3GPP TSG-RAN WG2 Meeting #116bis Electronic R2-220xxxx

Online, 17 – 25 Jan 2022

**Agenda item: 8.7.2.1**

**Source: Huawei, HiSilicon**

**Title: Summary of [AT116bis-e][608][Relay] RAN sharing (Huawei)**

**Document for: Discussion and Decision**

# 1 Introduction

This document is the summary report of the following offline discussion:

* [AT116bis-e][608][Relay] RAN sharing (Huawei)

Scope: Discuss the issue of RAN sharing for relays, taking into account the related parts of contributions from AI 8.7.2.1. Conclude on what will be supported and analyse spec impact (conclusions to be taken into account by rapporteurs of affected running CRs).

Intended outcome: Report to Tuesday CB session

Deadline: Monday 2022-01-24 1800 UTC

The rapporteur would like to suggest an intermediate deadline for companies' feedback: Friday 2022-01-21 1800 UTC. The summary and proposals will be provided in Monday morning for further review before the CB session.

# 2 Contact Points

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# 3 Discussion

RAN2 has discussed RAN sharing in last meeting, but no consensus was achieved. In this meeting, several contributions discussed whether and how to support RAN sharing as well as the potential RAN2 spec impact from the following aspects:

**SA2 aspects**

* Authorization of Relay UE and Remote UE, Security procedure of Relay UE and Remote UE, PLMN selection of Remote UE
* Relay and Remote UE’s PDU session Setup towards different PLMN

**RAN2 aspects**

* Access control (including UAC parameters), as well as TAC/Cell Identity
* Uu radio resources and PC5 Radio Resources allocation
* Mobility
* Stage 3 signalling of PLMN list broadcasting

**Other aspects**

* Use of PLMN specific features

**RAN sharing support in RAN2**

## 3.1 SA2 aspects

Although those aspects are in the SA2 scope, considering companies may think the SA2 design would bring RAN2 impact, we can have a general discussion to align companies’ understanding.

### 3.1.1 Authorization of Relay UE and Remote UE, Security procedure of Relay UE and Remote UE, PLMN selection of Remote UE

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| R2-2200552 MediaTek Inc., CATT, OPPO, Qualcomm Incorporated, ZTE, Huawei, HiSilicon, Apple, InterDigital | PLMN based authorization  Meanwhile, from relay discovery perspective, the current procedure can already support the distribution of PLMN information during discovery procedure (governed by SA2). By the way, PLMN based authorization for relaying operation is supported regardless whether there is RAN sharing or not.  Remote UE's PLMN selection in case of RAN sharing  During relaying operation in RAN sharing scenario, the selection of PLMN by Remote UE should be transparent to Relay UE, since this is out of Relay UE’s responsibility.  In case of RAN sharing, the Remote UE may select a PLMN is that is different from the R-PLMN from Relay UE. We did not see a reason for Remote UE to ask Relay UE to approve its PLMN selection, or vice versa. In practice, the PLMN serving the Remote UE may be different from the one serving the Relay UE. In addition, the NAS based PLMN selection is not a discussion in RAN2 scope.  Security  In case of RAN sharing or non-RAN sharing scenario, Remote UE and Relay UE run the security procedure independently. The key derivation should be dominated by the PLMN they selected. Although this is an area for SA3, we do not see any special handling needed for the case of RAN sharing. |
| R2-2200946 Nokia Shanghai Bell | The relay and the remote UEs should be authorized for relay services. This authorization may be PLMN specific. If the remote UE and the relay UE are registered to a different PLMNs then they may use authorizations that are not valid for the PLMN of the other UE. E.g., the discovery code from the operator of the relay UE is used to establish the relay connection towards another operator selected by the remote UE. This is an issue that SA2, and SA3 should investigate before standardizing the support of this scenario. Our view is that RAN2 should send an LS to SA2 and SA3 if it is decided to support this scenario. |
| R2-2201158 Ericsson | There are no guarantees that the Remote UE’s selected PLMN would even be allowed for the Relay UE  Security procedures (also affecting SA2/SA3) towards different CNs are not clear. |
| R2-2200166 CATT | Since RAN sharing has been supported in Rel-15, the effects due to RAN sharing mainly in the core network, such as remote UE’s PLMN selection and authorizations. Therefore, it is unnecessary to exclude RAN sharing for L2 U2N relay in Rel-17 from RAN2’s perspective.  Proposal 2: It is unnecessary to exclude RAN sharing from RAN2 perspective. |

In general, R2-2200946 and R2-2201158 raises concerns that there might be issues for authorization, security and PLMN selection for RAN sharing scenario, particularly when the Remote UE registers to a different PLMN from Relay UE’s PLMN, while R2-2200552 and R2-2200166 give some analyse and conclude there is no RAN impact on those aspects.

In the rapporteur’s understanding, the general architecture and procedures in TS 23.304 support RAN sharing with the unified solutions/procedures specified for non-RAN sharing cases, i.e. there is no PLMN specific authorization/security procedure/PLMN selection for RAN sharing case. Thus there is no particular issue on those aspects from RAN2 point of view as well. The detailed analyses are as below:

**Regarding RAN sharing support:** It clearly states that Relay UE and Remote UE can access and be service by different PLMNs in case of RAN is shared by MOCN architecture.

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| Excerpt from TS 23.304  4.2.7.2 5G ProSe Layer-2 UE-to-Network Relay reference architecture  Figure 4.2.7.2-1 shows the 5G ProSe Layer-2 UE-to-Network Relay reference architecture. The 5G ProSe Layer-2 Remote UE and 5G ProSe Layer-2 UE-to-Network Relay may be served by the same or different PLMNs. If the serving PLMNs of the 5G ProSe Layer-2 Remote UE and the 5G ProSe Layer-2UE-to-Network Relay are different then NG-RAN is shared by the serving PLMNs, see the 5G MOCN architecture in clause 5.18 of TS 23.501 [4]. |

**Regarding authorization of Relay UE and Remote UE**, the follow observations can be made according to 5.1 Authorization and Provisioning for ProSe service:

* Authorization of Relay UE: A UE is authorized in which PLMN networks it can act as a Relay, i.e. it allows the Relay UE act as a Relay as long as Relay’s registered PLMN is authorized PLMN.
* Authorization of Remote UE: A UE is authorized in which PLMN networks it can access 5GC via an U2N Relay, i.e. the Remote UE is allowed to discover a Relay UE as long as Remote’s registered PLMN is authorized PLMN.
* No combined authorization of Remote UE and Relay UE.
* No per PLMN specific design on authorization for RAN sharing case or non-RAN sharing case.

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| Excerpt from TS 23.304  5.1 Authorization and Provisioning for ProSe service  …  - The PCF in the HPLMN may configure a list of PLMNs where the UE is authorised to act as 5G ProSe UE-to-Network Relay. Authorisation for 5G ProSe Layer-2 UE-to-Network Relay and 5G ProSe Layer-3 UE-to-Network Relay are independent of each other.  - The PCF in the HPLMN may configure a list of PLMNs where the UE is authorised to access 5GC via 5G ProSe UE-to-Network Relay (i.e. to act as 5G ProSe Remote UE). Authorisation to access via 5G ProSe Layer-2 UE-to-Network Relay and via 5G ProSe Layer-3 UE-to-Network Relay are independent of each other. |

**Regarding security procedure of Relay UE and Remote UE**, we can see during authorization the Relay /Remote UE is provided with RSC and corresponding security related content as well, which means the Relay/Remote UE is allowed to perform discovery and establish security based on the provided RSC(s) in the authorized PLMN(s). No per PLMN specific procedure or requirement of security defined for RAN sharing case or non-RAN sharing case.

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| Excerpt from TS 23.304  5.1.4 Authorization and Provisioning for 5G ProSe UE-to-Network Relay  …  The following information is provisioned in the UE in support of the UE assuming the role of a 5G ProSe UE-to-Network Relay:  …  2) ProSe Relay Discovery policy/parameters for 5G ProSe UE-to-Network Relay:  - Includes the parameters that enable the UE to perform 5G ProSe UE-to-Network Relay Discovery when provided by PCF or provisioned in the ME or configured in the UICC:  - 5G ProSe UE-to-Network Relay Discovery parameters (User Info ID, Relay Service Code(s), UE-to-Network Relay Layer Indicator(s)); the UE-to-Network Relay Layer Indicator indicates whether a particular RSC is offering 5G ProSe Layer-2 or Layer-3 UE-to-Network Relay service.  …  - Includes security related content for 5G ProSe UE-to-Network Relay Discovery for each ProSe Relay Service Code.  …  The following information is provisioned in the UE in support of the UE assuming the role of a 5G ProSe Remote UE and thereby enabling the use of a 5G ProSe UE-to-Network Relay:  …  2) Policy/parameters for 5G ProSe UE-to-Network Relay Discovery:  - Includes the parameters for 5G ProSe Relay Discovery and for enabling the UE to connect to the 5G ProSe UE-to-Network Relay after discovery when provided by PCF or provisioned in the ME or configured in the UICC:  - 5G ProSe UE-to-Network Relay Discovery parameters (User Info ID, Relay Service Code(s), UE-to-Network Relay Layer indicator(s)); the UE-to-Network Relay Layer Indicator indicates whether a particular RSC is offering 5G ProSe Layer-2 or Layer-3 UE-to-Network Relay service.  …  - Includes security related content for 5G ProSe UE-to-Network Relay Discovery for each ProSe Relay Service Codes. |

**Regarding PLMN selection of Remote UE**, the Relay UE would advertise the PLMN(s) supported by its serving cell to the Remote UE, and Remote UE checks whether there is authorized PLMN which can be considered as available PLMN for the NAS PLMN selection as legacy. Then except the PLMNs advertising which would be discussed in RAN2 aspects, there is no new thing required.

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| Excerpt from TS 23.304  5.4.2 5G ProSe Layer-2 UE-to-Network Relay  …  For PLMN selection and relay selection in the 5G ProSe Layer-2 Remote UE:  - The 5G ProSe Layer-2 Remote UE checks whether the PLMN(s) supported by the serving cell of the 5G ProSe Layer-2 UE-to-Network Relay(s) are authorized to be connected to via a 5G ProSe Layer-2 UE-to-Network Relay(s), and only the authorized PLMN(s) are then available PLMNs for NAS PLMN selection;  - The 5G ProSe Layer-2 Remote UE selects the 5G ProSe Layer-2 UE-to-Network Relay considering the selected PLMN by NAS layer. |

**Observation 1: According to SA2 TS 23.304, the L2 U2N Relay UE and L2 U2N Remote UE are allowed to be served by the same or different PLMNs.**

**Observation 2: Regarding authorization and security procedure of Relay UE and Remote UE as well as PLMN selection of Remote UE in L2 U2N relay operation, according to SA2 TS 23.304 there is no PLMN specific handling and thus no corresponding RAN2 impact.**

**Question 1: Do companies agree with O1 and O2, i.e. there is no RAN2 impact (except PLMN list broadcasted in RAN) to support authorization/security procedure/PLMN selection in case of Remote UE register a different PLMN from Relay UE’s PLMN?**

If companies provide answer no, please indicate what explicit RAN2 impact would be in the comment column.

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| Company | Yes/No | Comments |
| InterDigital | Yes |  |
| MediaTek | Yes |  |
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### 3.1.2 Relay and Remote UE’s PDU session Setup towards different PLMN

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| R2-2200552 MediaTek Inc., CATT, OPPO, Qualcomm Incorporated, ZTE, Huawei, HiSilicon, Apple, InterDigital | We think that Relay UE and Remote UE perform the PDU session establishment independently. Relay UE is only responsible to bridge the communication between the Remote UE and the gNB, and then Remote UE should establish the PDU session with its selected 5GC via legacy procedure. Such NAS layer procedure (i.e. PDU session establishment) is managed by SA2/CT1. |
| R2-2201158 Ericsson | How is the Relay UE expected to set up PDU session towards a PLMN that is different from its RPLMN? The Remote UE’s choice of PLMN can’t dictate the Relay UEs PLMN selection. |

As clarified in R2-2200552, the Relay UE and Remote UE have its own NAS connection and PDU sessions. The PDU session setup for Relay UE and Remote UE are indecently and supported by existing procedures. No special impact in both RAN2 and SA2 is foreseen.

**Question 2: Do companies agree that there is no RAN2 impact to allow Relay and Remote UE’s PDU session Setup towards different PLMNs based on existing PDU session management procedures?**

If companies provide answer no, please indicate what explicit RAN2 impact would be in the comment column.

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| Company | Yes/No | Comments |
| InterDigital | Yes |  |
| MediaTek | Yes |  |
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## 3.2 RAN2 aspects

### 3.2.1 Access control (including UAC parameters), TAC, Cell Identity

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| R2-2200552 MediaTek Inc., CATT, OPPO, Qualcomm Incorporated, ZTE, Huawei, HiSilicon, Apple, InterDigital | The current UAC-based cell barring mechanism is designed based on PLMNs. In SIB1, the parameter uac-BarringPerPLMN-List is defined within the uac-BarringInfo. The IE UAC-BarringPerPLMN-List provides access category specific access control parameters, which are configured per PLMN/SNPN  It should be noted that, as agreed by RAN2 before, legacy UAC mechanism would be reused for L2 relay operation, i.e. the U2N Remote UE performs unified access control as defined in TS 38.331. The U2N Relay UE in RRC\_CONNECTED does not perform UAC for U2N Remote UE’s data. The legacy UAC has already supported the case of RAN sharing.  The same analysis can apply to TAC and cell ID. |
| R2-2200946 Nokia Shanghai Bell | The basic issue is the resources of which PLMNs are used by the radio bearers used for relayed traffic, as in shared cells a gNB may enforce PLMN specific resource limitations. Those bearers may be simply considered Uu bearers of the relay UE, and thus they may be considered to use the resources of the PLMN of the relay UE. When a new session is created for a remote UE, the access control (UAC) is performed by the remote UE based on the UAC parameters of the PLMN of the remote UE, and this may lead to inconsistent behaviour. If these radio bearers are considered to use the radio resources of the PLMN of the remote UE then multiplexing of traffic from different remote UEs can be a problem. |
| R2-2201158 | o UAC, TAC and cell ID are parameters that can be PLMN specific, so it needs to be sorted out which ones are going to be used when relay UE establish a connection |

As clarified in R2-2200552, in Uu the UAC parameters, TAC, Cell Identity are provided per-PLMN in SIB1. By supporting SIB forwarding including SIB1, the per-PLMN parameters are already available to Remote UE from signalling point of view. Then similar as the discussion on authorization, the Relay UE is assumed to advertise the configuration of PLMNs supported by its serving cell. Thus the Relay UE should forwards the existing parameters in SIB1 without sorting or filtering according to its registered PLMN. No RAN2 impact foreseen to obtain Remote UE’s UAC parameters, TAC, Cell Identity and other per PLMN parameters in SIB on top of the SIB request/forwarding.

**Question 3: Do companies agree that there is no extra RAN2 impact to provide per-PLMN parameters in SIB including UAC parameters, TAU, Cell Identity to the Remote UE on top of SIB request/forwarding procedures?**

If companies provide answer no, please indicate what explicit RAN2 impact would be in the comment column.

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| Company | Yes/No | Comments |
| InterDigital | Yes |  |
| MediaTek | Yes |  |
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### 3.2.2 Uu radio resources and PC5 Radio Resources allocation

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| R2-2200946 Nokia Shanghai Bell | The basic issue is the resources of which PLMNs are used by the radio bearers used for relayed traffic, as in shared cells a gNB may enforce PLMN specific resource limitations. Those bearers may be simply considered Uu bearers of the relay UE, and thus they may be considered to use the resources of the PLMN of the relay UE. When a new session is created for a remote UE, the access control (UAC) is performed by the remote UE based on the UAC parameters of the PLMN of the remote UE, and this may lead to inconsistent behaviour. If these radio bearers are considered to use the radio resources of the PLMN of the remote UE then multiplexing of traffic from different remote UEs can be a problem.  The remote UE and relay UE use PC5 resource allocation based on the parameters that are provided by different PLMNs. The PC5 resource coordination among PLMNs has not been standardized and there is no intention to standardize it. Therefore, from standardization perspective this is not an issue, but there may be deployment issues that operators of shared cells should considered. |

For radio resource management, in general there is no spec restriction on per-PLMN radio resource usage for RAN sharing/MOCN scenario (which literally means the gNB and the carrier are shared by operators), but it is allowed to perform per-PLMN configuration by network implementation if needed. Then in L2 U2N relay operation, the gNB is aware of the selected PLMN of Relay UE and Remote UE from msg5 and the Uu bearer/PC5 bearer carrying Remote UE’s service as well as the bearer mapping at Relay UE are configured by the gNB, the gNB is still able to provide per-PLMN configuration, e.g. some Uu RLC bearers can be PLMN exclusive (i.e. not shared with other PLMN’s traffic).

**Question 4: Do companies agree that there is no need to specify new RAN2 solutions to provide PLMN specific Uu and PC5 radio resource configuration for L2 U2N Relay operation?**

If companies provide answer no, please indicate what RAN2 solution/impact would be in the comment column.

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| InterDigital | Yes |  |
| MediaTek | Yes |  |
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### 3.2.3 Mobility

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| R2-2200552 MediaTek Inc., CATT, OPPO, Qualcomm Incorporated, ZTE, Huawei, HiSilicon, Apple, InterDigital | For idle mode based mobility, Remote UE and Relay UE operate independently for both non-RAN sharing and RAN sharing scenarios, where Remote UE and Relay UE may have different RPLMNs.  In case of RAN sharing, for connected mode based mobility for Relay UE, it follows the legacy behavior; for connected mode based mobility for Remote UE, there is no PLMN change during service continuity, which is true for both indirect-direct and direct-indirect path switch. |
| R2-2200946 Nokia Shanghai Bell | Path swich between the direct and indirect paths may means "inter-PLMN path switch", and therefore it requires additional investigations if this has any specification impacts. |

As analysed in R2-2200552, the path switch from direct to indirect or from indirect to direct is controlled by gNB and restricted to intra-gNB case, Remote UE’s PLMN won’t change during such procedures. Thus no RAN sharing specific impact needs to be considered.

**Question 5: Do companies agree that there is no RAN sharing specific impact needs to be considered by RAN2 for L2 U2N mobility?**

If companies provide answer no, please indicate what RAN2 impact would be in the comment column.

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| InterDigital | Yes |  |
| MediaTek | Yes |  |
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### 3.2.4 Stage 3 signalling of PLMN list broadcasting

Related to the “WA: cellAccessRelatedInfo from SIB1 is forwarded before PC5-RRC connection. FFS the exact signalling.” made in RAN2 #116 meeting, the contributions below give proposals on how to signal the PLMN list in cellAccessRelatedInfo.

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| R2-2200173 Qualcomm Incorporated | Proposal 9: Confirm the WA that cellAccessRelatedInfo from SIB1 is forwarded before PC5-RRC connection, no matter whether RAN sharing is supported or not in L2 relay  Proposal 10: cellAccessRelatedInfo from SIB1 is included in a RRC container of primary discovery message (i.e., not in “Relay Discovery Additional Information”) |
| R2-2200372 OPPO | Proposal 1 If the WA on cellAccessRelatedInfo forwarding before PC5-RRC connection is confirmed, RRC container in discovery is used to carry the SI before PC5-RRC connection. |
| R2-2200475 vivo | Proposal 9: RAN2 to discuss which option is preferred to include PLMN ID list in discovery message.   * Option 1: an RRC container, which may reuse plmn-IdentityInfoList included in cellAccessRelatedInfo; * Option 2: an additional IE explicitly included in Relay Discovery Additional Information.   Proposal 10: Send an LS to SA2, if any option is agreed in Proposal 9. |
| R2-2200166 CATT | Proposal 3: RAN2 confirms cellAccessRelatedInfo from SIB1 is forwarded before PC5-RRC connection establishment.  Proposal 4: Relay forwards cellAccessRelatedInfo from SIB1 to the remote UE by discovery message.  Proposal 5: RAN2 sends LS to SA2 to inform that cellAccessRelatedInfo should be included in the discovery message from relay UE to remote UE. |

All the proposals suggest to confirm the WA of forwarding cellAccessRelatedInfo from SIB1 for RAN sharing case (if supported) by discovery message. R2-2200173 and R2-2200372 propose RRC container to include the information, while R2-2200475 is open to RRC container or explicit IE. R2-2200173 propose primary discovery message, while R2-2200475 also consider additional discovery message. As the similar discussion is on-going for non-RAN sharing case, the same signalling design could apply to this RAN sharing case if RAN2 can conclude to support.

**Question 6: Do companies agree that cellAccessRelatedInfo from SIB1 is forwarded before PC5-RRC connection for RAN sharing case (if supported)? The same signalling design agreed for non-RAN sharing case should apply to this RAN sharing case?**

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| Company | Yes/No | Comments |
| InterDigital | Yes | We can confirm the working assumption. |
| MediaTek | Yes | We can confirm the working assumption. |
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## 3.3 Other aspects

### 3.3.1 Use of PLMN specific features

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| R2-2200946 Nokia Shanghai Bell | There can be PLMN specific features that may only be used in the shared cell by UEs connected to certain PLMN. The issue in this case is which PLMN should be considered by the remote UE: its own PLMN or the PLMN of the relay UE or both. |

In L2 U2N relay operation, Remote UE can establish its own NAS connection and RRC connection via Relay UE, and the existing NAS procedure and RRC procedures are supported in legacy way. It should not be a problem if network wants to provide PLMN specific configuration to enable some features in legacy way.

**Question 7: Do companies agree that the PLMN specific configuration/handing (if any) can be left to network implementation, thus no new RAN2 solutions need to be specified for RAN sharing support in L2 U2N relay operation?**

If companies provide answer no, please indicate what the RAN2 solution/impact would be in the comment column.

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| InterDigital | Yes |  |
| InterDigital | Yes |  |
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## 3.4 RAN sharing in RAN2

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| R2-2200166 CATT | Since RAN sharing has been supported in Rel-15, the effects due to RAN sharing mainly in the core network, such as remote UE’s PLMN selection and authorizations. Therefore, it is unnecessary to exclude RAN sharing for L2 U2N relay in Rel-17 from RAN2’s perspective.  Proposal 2: It is unnecessary to exclude RAN sharing from RAN2 perspective. |

Based on the discussion on RAN2 spec impact, it would also be helpful to collect company views on whether RAN sharing can/should be supported in L2 U2N relay operation from RAN2 point of view.

**Question 8: Whether RAN sharing can be supported in L2 U2N relay operation from RAN2 point of view?**

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| InterDigital | Yes |  |
| InterDigital | Yes |  |
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If consensus can be achieved on above aspects, the LS could be sent to SA2 with the RAN2 agreements.

# 4 Conclusion

TBD

# 5 References

1. R2-2200552 RAN sharing MediaTek Inc., CATT, OPPO, Qualcomm Incorporated, ZTE, Huawei, HiSilicon, Apple, InterDigital
2. R2-2200946 Discussion on RAN sharing with L2 U2N relays Nokia, Nokia Shanghai Bell
3. R2-2201158 Remaining issues on control plane for L2 sidelink relay Ericsson
4. R2-2200166 Control Plane Procedures of L2 Relay CATT
5. R2-2200173 Remaining issues on paging and SIB forwarding in L2 U2N relay Qualcomm Incorporated
6. R2-2200372 Left Issues on Control Plane Aspects for L2 Relay OPPO
7. R2-2200475 Remaining Issues of Discovery Message Transmission vivo