i.e., before transiting to RRC\_INACTIVE). We can first check company view on this:

Question 5.1: Do you agree “Intermediate relay UE could be authorized to work for multi-hop U2N relay and stay in RRC\_INACTIVE )” for Approach 2?

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No** | **Comments** |
| OPPO | See comments | This cannot be answered/decided in RAN2 since authorization is agreed/designed by SA2 and RAN3. |
| ZTE | See comments | First, this should be discussed in SA2.  Secondly, SA2 has made conclusion on authorization and we have received the corresponding agreements in SA2’s LS. I think we should follow the conclusion as much as possible. Any change on current SA2’s conclusion should be avoided. |
| Kyocera | Yes |  |
| Sharp | Yes, but | IDLE/INACTIVE UEs use pre-configured authorization/policy and CONNECTED UEs use received authorization/policy from NW. And CONNECTED UEs can receive updated policy from NW. Therefore, there may be different policies (e.g. max hop number) which may break the path. It may be a potential issue.  Anyway, this issue should not be discussed in RAN2. |
| Ericsson | Yes | While the intermediate relay UE is in RRC\_CONNECTED, the UE can be authorized. The related information can be stored at the gNB. There is no additional spec change/signaling exchanges to the gNB regarding the relay UE’s authorization information, when the intermediate relay UE transits to RRC\_INACTIVE. |
| LG | See comments | Same view as OPPO and ZTE. RAN2 can not answer this authorization issue. We needs to send an LS to SA2 or SA3. |
| InterDigital | Yes | At least for RRC\_INACTIVE case, the context of the UE is maintained, so there is no need to ask SA2/SA3 for this case (it is based on the baseline assumptions of authorization).  If we want to further support RRC\_IDLE, we can confirm with SA2/SA3. Alternatively, we can target approach 2 for RRC\_INACTIVE only. |
| Huawei, HiSilicon | See comments | Agree with OPPO and ZTE.  Furthermore if the intermediate relay UE was initially connected to a cell/gNB that authorized it for multi-hop relay operation and then moved it to RRC\_INACTIVE, is it certainly not authorized to transfer traffic for a remote UE to a different gNB as this gNB cannot have any information about this UEs authorisation.  If it is under the same cell/ gNB, it is unclear what would be the motivation for the gNB to move the intermediate relay UE to RRC\_INACTIVE state when the connected Remote UEs are in RRC\_CONNECTED state. |
| Qualcomm | Yes for Inactive state | Yes for Inactive state. Can ask SA3 for the need if IDLE state. |
| vivo | See comments | Agree to further check with SA2 if we agree to go for approach 2. |

Then, whether IDLE state of intermediate relay UE is supported or not, we can further check other working groups e.g., SA2 and SA3. But there seems no major specification impact which needs a TP to illustrate. There may be a need to single out “INACTIVE” state when describing the Approach 2 procedures occurring in the Intermediate Relay UE if IDLE state is not supported, which is quite trivial. There could be some upper layer specification impact to enable IDLE Intermediate relay UE authorization. But as far as in AS layer specifications, there seems hardly any major impact worth identifying.

Based on the above analysis, we collect company view on the specification impact regarding this aspect.

Question 5.2: Do you agree “if approach 2 is adopted, intermediate relay UE authorization issue may only have some trivial impact in AS layer specification”?

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No** | **If no, please identify the AS layer spec impact** |
| OPPO | See comments | We understand the most important thing is to keep our design align with other working groups and don’t make contradict conclusions. SA2 has already agree the authorization of L2 intermediate relay UE at gNB, and the LS has been sent to RAN3. So we should not make contradict conclusion just because “it may have trivial impact to our specification”. It has big impact to other WGs (SA2/RAN3), especially considering SA2 R19 Prose WI is closed. |
| ZTE | No | “trivial impact in AS layer specification” is an incorrect description. We shall not consider authorization issue is a trivial issue in AS layer. From wording change perspective, authorization may have small impact. But authorization is the premise of the whole RAN work, especially for Uu service. The proposed solution(based on prior authorization) means the network can not perform authorization verification. Operator will not accept such solution, especially for public safety.  Furthermore, it’s FFS on whether/how to handle authorization state change for approache2.  [Rapp: I understand this has impact on other WG and other specifications. It would be helpful to identify any “non-trivial” part in RAN2 spec if there is any. |
| Kyocera | Yes |  |
| Ericsson | Yes | Agree with Rapp that there is little/trivial impact to the gNB regarding authorization of intermediate relay UE in RRC\_IDLE. The authorization is performed between the UE and the CN. The intermediate relay UE in RRC\_IDLE can be authorized via the information stored/preconfigured in the UE.  But, if there is majority view, whether there is a concern on authorization to allow an RRC\_IDLE intermediate UE can be checked with SA2 and SA3. RAN2 can only work on mechanisms to support RRC\_IDLE intermediate UE if SA2 and SA3 indicates there is no authorization concern to doing so. |
| LG | No | Even the authorization issue is a trivial issue on RAN2 spec, it definitely will affect the other RAN group. We don’t think this issue is trivial in that it could affect to the other working group as well. So, we cannot say simply whether this issue is trivial in AS spec. We should consider the effect of the other working group. |
| NEC | Yes |  |
| InterDigital | Yes | Agree with rapporteur, that minimal changes are needed for RRC\_INACTIVE. For RRC\_IDLE, we can check with SA2/SA3 before making any changes in RAN2. |
| Huawei, HiSilicon | No | SA2 has clearly stated in their LS that the authorization for a UE to act as a 5G ProSe Layer-2 Intermediate UE-to-Network Relay is provided by the AMF to the NG-RAN during every IDLE to CONNECTED transition for Layer-2 multi-hop UE-to-Network relay operations. This authorization can also be revoked during the ongoing connection. Therefore, we cannot accept any unauthorized IDLE UEs participating in U2N network relay operations without the network's knowledge.  If we go with agree to approach 2, any authorization impacts for Approach 2 will have system-wide effects, including on both RAN and CN nodes. SA2 and SA3 will need to develop new mechanisms to authorize IDLE mode UEs as multi-hop relay UEs, which cannot be accomplished within the R19 timeframe |
| Qualcomm | Yes |  |
| vivo | No | We understand this cannot be answered right now, we need to further check the impacts by asking SA2 first and then we can evaluate the AS layer impact. |

## 2.6 Service Continuity

Based on the service continuity objective of Rel-19 Multi-hop SL Relay WID [4] as below:

|  |
| --- |
| 2 Specify the following intra-gNB service continuity scenarios for multi-hop U2N relay based on Rel-17/18 procedures (for remote UE):  **First Priority:**   1. Intra-gNB multi-hop indirect to direct path switching using existing framework 2. Intra-gNB multi-hop indirect to single-hop indirect path switching using existing framework   **Second Priority in order of importance:**   1. Intra-gNB direct to multi-hop indirect path switching 2. Intra-gNB single-hop indirect to multi-hop indirect path switching   The scenarios C and D are limited to path switching to a target indirect path consisting of the last relay UE in “direct” RRC Connected mode and all the other intermediate relay(s) in “indirect” RRC Connected mode to the same cell. |

We assume RAN2 has no intention to update the WID for enabling Approach 2 for Scenario C/D. Hence, there would be no spec impact regarding of scenario C/D for “Connected” path because Approach 2 will not occur in those handover cases. To be more specific:

1. For any hand-over triggered by HO command, the remote UE will send SL-RLC1 message in the selected target path towards a target relay UE, and this would force the legacy procedure (i.e., trigger the target relay UE entering CONNECTED and same for the upstream relay UE(s) along the path, which is part of baseline procedure.
2. Based on gNB implementation, gNB can avoid selecting the INACTIVE relay UE because the gNB has the relay UE context (assuming only INACTIVE relay UE will be allowed for Approach 2).

None of the above seems to have any additional spec impact or need a TP to illustrate.

Based on the above analysis, we collect company view on the specification impact regarding this aspect.

Question 6.1: Do you agree “WID only allows the remote UE to be handed over to a “Connected” path in Scenario C/D, relay UE(s) in the target path will be triggered to enter RRC\_CONNECTED as legacy procedure, so there is no any additional specification impact as Approach 2 is not used” ?

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No** | **If no, please identify the AS layer spec impact** |
| OPPO | No | We understand the issue for service continuity in approach is not just it doesn’t align with WID:   * For all the service continuity scenarios, the legacy principle not only for relay but also for NR, the connected state UE’s mobility is controlled by the NW. In approach-2, when the remote UE is RRC connected while the intermediate relay is not, it means NW needs to control the remote UE via the out-of-control intermediate relay UE. Which cannot be achieved. * For scenario C/D, our understanding of the restriction in the WID is not “relay UE(s) in the target path will be triggered to enter RRC\_CONNECTED”, but the relay UE(s) in the target path should be in RRC connected state already since the intention of this restriction is to avoid the complexity of triggering relay UE(s) to enter RRC\_CONNECTED. This cannot be supported by a Approach-2 based relay system. * [[Rapp: I understand this is not supported in WID for Sceneairo C/Ds. It would be helpful to identify any spec impact in RAN2 spec if there is a need to exclude this case. The rapporteur understands that excluding this can be based on gNB implementation’] |
| ZTE | No | If we agree that gNB will not select a inactive UE or IDLE/INACTIVE UE will be triggered to enter into connected state during HO, then we do not see too much benefits to support approach2. I believe for better QoS control, service continuity and authorization, gNB will trigger HO if remote UE is in approch2, so that approach2 becomes useless.  [Rapp: The question is not soliciting a debate of usefulness of Approach 2. It would be helpful to identify any spec impact in RAN2 spec if there is a need to exclude this case. The rapporteur understands that excluding this can be based on gNB implementation]  ZTE: I mean if we want to support approach2, such restriction “ select only target consisting of only connected relay” is unreasonable, as is said above, network will anyway hand over the remote UE to a target path having only connected relay UE. In other words, I think if we want support approach2, WID update is needed. |
| Kyocera | See comments | We have the same understanding as OPPO, that scenarios C/D assumes the target relay UEs are already in RRC CONN, so it shouldn’t be triggered into RRC CONN. However, in our understanding Approach 2 is not limited to only the case when intermediate relay UEs are in IDLE/INACTIVE, but RRC CONN as well. Therefore, we assume Scenario C/D can still apply to Approach 2, but limited to the case when the target relay UEs are in RRC CONN. |
| Sharp | Yes, with comment | In our understanding, WID only allows the remote UE to be handed over from “connected” path in scenario A/B. In case of I2I path switching gNB ensures that there is no packet loss while path switching i.e. gNB de-configures source path configuration after gNB receives all UL data from the source path. If it is approach 2, IDLE/INACTIVE UE de-configure relay configuration by UE implementation. Therefore, approach 2 cannot support service continuity scenario A/B in addition to scenario C/D. |
| Ericsson | Yes |  |
| LG | No | We think this is not just the problem whether the WID changes or not.  If the gNB force the target path to be in RRC\_CONNECTED, how to handle the increased latency caused by this procedure?  If there is no proper target path, which all the intermediate Relay UEs on the target path are not in RRC\_CONNECTED, the gNB cannot select the target path. We think this situation should be avoided. How to avoid this situation? |
| InterDigital | Yes | If the network wants to perform mobility in C/D, it will trigger the intermediate relay UEs in RRC\_CONNECTED. This has no impact on Approach 2 specification. |
| Huawei, HiSilicon | No | It is clear that scenario C/D cannot be supported by Approach 2. This is because the serving gNB has no control over the intermediate relay UE , which might be controlled by different gNB.  Therefore, this is not just a matter of RAN2 spec impacts. It is clear that Approach 2 does not meet the WID requirements, while Approach 1 does.  Then the real question is whether it is worth implementing a solution like Approach 2, which is limited to the potential enhancement to connection establishment procedure. |
| Qualcomm | See comments | There are different understanding about the restriction in the WID   * Understanding 1: All the relay UE on the candidate path should be CONNECTED state before Remote UE performs path switching. * Understanding 2: All the relay UE on the candidate path should enter CONNECTED state after Remote UE performs path switching.   If understanding 1, then this will also impact approach 1 that during target path selection relay UE RRC state has to be considered.  If understanding 2, then no impact on approach 2, that means during service continuity C/D, fallback to baseline procedure. |
| vivo | Yes with comments | To be fair that if we understand the WID in that way then we could of course say ‘no further spec impact’.  But we agree with companies that the key point here is if we totally avoid the discussion on service continuity for approach 2 then the benefit of approach 2 is reduced also and as Huawei mentions we are not sure about the benefits of implementing such a solution. |

3 Conclusion

This contribution makes the following proposals:

TBD

# 4 References

1. RAN2#128 Chairman Notes

[2] R2-2500433 Discussion on Control Plane for Multi-hop UE-to-NW Relay Apple discussion Rel-19 NR\_SL\_relay\_multihop

[3] R2-2500864 on control plane procedures Ericsson, Apple, AT&T, InterDigital Inc, FirstNet, Qualcomm Incorporated discussion Rel-19 NR\_SL\_relay\_multihop

[4] RP-243326 Rel-19 WID Revised WID on NR sidelink multi-hop relay

[5] RAN2#129 Chairman Notes