**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

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# 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:

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| *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.

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| 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 ?

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| **Companies** | **Yes or No** | **Comments** |
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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?

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## 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:

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| 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*

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| 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.

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**Figure 3: SRAP PDU format with a variant of SRAP header for MH U2N Relay (Example)**

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:

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| =================================== <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.

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| 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 in UL 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)

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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?

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## 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.

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**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:

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| --- | --- | --- | --- | --- | --- | --- |
| ====================================<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.

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| ================================ <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:

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| 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*

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| <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)

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| **Companies** | **Yes or No** | **Comments** |
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Question 3.2: Any other specification impact to enable gNB configuration of QoS split for IDLE/INACTIVE intermediate relay UE?

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| **Companies** | **Comments** |
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## 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:

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| ================================<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*/Preconfiguration, 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)?

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| **Companies** | **Yes or No** | **Comments** |
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Question 4.2: Any other specification impact to enable intermediate relay UE to determine its own PC5 Relay RLC channel configuration?

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| **Companies** | **Comments** |
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## 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?

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| **Companies** | **Yes or No** | **Comments** |
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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”?

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| **Companies** | **Yes or No** | **If no, please identify the AS layer spec impact** |
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## 2.6 Service Continuity

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

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| 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” ?

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| **Companies** | **Yes or No** | **If no, please identify the AS layer spec impact** |
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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