3GPP TSG-RAN WG3 #111-e draft R3-211004

**25 January – 4 February 2021**

**Online**

**Agenda item: 13.2.3 (Topology Redundancy)**

**Source: Samsung (moderator)**

**Title: Summary of offline discussion on topology redundancy**

**Document for: Approval**

# Introduction

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| **CB: # 37\_IAB\_TopoRed**  **SS etc.**  **Agree CR on F1-C traffic transfer over Xn.**  **the node terminating F1-C should determine the F1-C transfer path.**  **Depending on RAN2 progress, the additional functionality for non-donor CU is to deliver the IABOthereInformation to donor CU for IP address configuration.**  **Change WA to agreement to support the following two scenarios for inter-donor topology redundancy:**  **- Scenario 1: the IAB node is multi-connected with 2 Donors.**  **- Scenario 2: the IAB node’s parent/ancestor node is multi-connected with 2 Donors.**  **the F1 interface of the boundary IAB node and its descendant node(s) can be terminated to the MN.**  **For inter-donor topology redundancy, the granularity for F1-U and F1-C traffic is F1-U tunnel and TNL association, respectively.**  **The BAP header rewriting via BAP routing ID mapping configuration can be applied to support the traffic transmission across two topologies.**  **the boundary IAB node and the descendant IAB nodes should be allocated two sets of IP address(es), and each set is anchored to the donor DU of one topology.**  **multi-MT solution is not considered for topology redundancy.**  **QC**  **discuss which of the IAB-MT’s MN or SN determines whether topological redundancy or CP-UP separation is applied for an IAB-node that uses NR-DC.**  **For CP-UP separation, discuss which of the IAB-MT’s MN or SN determines whether scenario 1 (F1-C via MN, F1-U via SN) or scenario 2 (F1-C via SN, F1-U via MN) is applied for an IAB-node that uses NR-DC.**  **discuss whether topological redundancy should include the transport of traffic via two or more boundary nodes or otherwise how to avoid such a scenario.**  **consider BAP routing across multiple IAB-donor topologies.**  **discuss use of a common BAP routing ID for BAP routes that cross a topology boundary vs. concatenation of BAP routes with topology-specific BAP routing IDs at the topology boundary.**  **For inter-topology BAP routes that use a common BAP routing ID, consider inter-donor coordination of BAP routing IDs vs. global scope BAP routing entries to avoid BAP-name-space collisions.**  **To support inter-topology BAP route concatenation, consider BAP header rewriting vs. IP routing.**  **discuss bearer mapping rules for transport across multiple topologies.**  **Nok**  **enhance Xn interface to enable the transfer of F1-C traffic.**  **OAM can configure the IAB to only have F1 with MN or SN. When both set of parameters are configured in the IAB, it is up to IAB to select a Donor for F1 setup.**  **both Donors allocate the BAP address to the IAB node.**  **Inter-Donor Routing needs to be supported.**  **It is the IAB Donor who host the F1 interface for the IAB node determine the load balancing between the two legs.**  **Introduce a new XnAP procedure to support inter-Routing.**  **discuss how long the CU component of the routing ID could be and if the added overhead is tolerable.**  **consider solution opts 3, 4 and 5 for the BAP address collision problem.**  **LG**  **Opt2 (i.e. inter-donor negotiation based solution) is preferred for solving BAP address collision for supporting topological redundancy for IAB node.**  **Master donor-CU determines the degree of load balancing between both IAB-donors.**  **HW**  **In Rel-17 inter-CU migration/topology management cases, the baseline co-existence assumption is that IAB-MT and its collocated IAB-DU always controlled by the same IAB donor CU.**  **Liaise RAN1 asking about the possibility that an IAB-MT and its collocated IAB-DU are controlled by different IAB-donor CUs.**  **IAB-MT’s applied configuration and its parent IAB-DU’s applied configuration on the BH link should be always controlled/generated by the same CU.**  **inter-donor topology management, including concatenation of multiple IAB network fragments from different CUs, should support the specific BAP path for F1 traffic between one IAB-DU and its associated CU, where some of the intermediate nodes in this BAP path may be controlled by different CUs.**  **design unified solutions for inter-donor F1 transport, to cover the following three use cases together: inter-donor redundancy, inter-donor migration, and inter-donor re-routing.**  **agree the following principle for inter-donor topology management:**  **- Single CU is responsible for the E2E QoS division among multiple IAB network fragments.**  **- The per hop QoS and BH RLC channel management is still controlled by individual CU.**  **ask RAN2 for coordination when discuss the two manners (controlled by one CU in centralized way, or controlled by individual CU) for the following configurations in inter-donor topology management: BAP routing ID allocation, BAP routing ID determination, BAP routing configuration, BH RLC CH mapping configuration.**  **Len,Moto**  **The boundary IAB node and its descendant IAB nodes maintain terminating their F1 interfaces to the IAB-donor which they connected to before topology redundancy establishment.**  **The boundary IAB node and its descendant IAB nodes cannot terminate their F1 interface to different donors.**  **intra-CU topology redundancy load balance mechanism can be reused for inter-CU topology redundancy:**  **- The granularity of the F1-U load balance is per UE DRB;**  **- Both first and second legs can be used for F1AP messages transmission.**  **Only one BAP address is configured for the IAB node, and a mapping table between BAP addresses (BAP routing IDs) allocated by different IAB-donors can be configured for the boundary IAB node.**  **ZTE**  **For scenario 1, a new XnAP message needs to be introduced to enable F1-C traffic transfer over Xn interface.**  **For scenario 2 using SRB 3, a new XnAP message needs to be introduced to enable F1-C traffic transfer over Xn interface.**  **The non-donor node should indicate donor whether SRB 3 has been setup via Xn interface.**  **The granularity of F1-U traffic is per GTP-U tunnel in inter-donor redundancy scenario.**  **The granularity of F1-C traffic should be per F1-C traffic type, i.e. UE-associated F1AP, non-UE-associated F1AP.**  **the boundary IAB node and descendant IAB node(s) still terminate their F1 interfaces to the first donor CU.**  **use the BAP address space separation method, e.g. non-overlapping BAP address space is allocated to different CUs by OAM, to resolve BAP routing/address collision issue.**  **\*\*\*\*\***  **- whether to enable F1-C transfer over Xn?**  **- boundary IAB node and its descendants terminate their F1 to a single donor?**  **- whether and how to address BAP address collision?**  **- Check details; Revise CR if needed; endorse as BL if agreeable**  (SS - moderator)  Summary of offline disc [R3-211004](D:\\RAN3\\RAN3-111e\\CBs\\CB # 37_IAB_TopoRed\\Inbox\\R3-211004.zip) |

Relevant contributions:

[1] R3-210218 Discussion on CP-UP separation and inter-donor topology redundancy (Samsung)

[2] R3-210219 CR on CP-UP separation over Xn for Rel-17 IAB (Samsung, Nokia, Nokia Shanghai Bell, Verizon, Qualcomm Incorporated, CATT, ZTE, Fujitsu, AT&T, KDDI, Lenovo, Motorola Mobility, LG Electronics, Ericsson)

[3] R3-210349 Backhaul transport for inter-donor redundancy (Qualcomm Incorporated)

[4] R3-210489 discussion on Inter-CU topology redundancy (Nokia, Nokia Shanghai Bell)

[5] R3-210536 Considerations on topological redundancy for IAB (LG Electronics)

[6] R3-210549 Discussion on inter-donor topology management (Huawei)

[7] R3-210615 Discussion on IAB inter-donor topology redundancy (Lenovo, Motorola Mobility)

[8] R3-210717 Discussion on topology redundancy (ZTE)

[9] R3-210722 Simultaneous Connectivity to Two IAB-donors and the Use of CHO (Ericsson)

This e-mail discussion is divided into two phases:

* Phase I: View collection of multiple issues

Deadline: Thursday, Jan. 28th, 2021, 12:00 UTC. This allows us to discuss intermediate stage in Monday online session (Feb. 1, 2021).

* Phase II: TBD

# For the Chairman’s Notes

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# Discussions

## CP-UP separation

In last RAN3 meeting, the following two scenarios are agreed to be supported in Rel-17:

**- Scenario 1: F1-C uses NR access link via M-NG-RAN node (non-donor node) + F1-U uses backhaul link via S-NG-RAN node (donor node)**

**- Scenario 2: F1-U uses backhaul link via M-NG-RAN node (donor node) + F1-C uses NR access link via S-NG-RAN node (non-donor node)**

Contribution [1] (Samsung), [4](Nokia), and [8](ZTE) indicate that a new XnAP procedure is needed to support the F1-C traffic over Xn, and the corresponding CR is give in [2]. In addition, contribution [4] provides the stage-2 TP (TS38.420) for this feature. Since CR in [2] is co-signed by multiple companies, the moderator will call for the following proposal:

***Moderator’s proposal 1-1: Agree [2] as the BL CR for TS38.423, and change TP in [4] to the BL CR for TS38.420***

Considering the majority support to [2], the moderator would ask companies to provide views if the above *Moderator’s proposal 1-1* is **NOT** agreeable, especially, if any technical showstopper is identified. Of course, if any revision is needed, please also point it out here.

**Q1-1(BL CRs): please share your view on *Moderator’s Proposal 1-1* if it is NOT agreeable or some revisions are identified. Otherwise (i.e., the *Moderator Proposal 1-1* is agreeable), you can skip this question)**

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| **Company** | **Comments** |
| **Ericsson** | The CR is OK, but since the discussion on simultaneous connectivity is still open, we propose to add the following note to the CR:  Editor Note: FFS on whether or not the F1-C Traffic Transfer procedure can be applied to two NG-RAN-Nodes serving the IAB node in a non-NR-DC mode. |
| Huawei | Not sure we need to agree the BL CR for TS38.423 so hurry, because anyway we need to revisit such CR in future when R2 has progress on RRC design. |
| AT&T | Agree with moderator’s proposal |
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**Moderator summary:**

Except the scenario 1&2 agreed in last meeting, contribution [3] (Qualcomm) indicates that CP-UP separation is also applicable for the cases where both MN and SN have the capability being IAB donor node for an IAB node, as shown in the following figure. Among those four cases, the IAB node terminates its F1 interface to one donor CU. The resultant issue is which node decides the transmission path of the F1-C traffic (e.g., MCG, SCG , both). Contribution [1](Samsung) and [8](ZTE) indicates the donor CU of the IAB node has clear information on whether F1-C can be transmitted via the path served by such donor CU or not. Thus, the node terminating F1-C should determine the F1-C transfer path.” On the other hand, in Rel-16, the F1-C transfer path is determined by the en-gNB, which acts as the donor node of the IAB node. Thus, the moderator calls for the following proposal:



***Moderator’s Proposal 1-2: the node terminating F1-C determines the transfer path of F1-C traffic in case of CP-UP separation.***

**Q1-2 (Determination of F1-C transfer path): please share your view on *Moderator’s Proposal 1-2*.**

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| **Company** | **Agree/Disagree** | **Comments** |
| Samsung | Agree |  |
| **Ericsson** | OK |  |
| QC | Not clear | 1. The is a logical deadlock in Proposal 1-2: How can F1-C be established without determining a path for F1-C? For ENDC, we decided that the gNB (i.e. SN) determines the F1-C path **before** F1-C is established. How do we do it here?  2. There is a more fundamental question: If the IAB-node has an MN and an SN, which both have donor capabilities, which of the two becomes the donor and which becomes the non-donor (note that the IAB-node may be connected to the MN only with an access link when the SN is added). It is **also** possible that both, MN **and** SN becomes donors (i.e., establish inter-donor redundancy)  We propose:   * Proposal 1-2a: The IAB-node’s MN decides if it *itself* assumes donor functionality (i.e. establish BH connectivity), and/or, if the SN assumes donor functionality (i.e. establish BH connectivity)   This decides if CP/UP separation is used or inter-donor redundancy, and it decides who is the donor in case of CU/UP separation.   * Proposal 1-2b: If only one of MN and SN assumes donor functionality (i.e. CP/UP separation), the donor determines the transfer path of F1-C.   Note that this is done before F1-C is established. |
| Huawei | Ok |  |
| AT&T | Agree |  |
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**Moderator summary:**

In addition, some stage 3 issues are discussed. For example, contribution [4](Nok) and [8] (ZTE) discuss F1-C traffic via SRB3 or split SRB for the above scenario 2, contribution [1] (Samsung) discusses the additional functions between non-donor CU and donor CU, e.g., IABOtherInformation transfer. However, all those issues need RAN2 input first. So, the moderator suggest to postpone those discussions till RAN2 has made progress.

**Q1-3 (Others): please provide the view on other issues (if any) not mentioned above.**

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| **Company** | **Comments** |
| QC | SRB 1, 2, 3 can be discussed later.  Exchange of IABOtherInformation is discussed in Q2-7. |
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**Moderator summary:**

## Inter-donor topology redundancy

* Scenarios

Contribution [1] (Samsung) indicates to change WA in last meeting to agreement. Contribution [3] proposed to discuss whether topology redundancy should include the transport of traffic via two or more boundary nodes (an example is given below), or otherwise how to avoid such a scenario.



The moderator would like to raise the following questions to collect company’s view.

**Q2-1 (Scenarios): please provide view on the following questions:**

1. **Can we change WA in last meeting (i.e., support scenario 1 and scenario 2) to agreement?**
2. **Shall we support topology redundancy by considering the transport of traffic via two or more boundary nodes? If not, how to avoid such scenario?**

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| **Company** | **Comments** |
| Samsung | 1. Yes 2. Not now. We need first figure out the case of transmitting traffic via one boundary node. To avoid the transport via two or more boundary nodes, the F1-termination donor CU can determine to offload the traffic to one donor CU only. |
| **Ericsson** | a) OK  b) The scenario where we have 3 donor CUs in the same area is **very unrealistic,** so we should not even consider this scenario, let alone its prevention. The real life will prevent it. |
| QC | a. Yes  b. We should support transport via two or more boundary node. If not, how can it be avoided? Samsung’s idea doesn’t work. The green donor has no influence over how the blue donor routes the traffic. Also, after we have solved the two-topology transport problem, the multi-topology problem should be straightforward. |
| Huawei | a. ok  b. Theoretically, the scenario of transport via two or more boundary node may exist, but such scenario seems will make the inter-donor redundancy more complicated, we can deprioritize such scenario before we have progress on the two donor based redundancy case. |
| AT&T | 1. Yes 2. We are open to supporting two or more boundary node cases after we have completed the single boundary case. |
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**Moderator summary:**

* Realization of inter-donor topology redundancy at the boundary IAB node

(After coordinating with Qualcomm, this part can be addressed in CB#34 due to the overlapping)

~~In addition, two options are mentioned to realize the inter-donor topology redundancy at the boundary IAB node, i.e., NR-DC, Dual IAB Protocol Stack/dual-MT [9](Ericsson). In particular, DIPS/dual-MT solution in [9] is described as:~~

~~a. Two independent protocol stacks (RLC/MAC/PHY)~~

~~b. One or two independent BAP entities with some common and some independent functionalities.~~

~~c. Each CU allocates its own resources (e.g., addresses, BH RLC channels, etc.) without the need for coordination, and configures each protocol stack.~~

~~Moreover, to perform the load balance, contribution [9] mentioned that “When the CU determines that load balancing is needed, the CU starts the procedure requesting to a second CU resources to offload part of the traffic of a certain IAB node. The CUs will negotiate the configuration and the second CU will prepare the configuration to apply in the second protocol stack of the IAB-MT, the RLC backhaul channel(s), BAP address(es), etc.~~

~~The IAB-MT will use routing rules provided by the CU to route certain traffic to the first or the second CU. In the DL, the IAB-MT will translate the BAP addresses from the second CU to the BAP addresses from the first CU to reach the nodes under the control of the first CU. ”~~

~~The moderator feels that the above description is almost similar to the option 4 (routing via BAP header rewriting) for BAP routing across two topologies. If moderator’s understanding is correct, the difference between NR-DC/DIPS(or dual-MT) is the Xn signalling, e.g., for NR-DC, the current Rel-16 NR-DC related signalling may be used for configuration to the boundary node, while for DIPS(or dual-MT), some new Xn signalling may be needed. Thus, to resolve this issue, the moderator would require companies to provide the understandings to NR-DC/DIPS (or dual-MT), and give the preference.~~

**~~Q2-2 (Realization of topology redundancy): please provide view on the realization of inter-donor topology redundancy at the boundary IAB node based on the following questions:~~**

1. **~~What’s the key difference between NR-DC and DIPS/dual-MT in terms of, e.g., protocol stack at the boundary IAB node, coordination signalling over Xn for BAP routing across two donor CUs, etc.?~~**
2. **~~Which of NR-DC and DIPS/dual-MT is selected as the inter-donor topology redundancy?~~**

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| **~~Company~~** | **~~Comments~~** |
| ~~Samsung~~ | 1. ~~Comparison~~  |  |  |  | | --- | --- | --- | |  | ~~NR-DC~~ | ~~DIPS/dual-MT~~ | | ~~Protocol stack at boundary IAB node~~ | * ~~Two independent stacks with RLC/MAC/PHY~~ * ~~One BAP~~ * ~~One RRC~~ | * ~~Two independent stacks with RLC/MAC/PHY~~ * ~~One BAP~~ * ~~One RRC (maybe two RRC for dual-MT?)~~ | | ~~Xn signalling~~ | ~~NR-DC related signalling to configure the boundary IAB node~~ | ~~New Xn singaling to configure the boundary IAB node. The content of those signalling may be similar as NR-DC signalling~~ |   ~~The above comparison cannot indicate any essential difference between NR-DU/DIPS(dual-MT) except which Xn signalling is used.~~   1. ~~NR-DC, considering that no essential difference between NR-DC and DIPS/dual-MT~~   ~~Meanwhile, we also understand that RAN3 has agreed that “~~**~~Multi-MT Support is FFS in RAN3 pending RAN2~~**~~”~~ |
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**~~Moderator summary:~~**

* Unified solution for inter-donor transport

Contribution [6] (Huawei) proposes to design unified solutions for inter-donor F1 transport to cover 1) inter-donor redundancy, 2) inter-donor migration, and 3) inter-donor re-routing. The reason is that in those three scenarios, the inter-donor topology management, i.e., concatenate multiple IAB network fragments from different CUs (the intermediate nodes in a BAP routing path are controlled by different CUs), should be supported for the BAP routing path of F1 traffic between one IAB-DU and its associated CU. Thus, the moderator would like to collect views on the feasibility of such unified solution.

**Q2-3(Unified solution): please provide view on the feasibility of a unified solution for inter-donor F1 transport to cover 1) inter-donor redundancy, 2) inter-donor migration, and 3) inter-donor re-routing.**

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| **Company** | **Comments** |
| Samsung | Not now.  At this moment, those three aspects are discussed separately, and we even didn’t reach the agreeable procedure for each aspect. Moreover, those three aspects may be aiming at different scenarios, e.g., inter-donor migration for single connectivity IAB-MT, inter-donor re-routing for packet loss, inter-donor redundancy for IAB node with two parent nodes. We don’t know how to achieve a unified solution to cover all those scenarios. |
| **Ericsson** | We think that RAN3 should work on a unified solution that applies for all three cases, regardless of whether an IAB node is capable or incapable of simultaneous connectivity to two donors. |
| QC | We agree with Huawei.  In all scenarios (redundancy, Xn handover and RRC re-establishment), traffic is transported across topology sections managed by different donor-CUs. Furthermore, having a common mechanism for inter-topology transport allows to leverage the solutions developed for inter-donor redundancy for the other scenarios. The signaling may be different for each solution.  **We propose: Same inter-topology RLC and BAP transport solution is used for inter-donor redundancy, migration via Xn HO and RLF recovery via RRC Reestablishment.** |
| Huawei | We think design a unified solution for the three cases is feasible and important. The key point is to allow routing across inter-donor topology, so the solution to achieve such inter-donor routing should be same. |
| AT&T | Agree that it would be good to strive for a unified solution. Although there will be scenario-specific differences in signalling. |
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**Moderator summary:**

* F1 termination point

In last meeting, RAN3 has the following agreements:

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| As a starting point, the F1 interface of the boundary IAB node and descendant IAB node(s) terminate to the same donor. The following open issues need further discussion:  - FFS at which of the two donors these F1 interfaces terminate  - FFS if boundary and descendent IAB-nodes can have their F1 interfaces terminate at different donors. |

With the above two FFSes, the following views are indicated among the above contributions:

* **Option 1: terminate to the node before establishment of topology redundancy**. Contribution [7] (Lenovo) and [8] (ZTE) indicate that the F1 is terminated to the node before topology redundancy establishment. Contribution [1](Samsung) indicates that before topology redundancy establishment, the boundary node and its descendant nodes have established F1 interface with master node, which is aligned with [7] and [8] in case NR-DC is applied for topology redundancy.
* **Option 2: depend on IAB node selection**. Contribution [4] (Nok) mentioned “OAM can configure the IAB to only have F1 with MN or SN. When both set of parameters are configured in the IAB, it is up to IAB to select a Donor for F1 setup.” It seems to indicate that F1 termination point can be either master node or secondary node.

**Q2-4a(F1 termination – termination point): please provide view on the following two options for F1 termination point of the boundary IAB node and its descendant node(s):**

* **Option 1: terminate to the node before establishment of inter-donor topology redundancy**
* **Option 2: depend on IAB node selection**

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| **Company** | **Comments** |
| Samsung | Option 1  Moreover, if NR-DC is applied, the master node should terminate the F1 interface. |
| **Ericsson** | Option 1 |
| Qualcomm | Neither option 1 nor option 2. The MN should be able to configure the SN **before** F1 is set up. It should also be able to configure SN **after** F1 has been set up.  We should first agree on this.  **Proposal:**   * **IAB-node’s MN can configure SN before or after F1 has been set up.**   The next question is where F1 is set up in case SN has already been configured. If both MN and SN assume donor functionality, i.e., establish BH, we believe the MN should decide which of MN or SN terminates F1. We should certainly **not** use OAM since this prohibits inter-vendor operation.  **Proposal:**  **The MN informs the IAB-node which of MN or SN terminates F1.** |
| Huawei | Option 1 or OAM decision.  The key issue is when the IAB-node add SN, if the SN is added after F1 setup, it is sure that the F1 still terminates at MN.  If the SN is added before F1 Setup, the OAM will provide the CU’s IP address to the IAB-DU, and the node to terminate F1 termination is naturally decided by OAM. |
| AT&T | Option 1 |
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**Moderator summary:**

In addition, contribution [3](Qualcomm) raises the question on ” Which node determines whether the inter-donor topology redundancy is applied to an IAB node?” Similarly, contribution [4](Nokia) and [5] (LG) discuss the node determining the degree of load balancing between two donor CUs. Considering each IAB node terminates the F1 interface to one donor, it is natural to let the F1-termination donor CU to make decision since it has well knowledge on the load of its serving topology. Thus, the moderator calls for the following proposal:

*Moderator proposal 2-4b: the F1-termination donor CU determines the establishment of inter-donor topology redundancy.*

**Q2-4b(F1 termination – topology redundancy determination): please provide view to the *Moderator Proposal 2-4b*.**

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| **Company** | **Agree/disagree** | **Comments** |
| Samsung | Agree |  |
| **Ericsson** | OK |  |
| QC | Needs rewording | “Establishment of inter-donor topology redundancy” only refers to BH connectivity, not to the amount or degree of traffic offload. The proposal should refer to traffic offload, instead.  Further, the following issues need to be addressed:  1. Can the other donor reject the traffic offload request?  2. Can the other donor ask to move traffic back in case it gets loaded up with its own traffic over time?  We propose to converge on a first step:  Proposal: The F1-terminating donor initiates the traffic offload to the other donor’s topology. |
| Huawei | See comments | The original proposal is a little confusing, it should be the MN to determine the establishment of inter-donor topology redundancy, so the original proposal is correct when the “*F1-termination donor CU”* is the *MN.*  Suggest the revised version: *the MN determines the establishment of inter-donor topology redundancy.*  The proposal from QC also looks fine. |
| AT&T | Agree |  |
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**Moderator summary:**

* BAP routing across two topologies

To realize the topology redundancy, a fundamental issue is how to achieve the BAP routing across two different topologies controlled by two donor CUs. Please note that, the boundary IAB node and its descendant node(s) terminate F1 interface to one of them, which is the F1-termination donor CU (another donor CU is called non-F1-termination donor CU). However, terminating to which donor CU depends on discussion of Q2-4a.

In last meeting, five options are mentioned:

* Option 1: routing via unique BAP address based on OAM configuration
* Option 2: routing via unique BAP address coordinated between two donor CUs
* Option 3: routing via a new unique identity
* Option 4: routing via BAP header rewriting
* Option 5: routing via IP

In order to proceed the discussion, companies should have common understandings to the features of those five options. The following table gives the moderator’s understanding based on contributions in this meeting:

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|  | **BAP address space of each topology** | **BAP address allocated to boundary/descendant IAB node** | **Topology management (e.g., BAP address allocation, BAP routing ID allocation, routing configuration, BH RLC channel mapping, etc.)** |
| **Option 1** | Sub-set of 10-bit BAP address space, which is assigned by OAM | One or two 10-bit BAP addresses (in case of two, the BAP addresses are allocated by two donor CUs, respectively) | The two topologies are managed by two donor CUs, respectively.  The boundary IAB node belongs to two topologies;  The descendant node belongs to the topology of F1-termination donor CU in case of one BAP address, or belongs to two topologies in case of two BAP addresses |
| **Option 2** | Sub-set of 10-bit BAP address space, which is derived via coordination between two donor CUs | Same as option 1 | Same as option 1 |
| **Option 3** | Extended BAP address, i.e., CU component (e.g., CU ID or topology ID) + 10-bit BAP address | One extended BAP address  [QC] BAP address on packet does not have to change! See below. | The two topologies are managed by two donor CUs, respectively.  The boundary node belongs to two topologies;  The descendant node belongs to topology of F1-termination donor CU. |
| **Option 4** | 10-bit BAP address space | Two 10-bit BAP addresses at boundary node (allocated by two donor CUs, respectively);  One 10-bit BAP address at descendant node(s) | Same as Option 3 |
| **Option 5** | Same as option 4 | Same as option 4 | Same as option 3 |

[QC] Option 3 can be handled more elegantly:

* The BAP address in the BAP header is the **same** as in Rel-16.
* Configurations of BAP address, BAP routing entry, mapping entry include a topology indicator (i.e. if it refers to topology 1 vs. topology 2).
* On the BH link, a separate set of (e)LCIDs is used for each topology.

This approach essentially resolves the two topologies in the eLCID space, which is large enough (65k).

It seems that more discussion is necessary.

Among those options, the moderator can observe the following common parts:

* Observation 1: each donor CU is responsible for topology management of its own topology (e.g., BAP address allocation, BAP routing ID allocation, routing configuration, BH RLC channel mapping, etc).
* Observation 2: the boundary IAB node belongs to two topologies controlled by two different donor CUs so both donor CUs will configure BAP routing from/to it.
* Observation 3: the BAP routing across topologies can be transparent to the descendant nodes, i.e., Rel-16 scheme can be completely reused at the descendant node(s) (e.g., each node has one BAP address, etc.)

In observation 2, the number of BAP addresses at the boundary IAB node depends on the selected option, e.g., option 1/2/3 allows one BAP address, while option 4/5 requires two BAP addresses. While the intention of observation 3 is to reduce the impact to the IAB network. Since the five options have some common part, the moderator propose to agree them, i.e.,

*Moderator Proposal 2-5a: to support the inter-donor topology redundancy, the selected option for BAP routing across topologies can be featured by:*

* *1. Each donor CU is responsible for topology management of its own topology (e.g., BAP address allocation, BAP routing ID allocation, routing configuration, BH RLC channel mapping, etc).*
* *2. The boundary IAB node belongs to two topologies controlled by two donor CUs (number of BAP address depends on the selected option), i.e., the two donor CUs need configure the BAP routing to/from it.*
* *3. The BAP routing across topologies is transparent to the descendant node(s) (i.e., no additional work is needed on top of Rel-16 scheme)*

**Q2-5a (BAP routing-Common part): please provide views to the *Moderator Proposal 2-5a*. If any misunderstanding to each option or any additional common part among five options is identified, please also point it out here.**

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| **Company** | **Comments** |
| Samsung | * + - 1. Agree       2. Agree. It is because that the boundary IAB node is the only node in the network to transmit/receive packets to/from two topologies. If it belongs to two topologies, the packets toward to it is routable via the BAP layer, and it can forward the packets to the correct topology.       3. Agree. In our understanding, the descendant node should be invisible for the inter-donor topology redundancy. With that, the network can save the configuration to those nodes when perform inter-donor load balancing. |
| **Ericsson** | Agree |
| QC | We agree with the moderator’s intention to extract the commonality of the 5 options. We believe some rewording is needed:   * *1a. Each donor CU is responsible for the management of its own topology, which includes the connectivity graph and the routing paths, as well as configuration of BAP address, BAP routing ID, routing paths, BH RLC channel mapping, etc.* * *1b.* ***The donor CU does not have to know the connectivity graph and routing paths in the other topology.*** * *2. The boundary IAB node belongs to two topologies controlled by two donor CUs, i.e., the two donor CUs need to configure the BAP routing to/from it.*   To 1a: BAP configuration is different from BAP allocation. The BAP address may be allocated by CU2 but configured on the IAB-node by CU1.  To 3: Additional work is at least needed for option 3. Further, BAP routing across topologies is not transparent to the descendent nodes since they need to be configured with additional UL mapping, and routing entries, and potentially BAP address. |
| Huawei | 1. In our view, the observation 1 seems only summarize the common part for solution 4 and solution 5. For solution 1, 2 and 3, according to the current description, the three solutions just focus on how to avoid the BAP address confliction. While solution 4 and solution 5 avoid to solve the potential BAP address confliction problem through using concatenated routing manner. So for solution 1-3, the only common point is the BAP address of each IAB node is allocated by the connected CU. And we still have two possible ways for the BAP routing: using common BAP routing ID across the whole path, or using two BAP routing IDs in concatenated routing manner.  If using a common BAP routing ID across the whole inter-donor path (i.e. the BAP routing ID will not be changed by any intermediate IAB node), one CU should be responsible for allocating the BAP path ID part, and it means that the BAP routing ID is allocated by one single CU. Accordingly, the routing configuration is determined by the same CU, because the BAP routing ID only indicates single path towards some destination node, and the next hop node related to this BAP routing ID for each node in this path is determined accordingly. And there is no description about how to perform BH RLC channel mapping for each hop in solution 1-3 also, it may be decided by one single CU, or determined by individual CU.  Based on the above concern, the observation 1 does not cover all the possible solutions. At least for solution 1-3, it is also possible that the BAP routing ID allocation, routing, and BH RLC channel mapping are performed by single donor CU.  So the only common part for the 5 solutions is “*Each donor CU is responsible for BAP address allocation for nodes in its own topology.* ”  2. Partially agree. According to our view for the 1st observation, the BAP routing for solution 1-3 can be configured by one CU, or by individual CU, such principle also applicable for the boundary node. So we think the correct part of this observation is “*The boundary IAB node belongs to two topologies controlled by two donor CUs.”*  3. Agree  By the way, the new solution 3 proposed by QC are not clear for us, more clarification is necessary on the new solution. |
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**Moderator summary:**

In this meeting, contributions [1](Samsung), [3](Qualcomm), [4](Nokia), [5](LG), and [8](ZTE) compare the above five options, which are summarized in the following table.

|  |  |  |
| --- | --- | --- |
|  | Pros. | Cons. |
| Option 1 | No additional processing at the boundary IAB node | * BAP address space partition, and limit number of IAB nodes under one donor CU [1][4][8] |
| Option 2 | * BAP address space partition, and limit number of IAB nodes under one donor CU [1][4] * Introduce inter-donor signalling, reconfiguration of BAP address and routing table [4][8] |
| Option 3 | No limitation to the BAP address space under one donor CU  [QC]No additional processing at the boundary IAB node | * New BAP header design (i.e., adding CU component), and more transmission overhead in each packet [1][3][4][5][8] * [QC] This is not necessary. See comment above. We should say eLCID space reduction by factor of two. |
| Option 4 | No limitation to the BAP address space under one donor CU | * New BAP functionality, i.e., BAP header rewriting at boundary IAB node [1][3][4][5] * End-to-end QoS may not be fulfilled [4] |
| Option 5 | * New function at the boundary IAB node, i.e., IP header interpretation (in Rel-16, intermediate IAB node does not interpret IP header information)[1][3][4][5][8] |

Based on the moderator’s analysis, the preferred option seem to be diverse among companies, e.g., [1][7](Lenovo) and Ericsson supports Option 4, [4] proposed to consider option 3/4/5, [5] supports option 2, while [8] supports option 1. Among those options, option 1/2/3 can be considered as Category 1 aiming at achieving the unique BAP routing ID across the two topologies, while option 4/5 can be considered as Category 2 aiming at performing BAP routing ID remapping at the boundary IAB node. To make progress, the moderator proposes to perform the down-selection via two steps:

* Step 1: select the preferred one among all options
* Step 2: select one preferred option in each category if convergence in step 1 is difficult

If the convergence is achieved among companies’ choice in Step 1, it is a perfect result; otherwise, step 2 can be applied. Moreover, in step 2, the moderator would appreciate that the companies can provide the views on the co-existence of two selected options from two categories (e.g., different options are applied for different scenarios).

**Q2-5b (BAP routing-Option down-selection): please provide views to the down-selection of options based on the following questions:**

* **1. Which option is the most preferred one?**
* **2. If the convergence cannot be achieved, which option is preferred in each category, where category 1 contains option 1/2/3, and category 2 contains option 4/5?**
* **3. If one option is selected for each category, would it be possible to consider the co-existence of two options? If possible, how to achieve it?**

**(please note that, if convergence to one option is difficult, the moderator may select one option for each category for progress based on majority view)**

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| **Company** | **Comments** |
| Samsung | * + - 1. Option 4. This option does not introduce any limitation for the network capacity and any additional overhead in the packet. Moreover, it does not change the protocol stack of the IAB node (Option 5 need revise the protocol stack of the boundary IAB node, i.e., allow IP routing) ;       2. Option 1 for Category 1, and Option 4 for Category 4       3. Option 1 and Option 4 can be co-existed with each other   At the initial stage of the IAB network, the number of IAB nodes under each IAB donor CU may not be very large, the OAM can configure separate BAP addresses/path ID to each donor CU. With this, the collision of BAP address/BAP routing ID can be avoided. Thus, option 1 can be selected with minor specification impact (e.g., one donor CU needs inform another one of the BAP address of boundary/descendant node).  With the increase of number of IAB nodes, the option 4 can be applied. |
| **Ericsson** | 1) Option 4  2) Option 4 + Option 1  3) Options 4 and 1 can coexist |
| QC | Option 1 is up to implementation in a single-vendor network and should not be further discussed.  The above discussion of the various options is still missing a few relevant aspects:   * Option 3 can also work **without** BAP address extension since transport differentiation can be accomplished via topology-specific eLCID selection. * The selection among options 2-5 critically depends on bearer (re-)mapping at the boundary node which is discussed in Q2-6. We should converge on this topic before making a decision on BAP routing. Note that bearer-remapping cannot be supported for options 2 and 3. Note that it would require enhancements over Rel-16 for option 4 and 5. * For option 5, the descendent node needs to set IPv6 flow label, which is not supported in Rel-16.   We are in favor of option 3, 4, and 5. Again, option 1 is not an option. Option 2 does not scale well. |
| Huawei | The down selection among the 5 options seems meaningless. According to our feedback in Q2-5a , Option 1-3 are just focus on how to avoid the BAP address confliction. While solution 4 and solution 5 are two ways of concatenated routing manner. Comparatively, the solution 1-3 are not complete for the inter-donor topology management, It is unclear of how to perform the E2E QoS division, BAP routing ID allocation, routing table configuration, BH RLC channel mapping, BAP routing ID derivation at access IAB node/IAB-donor-DU, etc.  So we think it is hard to do down selection from the 5 solutions which are focus on different issues.  Besides, We don't think RAN3 is the right group to do the down selection solely without any RAN2 input. As we analysed in our contribution R3-210549, the BAP routing ID allocation is totally RAN2 scope, and how to perform the BAP routing ID determination, BAP routing configuration, BH RLC CH mapping configuration for IAB node most rely RAN2’s work since R16. Furthermore, even for the down selection among solution 4 and solution 5, it should up to RAN2 because both solutions has impact on the BAP layer procedure in the boundary node. |
| AT&T | 1. Option 4 2. Option 1 in Category 1, and Option 4 in Category 4 3. Option 1 and 4 can coexist |
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**Moderator summary:**

In addition, companies also indicate stage-3 impact for each option, e.g., [1](Samsung), [4](Nokia), [8](ZTE). The moderator think that it may be early to discuss those details before finalizing the option. So, the discussion can be on hold for a moment.

* BH RLC channel mapping

Despite of BAP routing, another important issue is the BH RLC channel mapping across two topologies, which are mainly implemented at the boundary IAB node. To configure the BH RLC CH mapping, the two donor CUs need share some information. Contribution [3](Qualcomm) gives two possible options:

* Option 1: mapping per BH RLC CH

In the option, bearer mapping (mapping between F1-U tunnel and BH RLC CH) is the same in both topologies. Thus, F1-termination donor CU needs share BH RLC CH-level QoS with non-F1-termination donor CU

* Option 2: mapping per F1-U tunnel

In the option, bearer mapping (mapping between F1-U tunnel and BH RLC CH) could be different in two topologies. Thus, F1-termination donor CU needs share F1-U tunnel-level QoS with non-F1-termination donor CU. However, as indicated in [3], to support this option, the above option 5 (i.e., routing via IP) for BAP routing across

**Q2-6a (BearerMapping-granularity): please provide views to the following options of inter-donor signaling for bearer mapping at boundary IAB node:**

* **Option 1: mapping per BH RLC CH**
* **Option 2: mapping per F1-U tunnel**

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| **Company** | **Comments** |
| Samsung | Option 1 (bearer mapping at the boundary IAB node is per BH RLC CH).  In our understanding, the main intention of option 1 is to use the same mapping at the boundary IAB node between two topologies, especially for the UL mapping. This can avoid one ingress BH RLC CH is mapped to two egress BH RLC CHs in UL. However, how to signalling over the Xn for such configuration (e.g., providing BH RLC CH level QoS or F1-U level QoS) is a stage 3 issue, we can address it at the later stage. In addition, Option 1 is better than option 2 since option 2 relied on the IP routing for BAP routing across two topologies (i.e., option 5). |
| **Ericsson** | We prefer Opt1, but are also open to Opt2, since the second donor may have a different radio and traffic situation from the first donor, and still be able to provide the desired service. |
| Qualcomm | Option 1, because it only requires exchange of BH RLC CH information  Option 2 requires exchange of all F1-U info which is very inefficient.  Further, bearer remapping at the boundary node is only supported in BAP-routing options 4 and 5 and not in BAP routing options 1-3 (see Q2-5a/b).  NOTE that option 1 can support load balancing with F1-U granularity, i.e., one F1-U tunnel is routed via the old path and another via the new path. |
| Huawei | We are open to both option 1 and option 2. Two different F1-U tunnels which is mapped to one BH RLC channel in topology 1 can be mapped to either single BH RLC channel in topology 1 or to separate BH RLC channels in topology 2, only if the E2E QoS can be guaranteed.  But for option 2, it is unclear that how can the boundary node perform mapping per F1-U tunnel since the boundary node cannot investigate the F1-U related headers in the forwarded BAP SDUs? More clarification seems necessary for this option.  Besides, we also add an additional option that the mapping can be based on IP header information (e.g. DSCP, flow label) at the boundary node.  Option 3: mapping per IP header info (e.g. IP address and/or DSCP, and/or flow label). |
| AT&T | We prefer Option 1 |
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**Moderator summary:**

Moreover, to implement the bearer mapping, the boundary IAB node needs know the ingress BH RLC CH to perform the mapping to the egress BH RLC CH for DL, and needs know the egress BH RLC CH to perform the mapping from the ingress BH RLC CH for UL. However, the ingress BH RLC CH for DL and the egress BH RLC CH for UL are configured by the non-F1-termination donor CU. Thus, the non-F1-termination donor CU needs share the ingress BH RLC CH for DL and the egress BH RLC CH for UL with the F1-termination donor CU. Based on this, the moderator calls for the following proposal:

*Moderator proposal 2-6b: to support the bearer mapping across two topologies, the non-F1-termination donor CU needs to share the ingress BH RLC CH for DL traffic and egress BH RLC CH for UL traffic with the F1-termination donor CU for the boundary IAB node.*

**Q2-6b (BearerMapping-Ingress/egress BH RLC CH): please provide views to the *Moderator proposal 2-6b*.**

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| **Company** | **Agree/Disagree** | **Comments** |
| Samsung | Agree |  |
| **Ericsson** | Agree |  |
| QC | Agree | One solution could be:  1. F1-terminating donor (CU1) reports to non-F1-terminating donor (CU2) the number of BH RLC CHs incl. their respective QoS it needs to have connected at the boundary IAB-node.  2. CU2 configures the corresponding BH RLC CHs at the CU2 side of the boundary node and returns the BH RLC CH IDs.  3. CU1 configures the mapping of BH RLC CHs at the boundary node. |
| Huawei | Agree |  |
| AT&T | Agree |  |
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**Moderator summary:**

* IP address assignment

In contribution [1][4], the IP address assignment is discussed. After establishing topology redundancy, the boundary IAB node/descendant node(s) may transmit packets with both F1-termination donor CU and non-F1-termination donor CU. Thus, the IP addresses belonging to two topologies should be assigned. For F1-termination donor CU, Rel-16 scheme can be reused. While for non-F1-termination donor CU, the IP address allocation may be performed via F1-termination donor CU. Contribution [4] indicates that the Rel-16 like solution can be used, e.g., include IABOtherInformaiton in the Xn RRC Transfer message for IP address request. The moderator thinks that such issue deserves some discussions.

**Q2-7 (IP address assignment): please provide views to IP address assignment in terms of the following questions:**

* **1. Which node is responsible for the IP address allocation for the boundary node/descendant node? (e.g., F1-termination donor CU, non-F1-termination donor CU, both)**
* **2. Any new functionality to support the IP address assignment? (e.g., IABOtherInformaiton transfer via Xn RRC transfer message)**

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| **Company** | **Comments** |
| Samsung | Both  IABOtherInformation transfer via Xn RRC transfer is needed. However, this depends on RAN2 progress |
| **Ericsson** | 1) **For boundary node**: Both donors should be responsible for the allocation of IP addresses. We think that whether **the descendant nodes** should receive IP addresses from the second donor should be further discussed.  2) Let us **wait for RAN2** |
| QC | This is also discussed in CB34.  IP address allocation to the IAB-node is done in Rel-16 over RRC. We do not understand why we make the distinction b/w the CU that terminates F1 and the CU that does not terminate F1.  Using Rel-16 IP routing principles, the IP address of the IAB-node is allocated by the anchor IAB-donor-DU and the corresponding CU. If the CU allocating the IP addresses has no direct RRC connection to the IAB-node, IP address info has to be exchanged over Xn.  This means that we need IABOtherInformation transfer via Xn. We should agree that this is needed and then send an LS to RAN2.  **Proposal: For IP address allocation, the IABOtherInformation transfer via Xn needs to be supported.**  **Proposal: RAN2 to be liaised to support IABOtherInformation transfer via Xn.** |
| Huawei | 1. both  2. Should wait RAN2 progress. |
| AT&T | Agree with QC’s view |
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**Moderator summary:**

* Offloading granularity

In last meeting, two FFSes are left for the granularity of load balancing, i.e.,

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| - FFS on the granularities of the load balancing for F1-U traffic.  FFS on granularities for F1-C traffic |

In this meeting, contribution [7](Lenovo) indicates that the granularity for F1-U is UE DRB. While contribution [1] (Samsung) indicates the granularity for F1-U and F1-C traffic is F1-U tunnel and TNL association, respectively, which is agreeable for majority companies in last meeting. Thus, the moderator would like calling for the following proposal:

*Moderator Proposal 2-8: In inter-donor topology redundancy, the granularities of the load balancing are per GTP-U tunnel for F1-U traffic and per TNL association for F1-C traffic.*

**Q2-8(Load balance granularity): please provide view to the *Moderator Proposal 2-8*.**

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| **Company** | **Agree/disagree** | **Comments** |
| Samsung | Agree |  |
| **Ericsson** | Agree |  |
| QC | Agree | This is also discussed in CB 34. We believe it is straightforward. |
| Huawei | Agree |  |
| AT&T | Agree |  |
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**Moderator summary:**

* Others

In the contributions, some additional issues are raised, e.g., BAP address allocation, signalling enabling routing, resource configuration in [4], the responsible node for BAP routing ID allocation, BAP routing ID determination, BAP routing configuration, BH RLC CH mapping configuration [6]. Also, some stage-3 details are mentioned in [1][4]. The moderator considers that those issues may be either covered by the above discussion, or too early for the discussion. Thus, there is no dedicated discussion items list in this document. However, companies are welcome to raise any issues not covered above and being worthy for the discussion.

**Q2-9 (Others): please provide the view on other issues (if any) not mentioned above.**

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| **Company** | **Comments** |
| **Ericsson** | The Q2-2 has not been moved to CB#34 as the moderator claims, because it is only mentioned in the text of #34 and not really discussed. |
| Huawei | Some issues discussed in our contribution R3-210549 is missing: How to perform the E2E QoS division and the BH RLC channel management is important for the traffic across the inter-donor topology.   * **E2E QoS division**: In our view, For the inter-donor path, there should be one donor CU to determine the E2E QoS and how to divide it for each IAB network fragment of the whole inter-donor BAP path, then the QoS of the network fragment may be divided into QoS per BH link for further step by the fragment’s corresponding CU. * **BH RLC channel management**. The setup/modification/release of the BH RLC channel are performed via F1AP messages and RRC messages, so it is natural that such BH RLC channel management in each BH link should be controlled by the connected CU of the parent DU in this BH link. And this issue also includes the per hop QoS determination for each BH RLC channel.   In summary, we suggest the following:  **The E2E QoS division should be controled by single CU, FFS on which donor CU**  **The BH RLC channel management for each BH link is controlled by individual CU.** |
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**Moderator summary:**

# Conclusion, Recommendations [if needed]

If needed

# References