3GPP TSG RAN WG1 Meeting #103-e R1-20XXXXX 26th October – 13th November 2020

Agenda Item: 8.10.2

Source: Moderator (Qualcomm Incorporated)

Title: Summary #1 of [103-e-NR-eIAB-02]

Document for: Discussion and decision

### 1 – Introduction

This contribution provides a summary of the following email discussion:

[103-e-NR-eIAB-02] Email discussion on other enhancements for simultaneous operation of IAB-node’s child and parent links – Luca (Qualcomm)

* 1st check point: 11/5
* 2nd check point: 11/10
* 3rd check point: 11/12

There are three areas of discussion:

* Timing modes, covered in section 2.
* Interference management, covered in section 3
* Power control, covered in section 4

Active discussion items where companies input is sought are yellow highlighted.

FL agreements or conclusions from email discussion are green highlighted.

### 2 – Discussion on timing modes

**Topic 2.1**

This discussion topic relates to the discussion on Case 6 and Case 7 timing modes, which were agreed in RAN1#102-e to be supported.

Related input from contributions:

|  |  |
| --- | --- |
| Huawei, HiSiliconR1-2007595 | ***Observation 1****: Introducing additional TA for IAB MT for Case 6 timing leads to several issues, such as implementation complexity of MT, new mechanism for determining/sending additional TA command.****Observation 2:*** *To achieve slot level alignment of MT and DU simultaneously reception, negative TA is required to be implement at IAB MT, and negative TA leads to symbol puncturing, it may impact PUCCH transmission.****Proposal 1****: Dynamic switching between legacy UL Tx timing and Case 6 timing should be supported.****Proposal 2****: To achieve Case 6 timing, IAB MT can determine its Tx timing by referring to co-located DU Tx timing.****Proposal 3:*** *Case 7 timing is supported to enhance self-interference cancelation for multiplexing scenario Case 4.****Proposal 4:*** *Dynamic switching between legacy UL Tx timing and Case 7 timing should be supported.****Proposal 5:*** *Case 7 timing can be achieved under current TA framework, i.e. existing TA for legacy UL Tx timing plus an offset.****Proposal 6****: Symbol level alignment should be supported for Case 7 timing.* |
| vivoR1-2007685 | **Proposal 1: Enhance negative TA indication method to support Case #7 timing mode as defined in TR38.874.** |
| Fujitsu R1-2007786 | **Observation 1: Symbol-level alignment for case#7 timing in which UL RX timing is ahead of DL RX timing by a few symbols can be achieved by using the legacy TA mechanism.****Observation 2: Slot-level alignment for case #7 can be achieved by introducing a symbol level timing shift in addition to the symbol-level alignment. The IAB node can schedule the child node and/or UEs which****is capable or not capable of symbol level timing shift in the same slot.****Proposal 1: Support slot-level alignment of case #7 timing for simultaneous operation of MT RX/DU RX in Rel-17.****Observation 3: In a scenario where simultaneous TX is operated by using a single panel, UL TX timing is not adjusted by the TA.****Observation 4: In a scenario where the UL TX and the DL TX are operated by using separate panels, the requirement on the degree of timing alignment for simultaneous TX is not clear. From the perspective of RX operation at the parent node, it may still be useful to apply TA to the UL TX in a slot used for simultaneous TX.****Proposal 2: Clarify the requirement on the degree of timing alignment of case#6 timing for multi panel scenarios.** |
| CMCCR1-2008030 | **Observation 1: When multiple child nodes supporting Case 6 timing are scheduled in the same occasion, the UL reception timing at the IAB node may not be aligned. The misalignment that cannot be****covered by the CP will cause performance degradation.****Observation 2: When a legacy UE is scheduled with a child node supporting Case 6 in the same occasion, of which the propagation delay is twice larger than that of the child node, negative TA should****be introduced to the UE.****Observation 3: Either slot-level alignment or symbol-level alignment can be used for supporting Case 7 timing. For the slot-level alignment, negative TA should be introduced. For the symbol-level alignment, the current TA mechanism can be reused.****Proposal 1: The support of the Case 6 timing should be controlled by the parent node.****Proposal 2: The following solutions can be considered to achieve the alignment to support Case 7 timing:*** **Alt 1: Introduce negative TA for IAB nodes to achieve the slot-level alignment of the MT DL and DU UL timing;**
* **Alt 2: Reuse the current TA mechanism, symbol-level alignment of the MT DL and DU UL timing is applied**

**Proposal 3: Timing mode should be defined (either a new timing mode or an enhanced Case 7 timing) to facilitate the simultaneous operation of MT-Tx and DU-Rx.** |
| SamsungR1-2008185 | ***Proposal 1: For multiplexing Case A, Case #1 and Case #6 timing are always time multiplexed in Rel-17.******Proposal 2: For multiplexing Case B, symbol alignment is supported in Rel-17.*** |
| AT&TR1-2008313 | **Proposal 4: Case 6 and Case 7 timing is only applied in resources which are orthogonal from those used by access or TDM-only backhaul links.** |
| LG ElectronicsR1-2008407 | ***Observation 1:*** If it is assumed for Case 7 timing that the both slot and OFDM symbol boundary of IAB-DU is aligned with received time duration (i.e., slot and OFDM symbol) of IAB-MT, the slot boundary of IAB-DU needs to be changed for receiving UL signal.***Observation 2:*** Even if the slot boundary of IAB-DU is not aligned with that of received signal of IAB-MT, Case 7 timing can be operated based on the assumption of OFDM symbol level alignment between IAB-DU and IAB-MT.***Proposal 1:*** Discuss whether the assumption that slot-level timing alignment within IAB-node (i.e., between IAB-DU Rx and IAB-MT Rx) is needed or not for operating the cases of timing alignment for IAB. And, discuss whether slot boundary of IAB-DU for both downlink and uplink should be kept or not for operating the timing alignment cases for IAB.***Proposal 2:*** Discuss TA indication mechanism and UE behavior for enabling case 7 timing.* The examples of solutions captured in TR38.387 can be starting points for discussion.
* Which type of container (e.g., MAC-CE, RRC) is used for TA indication

***Proposal 3:*** Case 7 like Timing (e.g., Case 7D timing) is supported for multiplexing scenario Case D (simultaneous MT-Tx/DU-Rx). Unified mechanism is designed for Case 7 timing and Case 7 like timing.***Proposal 4:*** Discuss an indication mechanism and UE behavior for enabling case 6 timing.* The examples of solutions captured in TR38.387 can be a starting points for discussion.
 |
| ZTE, SanechipsR1-2008859 | ***Proposal 1: Parent node can indicate which timing between case-1 timing and case-6 timing is used for UL transmission at a particular slot to its child node.******Proposal 2: UL-Tx timing of case-6 timing should be further studied by RAN4.******Proposal 3: Symbol level alignment between IAB node’s UL-Rx timing and DL-Rx timing should be supported as a solution to resolve potential negative TA issue of case-7 timing.******Proposal 4: So-called “case-7 timing” is not supported for multiplexing case D (i.e., simultaneous MT-Tx/DU-Rx).******Observation 1: In multiplexing Case A, TDM-based resource allocation among access UEs and different child IAB nodes should be applied to resolve the UL Rx timing asynchronization issue caused by case-6 timing alignment.******Observation 2: Case-6 timing will also seriously affect RAN4’s specification work.******Observation 3: Slot level alignment of case-7 timing may have more compatibility issues with legacy access UEs.******Observation 4: Whether “case-7 timing” is supported for simultaneous MT-Tx/DU-Rx depends on the clear decision whether MT-Tx/DU-Rx still needs to support when multi-panel does not have good isolation. If no, the FFS should******be completely omitted.******Observation 5: The so-called “case-7 timing” for simultaneous MT-Tx/DU-Rx is a new kind of timing mode which has not been discussed during Rel-15 SI.******Observation 6: If MT-Tx/DU-Rx timing alignment was supported, several serious problems may happen due to chain reaction:***▪ ***The time offset between UL-Rx timing and DL-Tx timing (i.e., Tdelta) would be increased as IAB node’s hopping number increases.***▪ ***Any adjustment of UL-Tx timing of an IAB node would lead to adjustments of UL-Tx timing on all its follow-up hops.*** |
| Nokia, Nokia Shanghai BellR1-2008864 | **Observation 1: The spec impact when introducing new timing information to support Case #6 timing mode is minimal as most of the design and signalling of Case #1 can be reused.****Proposal 1: The following shall be supported for Case#6 timing.**o **Signaling the time difference of the DL Tx and UL Rx timing at the parent node in order to correct potential misalignment of the DL Tx timing at the child node (Alt.2 agreed for Case#6 in the Rel-16 IAB SI).**o **Use the existing timing delta MAC-CE to indicate the time difference of the DL Tx and UL Rx timing at the parent node.****FFS: Required range and granularity for the time difference of the DL Tx and UL Rx timing at the parent node.****Observation 2: Case#7 timing can apply the same principles as Case#1 with the exception to consider possible negative values of TA. This could be compensated with proper TA control on the child link(s) to reach symbol****alignment of MT and DU RX signals.****Observation 3: Rel.17 T\_delta signalling and its value range can be used with Case#7 timing.****Proposal 2: Alternatives for Case #7 timing control, discussed during the SI phase, can be taken as the basis for possible Rel.17 timing enhancement.** |
| ETRIR1-2009019 | **Proposal 1**: We propose discussing possible specification impacts of the timing alignment method that aligns DU-Rx timing to MT-Tx timing for supporting simultaneous MT-Tx/DU-Rx. |
| Lenovo, Motorola Mobility R1-2009109 | **Proposal 1: Deprioritize timing alignment for Case C and Case D duplexing.****Proposal 2: Support configuration and control signaling for applying Case‐6 and Case‐7 timing alignment at enhanced IAB nodes.****Proposal 3: Define signaling to communicate information of the parent link propagation delay to child IAB nodes.** |
| NTT DOCOMO, INC.R1-2009191 | **Proposal 1: Indication of implementing multiple transceivers/antenna panels should be reported.****Proposal 2: MT UL Tx timing should be controlled by TA as in Rel-15/16 for all cases (“case #1”, “case #6”, and “case #7”)****Proposal 3: IAB node should set its DL Tx timing ahead of its DL Rx timing by TA for case #6 timing mode.****Proposal 4: IAB node should set its DL Tx timing ahead of its DL Rx timing by TA/2 + T1/2 for case #7 timing mode. T1 is signalled from the parent node, which is the offset between parent DU Tx and DU Rx.****Proposal 5: IAB node should recognize TA types (case #1, case #6, case #7) to derive DL Tx timing.****Proposal 6: Negative TA value should be supported for case #7 timing mode.****Proposal 7: Detailed signalling design for negative TA in MAC RAR should be specified and following alternatives can be considered.****Alt.1: Indicate negative or positive for TA value in MAC RAR using 1 reserved bit****Alt.2: Reserved values of TA in MAC RAR (values from 3847 to 4095) is used to indicate negative TA,****e.g.** 𝑵𝑻𝑨\_𝒏𝒆𝒈𝒂𝒕𝒊𝒗𝒆 =(𝟑𝟖𝟒𝟔 - 𝑻𝑨\_𝒏𝒆𝒈𝒂𝒕𝒊𝒗𝒆) ∗ 𝒈𝒓𝒂𝒏𝒖𝒍𝒂𝒓𝒊𝒕𝒚 |
| Qualcomm IncorporatedR1-2009270 | **Observation 2.1:****Operation in Case 6 timing mode of an IAB-node may cause uplink interference at the IAB-DU receiver of its parent node and/or may require special handling in the uplink scheduler of its parent node to TDM users to****avoid such interference. This concern is addressed by letting the parent node be in control of Case 6 timing at a child node.****Observation 2.2:****Case 6 timing at a given IAB node can be achieved by the parent node controlling the IAB node UL timing appropriately.****Observation 2.3:****OTA synchronization for IAB can be achieved using the Rel-16 mechanism concurrently with Case 6 timing controlled by the parent node.****Proposal 2.1:****Case 6 timing is supported using Rel-16 mechanisms.****Observation 2.4:****Operation in Case 7 timing mode may require in some conditions a negative effective TA on the uplink transmission timing. Specifically, this would occur when the one way delay to the parent node is larger than the****round trip delay to the child node.****Proposal 2.2:****The effective TA for UL timing control is extended to the negative domain for the IAB-MT.** |
| EricssonR1-2009302 | **Observation 1 For Case‐6, the UL reception of an IAB‐node is delayed due to the propagation delay of the child backhaul link and for Case‐7, the UL reception of an IAB‐node is delayed due to the propagation delay of the parent backhaul link.****Observation 2 For both Case‐6 and Case‐7, a Rel‐15 UE can have a negative timing advance for certain link conditions.****Observation 3 A UE connected to an IAB‐node that operates with timing aligned transmission or reception, may require a negative TA.****Observation 4 NR does not support Rel‐15/16 UEs, connecting to an IAB‐node operating with timing aligned transmission or reception, having a negative TA already during the RA phase. And as a consequence, such UEs might not be able to complete RA to IAB‐node****operating in a Case‐6 or Case‐7 timing configuration on access links.****Observation 5 In Case‐7, no additional signaling is required to align the UL reception timing of an IAB-node to its DL reception timing.****Observation 6 In Case‐6, a T\_delta‐based OTA timing alignment does not require any principal change of method and signaling type compared to Case‐1, only a new range specification.****Proposal 1 Specification on simultaneous transmission or reception is limited to only consider operation on backhaul links.****Proposal 2 Adopt Scenario 2 as defined in RAN4 (i.e., transmissions on BH links only in DL time slots) as baseline for studies related to simultaneous transmission or reception of IAB-nodes.****Proposal 3 Adapt T\_delta based Rel‐16 Case‐1 timing alignment as baseline for Case‐6 timing synchronization.** |

**FL Proposal 2.1**

**Case 7 timing is supported with at least symbol level alignment.**

* **FFS whether slot level alignment needs to be supported.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 2.1?** | **Comments** |
| AT&T | Yes | In our view, slot level alignment is beneficial to minimize interference and useful for certain implementations (including shared MT/DU panels). At the same time, since it requires new negative TA functionality it should be limited to only resources multiplexing child and parent backhaul links |
| Ericsson | No | Symbol level alignment is a prerequisite for OFDMA and is hence supported by all timing cases. Instead we think the proposal should state that slot level alignment may not be required, e.g.,**Case 7 timing supports slot level misalignment with symbol level alignment.** |
| Nokia  | Yes  | It is much easier to support symbol level alignment without needing of negative TAs  |

**FL Proposal 2.2:**

**Case 1, Case 6 and Case 7 timing modes need not to be restricted to specific multiplexing modes (e.g. Case A, B, C, D).**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 2.2?** | **Comments** |
| AT&T | Yes | We do not see a clear need for any such restriction given that these additional timing modes will be optional to implement in practice. |
| Ericsson | No | It is our understanding that Case 6 timing is associated with Case A MUXing and Case 7 timing is associated with Case B MUXing and would prefer a more concrete proposal for timing and multiplexing combinations. |
| Nokia  | Yes  | Case #6 and Case #7 are directly related to different cases and should be specific to those modes. However, we think that additional spec work is not required for this.   |

**FL Proposal 2.3**

**Rel-16 OTA time synchronization is supported when operating in Case 6 and Case 7 timing modes.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 2.3?** | **Comments** |
| AT&T | Not sure | Perhaps it is better to be more specific and discuss what modifications are necessary for T\_delta and associated signaling to support Case 6/7 timing modes? Also we think it should be discussed how new timing modes coexist with Rel-16 operation and each other. |
| Ericsson | Yes | A new range for T\_delta will likely be needed, but this can likely be comprised within the existing signalling format. |
| Nokia  | Not sure  | The intention of the proposal is not clear to us. What is meant by Rel-16 OTA time synchronization here ? is that T\_delta that is needed defined for Case #1, or include any other aspects. For Case #6, it is not required to have Case #1 timing.   |

**FL Proposal 2.4**

**Case 6 timing at an IAB-node is under the control of the parent node to which the UL transmission is intended for.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 2.4?** | **Comments** |
| AT&T | Not sure | It is unclear what is the implication of the proposal on the co-located child DU Tx timing. At the same time some level of parent node awareness/control of the usage of Case 6 timing seems to be needed. |
| Ericsson | Yes |  |
| Nokia  | Yes, partly  | May be the wording is not fully clear. But we agree that as we did in the SI stage, the use of Case #6 in UL at the IAB MT should be at least controlled by the parent as parent node UL Rx is impacted by this.   |

### 3 – Discussion on interference management

**Topic 3.1**

This discussion topic relates to the discussion on the relevant interference scenarios that should be further discussed.

Related input from contributions:

|  |  |
| --- | --- |
| Huawei, HiSiliconR1-2007595 | ***Observation 5:*** *For uplink full-duplex, IAB node may not be able to cancel the self-interference if the power gap between the interference and desired signals is too large, and the power gap can be reduced by enhanced power control of MT.****Observation 6:*** *For downlink full-duplex, IAB node may not be able to cancel the self-interference if the power gap between the interference and desired signals is too large, and the power gap can be reduced by decreasing DU transmission power which is an implementation issue.****Observation 8:*** *Different from conventional CLI scenarios including BS-BS and UE-UE interference, the interference from IAB backhaul link is relative stable and can be well managed.****Proposal 8:*** *For the enhancements on CLI and interference measurements of BH links, the interference between MT and DU, inter-UE interference, interference from UE to MT, interference from MT to UE should be studied.****Proposal 10:*** *To handle various types of interference, regardless of interference source is MT or DU, a unified CLI measurement and management framework can be adopted in IAB.*  |
| vivoR1-2007685 | **Proposal 5: Reuse Rel-16 CLI framework for interference management in IAB network, e.g. intended TDD configuration exchange between gNBs and the related CLI measurement and report schemes.****Proposal 7: In the moment of simultaneous MT Tx/DU Rx, MT determines UL transmission power based on MT-to-DU self-interference.****Proposal 8: In case simultaneous MT Rx/DU Tx or MT Rx/DU Rx is enabled, support measurement/report of DU-to-MT self-interference or UE/MT-to-MT interference respectively.** |
| CMCCR1-2008030 | **Proposal 5: The measurement to prevent the self-impulse interference in simultaneous transmission and reception of IAB should be discussed and introduced.** |
| SamsungR1-2008185 | ***Proposal 4: Rel-16 CLI is a starting point at least for MT-to-MT interference in Rel-17.*** |
| AT&TR1-2008313 | **Proposal 1: DU‐DU and MT‐MT CLI measurements such as short‐term (L1/L2) and long term (L3) measurements, multiple antenna and beamforming based measurements should be studied to enable CLI mitigation in IAB.****Proposal 2: Specify, if needed, enhancements to UE‐UE Rel. 16 CLI measurement framework.****Proposal 3: Specify DU‐DU CLI measurements techniques to enable CLI mitigation for IAB.** |
| LG ElectronicsR1-2008407 | ***Proposal 5:*** Discuss which cases of inter-IAB-node interference scenario is/are targeted for Rel-17 eIAB.* Case 1: Victim IAB-node is receiving in DL via its MT, interfering IAB-node is transmitting in ULvia its MT;
* Case 2: Victim IAB-node is receiving in DL via its MT, interfering IAB-node is transmitting in DLvia its DU;
* Case 3: Victim IAB-node is receiving in UL via its DU, interfering IAB-node is transmitting in UL via its MT;
* Case 4: Victim IAB-node is receiving in UL via its DU, interfering IAB-node is transmitting in DL via its DU.

***Proposal 7:*** Discuss whether/how to operate measurement of intra-IAB interference. |
| CEWiT, Tejas Networks, Reliance Jio, IITM, Saankhya Labs, IITHR1-2008816 | **Observation 3:** The amount of SI cancellation is implementation specific. Having multi-panel does not fully ensure that there will be no residual SI.**Observation 4:** Techniques to handle the residual amount of SI will be independent of whether the system is single panel or multi-panel. The technique should be equally applicable to both single and multi-panel to ensure better performance.**Proposal 2:** SI handling methods should be supported for both single panel or multi-panel systems to ensure better performance. |
| NTT DOCOMO, INC.R1-2009191 | **Proposal 10: No additional mechanism is necessary for cross link interference for IAB.** |
| Qualcomm IncorporatedR1-2009270 | **Observation 3.1:****There are two self-interference components:**‐ **Local coupling between the transmit and receive antennas**‐ **Reflection of the transmitted signal, by a remote object, back to the receive antennas**.**The amount of self-interference (and hence the efficiency of full-duplex capability) depends on TX and RX beamforming configurations and may change over time (due to change in the reflections).****Observation 3.2:****To determine how efficiently an IAB-node can operate in the full-duplex mode, it needs to periodically perform SI measurements.****Observation 3.5:**‐ **A standardized DU-to-DU CLI management is needed for inter-operability and especially in IAB, for a CU to determine proper resource configurations for its IAB-DUs.**‐ **MT-to-MT CLI measurements/reports may not be always sufficient to provide the required information about the collocated DU-to-DU CLI.****Observation 3.7:****A DU may or may not be capable of supporting dynamic TDD across its served cells – e.g. (DU cell m TX, DU cell n RX).** |
| EricssonR1-2009302 | **Observation 7 IAB‐nodes transmitting in UL slots may jeopardize fundamental network functions on both the same and adjacent carriers.****Proposal 4 Interference caused by operation of IAB‐nodes is assessed in relation to the interference if the IAB‐node was an ordinary gNB.** |

The majority view is that Rel-17 IAB should consider interference scenarios showing up among IAB-nodes (including MT-to-MT, DU-to-DU, MT-to-DU, DU-to-MT).

Many companies also believe self-interference (intra-IAB-node) scenarios, showing up in multiplexing cases C and D, should be further discussed.

A few companies suggest considering the interference between IAB-nodes and non-IAB nodes (e.g. interference between MTs and UEs, or interference between IAB-DUs and non-IAB DUs). Also, only two companies propose to further consider UE-to-UE interference.

**FL Proposal 3.1:**

**Interference management for the following IAB interference scenarios should be discussed:**

**Inter-IAB scenarios including:**

* + **MT-to-MT, DU-to-DU, DU-to-MT, and MT-to-DU.**

**Intra-IAB-node (self-interference) scenarios:**

* + **Interference between a collocated DU and MT.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 3.1?** | **Comments** |
| AT&T | Yes | Since the level of self-interference can potentially be greater than inter-IAB node interference at the victim node, we are OK to differentiate the scenarios for study. However, we do not believe this precludes a common solution framework for measurement and mitigation (e.g. DU Tx -> MT Rx could be handled with a common set of reference signals/signalling regardless of whether the functions are co-located). |
| Ericsson | Partially | First, interference to nodes outside the IAB network must also be considered, in particular for UL slots. Second, we don’t think a discussion about full duplex specific issues is warranted until full duplex has been agreed. |
| Nokia  | Yes, partly  | Agree with the first part, not with the self-interference scenarios. That is not having any spec impact.   |

**Topic 3.2**

This discussion topic relates to the discussion on the interference management (measurement and mitigation) solutions for the relevant interference scenarios.

Related input from contributions:

|  |  |
| --- | --- |
| Huawei, HiSiliconR1-2007595 | ***Observation 5:*** *For uplink full-duplex, IAB node may not be able to cancel the self-interference if the power gap between the interference and desired signals is too large, and the power gap can be reduced by enhanced power control of MT.****Observation 6:*** *For downlink full-duplex, IAB node may not be able to cancel the self-interference if the power gap between the interference and desired signals is too large, and the power gap can be reduced by decreasing DU transmission power which is an implementation issue.****Observation 7:*** *Some specification enhancements can be considered to better support full duplex implementation, such as on self-interference channel estimation.****Proposal 9****: Enhancements on CLI to support the simultaneous operation of IAB MT and DU including inter-multiplexing chain scenarios, at least should consider*- *Interference measurement*- *Interference coordination/management****Proposal 10:*** *To handle various types of interference, regardless of interference source is MT or DU, a unified CLI measurement and management framework can be adopted in IAB.*  |
| vivoR1-2007685 | **Proposal 5: Reuse Rel-16 CLI framework for interference management in IAB network, e.g. intended TDD configuration exchange between gNBs and the related CLI measurement and report schemes.****Observation 1: The CLI interference measurement and report mechanism specified in Rel-16 can be directly reused in IAB network.****Proposal 6: For CLI mitigation, exchange of resource configuration between IAB nodes should be specified, including TDD configuration and/or resource type configuration. Related signaling is up to RAN3.****Observation 2: DU implementation can handle the interference measurement regarding DU Rx interference.****Proposal 7: In the moment of simultaneous MT Tx/DU Rx, MT determines UL transmission power based on MT-to-DU self-interference.****Proposal 8: In case simultaneous MT Rx/DU Tx or MT Rx/DU Rx is enabled, support measurement/report of DU-to-MT self-interference or UE/MT-to-MT interference respectively.** |
| CMCCR1-2008030 | **Proposal 5: The measurement to prevent the self-impulse interference in simultaneous transmission and reception of IAB should be discussed and introduced.** |
| SamsungR1-2008185 | ***Proposal 4: Rel-16 CLI is a starting point at least for MT-to-MT interference in Rel-17.*** |
| AT&TR1-2008313 | **Proposal 1: DU‐DU and MT‐MT CLI measurements such as short‐term (L1/L2) and long term (L3) measurements, multiple antenna and beamforming based measurements should be studied to enable CLI mitigation in IAB.****Proposal 3: Specify DU‐DU CLI measurements techniques to enable CLI mitigation for IAB.** |
| LG ElectronicsR1-2008407 | ***Proposal 6:*** For the Case 1 (Victim IAB-node is receiving in DL via its MT, interfering IAB-node is transmitting in UL via its MT) of inter IAB-node interference scenario, Rel-16 CLI measurement and handlingmechanism can be applied.* Considering the IAB specific TDD configuration (i.e., U-F-D), measurement resource configuration and/or signalling for network coordination (i.e., intended UL/DL configuration) can be modified.

***Proposal 7:*** Discuss whether/how to operate measurement of intra-IAB interference. |
| CEWiT, Tejas Networks, Reliance Jio, IITM, Saankhya Labs, IITHR1-2008816 | **Observation 1:** Using Rel. 16 CLI management scheme, which is not designed specific to IAB network, the CLI measurement accuracy of SRS RSRP will be degraded due to factors like network synchronisation error, unknown propagation delays between the IAB nodes, very less CP duration in FR2, different TA across nodes, large distance between child and parent node etc.**Proposal 1:** Mechanism specific to IAB network to improve the CLI measurement accuracy as compared to Rel. 16 CLI management is needed.**Observation 2:** Resource partitioning methods can help to overcome the impact of simultaneous operation of IAB node on access UEs.**Proposal 2:** SI handling methods should be supported for both single panel or multi-panel systems to ensure better performance.**Observation 5:** IAB node MT might need time-frequency resources for SI measurement, which are free from backhaul reception and transmission. This requires cooperation with the parent.**Proposal 3:** SI measurement occasions are required at an IAB node operating in Case C and Case D. The following options can be considered in configuring SI measurement occasions**Alt 1:** Parent node configures measurement occasions to IAB-MT at regular intervals**Alt 2:** IAB node requests for measurement occasions to parent node and parent-DU configures it**Alt 3:** IAB node configures measurement occasions and report it to parent node in advance**Observation 6:** Severe SI/CLI will not always allow an IAB node to work insimultaneous Tx and/or Rx mode of operation efficiently.**Proposal 4:** In case of severe interference, IAB node signals fall back request to parent and donor node, and switches to TDM mode with default configuration after receiving confirmation from the parent node. The default configuration of the fall back TDM mode is configured by the parent node either semi-statically or dynamically.**Proposal 5:** For Case D, there should be a feedback mechanism regarding theinterference at an IAB node from MT to the parent to aid power control. |
| ZTE, SanechipsR1-2008859 | ***Proposal 9: The existing TCI scheme can be a starting point in support of CLI mitigation for multiplexing Case B.******Proposal 10: The existing SRI scheme can be a starting point in support of CLI mitigation for multiplexing Case A.*** |
| Nokia, Nokia Shanghai BellR1-2008864 | **Proposal 3**: **An IAB node can be configured to be made aware of the semi-static DU resource configuration (D/U/F/H/S/NA) of its parent IAB node(s) and neighboring nodes.** |
| Lenovo, Motorola Mobility R1-2009109 | **Proposal 5: Consider enhancements for improving resource management and timing adjustment for CLI measurements in IAB systems.** |
| NTT DOCOMO, INC.R1-2009191 | **Proposal 10: No additional mechanism is necessary for cross link interference for IAB.** |
| Qualcomm IncorporatedR1-2009270 | **Observation 3.2:****To determine how efficiently an IAB-node can operate in the full-duplex mode, it needs to periodically perform SI measurements.****Proposal 3.1:****SI measurement can be performed autonomously by an IAB-node.****Proposal 3.2:****Extend the enhanced multiplexing capability indication as follows:*** **(a) support local refinement indication of the enhanced multiplexing capability (i.e. whether the capability is available to what degree under which conditions) to the parent-node (e.g. via MAC-CE)**
* **(b) support indicating to the CU the configuration(s) required to enable an enhanced multiplexing capability**
	+ **e.g. for which beams (SSBs) or which served child-nodes, the IAB-node can operate in the enhanced multiplexing mode.**

**Observation 3.3:*** **Rel-16 CLI framework does not support coordination across CUs to indicate the SRS configurations for UEs/IAB-MT’s CLI measurement.**
* **Rel-16 CLI signaling (intended TDD configuration) should be extended to support IAB-specific resource configurations.**

**Proposal 3.3:****Send an LS to RAN3 to (a) support exchange of SRS configurations among CUs for CLI measurements, and (b) extend the intended TDD configuration signaling to support IAB-specific resource configurations.****Observation 3.4:*** **Rel-16 CLI measurements are RRC configured, and reports are L3 reports. Hence the DU (or parent-node DU) is not involved in configuring the measurements of its UEs (or child MTs) and more importantly does not know about the result of their CLI measurements.**
* **IAB-MTs may be subject to strong and persistent CLI from other IAB-nodes.**

**Proposal 3.4:****An IAB-DU is provided with the result of CLI measurements by its child MTs, e.g. which child MTs are subject to strong CLI from neighboring nodes.****Observation 3.6:****An IAB-DU can autonomously measure CLI from neighboring DU cells, based on the available information at the IAB-MT (e.g. SMTC).****Proposal 3.5:****Support IAB-DU reporting the result of its CLI measurements to the CU, e.g. the list of neighboring DU cells with strong CLI can be reported.****Proposal 3.6:****Support IAB-DU reporting multiplexing capability across its served cells (DU cell m TX, DU cell n RX).** |
| EricssonR1-2009302 | **Observation 8 IAB‐nodes transmitting in DL slots will mostly limit interference to within the IAB network.****Proposal 5 Limit IAB‐node transmissions to DL slots.****Proposal 6 Adopt RAN4’s Scenario 2 for Rel‐17.** |

The majority view is to extend the Rel-16 CLI to handle inter-IAB interference scenarios. Companies propose various ideas to extend Rel-16 CLI:

* Specify DU-to-DU CLI management
* Extend the information exchange (e.g. the resource configuration, result of CLI measurements, etc.) among different entities
* Enhance the CLI measurement accuracy (e.g. via timing adjustment, etc.)
* Extend CLI measurements (e.g. introducing short-term measurements, multi-beam measurements, etc.)

To handle intra-IAB interference (self-interference):

* For self-interference (SI) measurement: some companies propose to specify SI measurement configurations, others suggest leaving the measurements to implementation.
* For SI report: most of the companies, commenting on this topic, believe an IAB-node should notify the network about the result of its SI measurement – e.g. via SI measurement report, sending minimal indication (e.g. a fallback indication, or conditions required to support operating in the enhanced multiplexing modes), UL Tx power adjustment suggestion to the parent-node, etc.

To further mitigate the interference, in various scenarios, companies also propose:

* Enhanced DL/UL power control (which is the subject of the next Section),
* Resource and beam coordination.

**FL Proposal 3.2a:**

**Extend the Rel-16 CLI framework to handle inter-IAB interference scenarios.**

* **FFS: specify DU-to-DU CLI management**
* **FFS: extend the information exchange (e.g. the resource configuration, result of CLI measurements, etc.) among different entities**
* **FFS: enhance the CLI measurement accuracy (e.g. via timing adjustment, etc.)**
* **FFS: extend CLI measurements (e.g. introducing short-term measurements, multi-beam measurements, etc.)**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 3.2a?** | **Comments** |
| AT&T | Mostly | As we mentioned in the comments to Proposal 3.1, it is unclear if SI measurement requires an independent framework from interference measurement for other multiplexing cases and it is good to strive for as much of a common framework at this stage.So we would prefer a bit more generic wording of the proposal:**Extend the Rel-16 CLI framework to handle ~~inter-~~IAB interference scenarios.** |
| Ericsson | Partially | We think we should discuss whether DU-to-DU CLI management can recycle the existing RIM framework. Furthermore, MT-to-MT can follow existing UE-to-UE CLI management. Per Proposal 3.1, also DU-to-MT and MT-to-DU interference management may need to be included. |
| Nokia  | Yes  | We think that wording should be bit relaxed here as specification impact is not fully clear with different proposals.   Extend the Rel-16 CLI framework to handle inter-IAB interference scenarios. * FFS: ~~specify~~ consider required enhancements on DU-to-DU CLI management
* FFS: extend the information exchange (e.g. the resource configuration, result of CLI measurements, etc.) among different entities (e.g. between parent-child nodes, adjacent IAB nodes)
* FFS: enhance the CLI measurement accuracy (e.g. via timing adjustment, etc.)
* FFS: ~~extend~~ required enhancements on CLI measurements (e.g. introducing short-term measurements, multi-beam measurements, etc.)
 |

**FL Proposal 3.2b:**

**An IAB-node capable of operating in multiplexing Case C (MT-Rx/DU-Tx) and/or Case D (MT-Tx/DU-Rx) should perform self-interference (SI) measurement.**

* **FFS: specify SI measurement configuration or leave it to implementation.**
* **FFS: report of SI measurement result.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 3.2b?** | **Comments** |
| AT&T | Yes | But see our response to Proposal 3.2a. |
| Ericsson | No | As stated earlier, we don’t think a discussion about full duplex specific issues is warranted until full duplex has been agreed. Despite that, we think any self-interference measurements would be up to implementation. |
| Nokia  | No  | This does not have spec impact and should be pure implementation handling.   |

**FL Proposal 3.2c:**

**Consider resource and beam coordination techniques to mitigate/avoid interference.**

* **FFS: limit IAB‐node transmissions to DL slots.**
* **FFS: whether Rel-16 resource management framework is sufficient.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 3.2c?** | **Comments** |
| AT&T | Yes | This may have some dependencies with discussions in Agenda 8.10.1 on whether/how the Rel-16 resource indication framework is extended to support new multiplexing cases, so we don’t think the second FFS bullet is needed here (but also doesn’t hurt) |
| Ericsson | Yes | Regarding limitations to DL slots, we think that a discussion of IAB backhaul operations in UL slots must address legacy UE timing issues (potential negative TA during RA) w.r.t. Case 6 and Case 7 timing (either here or in the timing section). |
| Nokia  | Yes  | We are open to discuss issues within this.   |

### 4 – Discussion on power control

**Topic 4.1**

This discussion topic relates to the discussion on the need for enhanced power control and the related solutions.

Related input from contributions:

|  |  |
| --- | --- |
| Huawei, HiSiliconR1-2007595 | ***Observation 3:*** *Transmission power gap may degrade the quality of the weaker signal, and this may be mitigated by uplink power control of MT or the downlink power control of DU.****Observation 4:*** *Reception power gap may lead to performance deterioration of the link with lower reception power, and this issue can be mitigated by network implementation.****Observation 5:*** *For uplink full-duplex, IAB node may not be able to cancel the self-interference if the power gap between the interference and desired signals is too large, and the power gap can be reduced by enhanced power control of MT.****Observation 6:*** *For downlink full-duplex, IAB node may not be able to cancel the self-interference if the power gap between the interference and desired signals is too large, and the power gap can be reduced by decreasing DU transmission power which is an implementation issue.****Proposal 7:*** *Enhanced power control mechanism should focus on IAB MT.* |
| vivoR1-2007685 | **Proposal 2: RAN1 to consider the following power control enhancement options for the purpose of Rx PSD imbalance mitigation at IAB node, with preference to option 1:**- **Option 1: IAB node to send desired TX power adjustment information to parent node to assist the DL transmission power control of parent node.**- **Option 2: IAB node to consider DL reception power from parent node upon performing its UL power control.****Proposal 3: For the purpose of Tx PSD imbalance mitigation and transmission power sharing between DU and MT at IAB node, the total transmission power and EPRE split between DU and MT should be coordinated, e.g., via CU.**- **Power coordination schemes specified for NR-DC is taken as the starting point.****Proposal 4: Regarding transmission power sharing between DU and MT, RAN1 to study the impact on power sharing mechanism of NR-DC operation.****Proposal 7: In the moment of simultaneous MT Tx/DU Rx, MT determines UL transmission power based on MT-to-DU self-interference.** |
| CMCCR1-2008030 | **Proposal 4: The power control should be enhanced for both uplink and downlink considering the issue of transmit power imbalance, signal blockage due to AGC and interference of simultaneous****transmission and reception.** |
| SamsungR1-2008185 | ***Proposal 3: Discuss reception power imbalance and transmission power splitting issues in Rel-17.*** |
| AT&TR1-2008313 | **Proposal 5: DL and UL power control enhancements should be supported to allow for inter‐ and intra‐panel SDM/MPTR of backhaul and access links.** |
| LG ElectronicsR1-2008407 | ***Proposal 8:*** It should be clarified or identified which type of UL power class is applied for IAB-MT.• Power class of normal UE should be applied for IAB-MT during the time designated for UE transmission.• Power class of gNB can be applied for IAB-MT during time designated for gNB transmission.***Proposal 9:*** The details of configuration to designate power class for IAB-MT should be discussed.***Proposal 10:*** It should be discussed whether DL power control depending on the type of resources is considered or not when simultaneous operation is applied (e.g., IAB-MT Rx/ DU Rx, Rx/Tx).***Proposal 11:*** The IAB-MT assisted DL power control should be discussed. |
| CEWiT, Tejas Networks, Reliance Jio, IITM, Saankhya Labs, IITHR1-2008816 | **Proposal 5:** For Case D, there should be a feedback mechanism regarding theinterference at an IAB node from MT to the parent to aid power control. |
| ZTE, SanechipsR1-2008859 | ***Proposal 5: Beam depended DL power control of IAB-DU should be considered (e.g., different PC parameters could be associated with different TCI states, or CSI-RSs).******Proposal 6: Expected DL Rx power level or equivalent parameters could be indicated from child node to IAB node to assist the DL power control of IAB-DU.******Proposal 7: UL power control mechanism of NR access UEs can be used as a starting point of UL power control mechanism for MTs to minimize the impact on specification.******Proposal 8: For UL power control of child-MT, different maximum allowed Tx power can be indicated to IAB node for different multiplexing scenarios or time resources.*** |
| Intel corporationR1-2008996 | **Proposal 1:** Baseline DL power control mechanisms (open-loop and closed-loop DL power control) should be supported to fulfil child node assisted DL power control.**Proposal 2:** Introduce TPC for DU from parent DU to IAB MT for parent node assisted DL power control.**Proposal 3:** Child node assisted or parent node assisted UL power control can be fulfilled with existing UL power control mechanisms. |
| ETRIR1-2009019 | **Proposal 2**: Discuss how to split transmit powers between the MT and DU at an IAB node when in a MT-TX/DUTX mode.**Proposal 3**: Discuss uplink and downlink transmit power mechanism to avoid received power imbalance at the MT and DU of the IAB node.**Proposal 4**: Discuss transmit power control scheme considering self-interference cancellation capability of the IAB node. |
| Lenovo, Motorola Mobility R1-2009109 | **Proposal 4: Support power control configurations and signaling at least for Case A and Case B duplexing.** |
| Sharp R1-2009137 | **Proposal 1:**The scope of the power control enhancements should be limited. In the WID, the limitation is mentioned between parent-child links, and so the *control* should take place between these links, but also CLI *measurements* should be limited to minimize signaling.**Proposal 2:**Specification of power control for IAB nodes should appropriate as much as is feasible from the existing power control framework of NR.**Proposal 3:**The scope of the power control enhancements should consider MT/DU power transmit requirements and capabilities dependent on the RF parameters involved, duplex capability, etc. We do not see this as in conflict with FL proposal 5.1 from RAN1 #102-e.**Proposal 4:**FL Proposal 5.1b can be agreed with the understanding that “assistance information” can include, but is not be limited to configured total power allocations for IAB-nodes. In addition, said assistance information may re-use mechanisms from LTE €ICIC, reference signals, and so forth. |
| NTT DOCOMO, INC.R1-2009191 | **Proposal 8: Power adjustment between DU DL and MT UL should be considered.****Proposal 9: Assistant information for DL power control at parent node can be semi-statically and/or dynamically reported by IAB-node for simultaneous MT and DU reception.** |
| Qualcomm IncorporatedR1-2009270 | **Observation 4.1:****In case of (MT TX, DU TX), the potential power issues may happen only if MT and DU share the same Pas and antennas for their concurrent transmissions. In which case,**‐ **TX power imbalance seems to be less of a concern.**‐ **TX power sharing rules are needed.****Observation 4.2:****In case of (MT TX, DU TX), and if TX power adjustment is needed to address either a power sharing or a power imbalance issue, the IAB-node prioritizes between its MT’s UL TX and DU’s DL TX based on the DU’s resource type (HARD and SOFT).****Note: SSB and CSI-RS should be transmitted with constant power.****Observation 4.3:****In case of (MT RX, DU RX), MT’s received DL signal can be too strong that it may block DU’s reception of an UL signal.****Proposal 4.1:****Support CU providing an IAB-DU, for each of its served cells, an indication of the max allowed DL TX power.** |
| EricssonR1-2009302 | **Observation 9 Power control in DL broadcast signals and channels will affect cell coverage.****Observation 10 To suit all IAB‐DU power control requirements would necessitate slot‐by‐slot or symbol-by‐symbol power control which is infeasible.****Proposal 7 The specification should allow for different IAB‐MT power control capabilities, considering existing and future HW architectures.****Proposal 8 DL power control is optional for IAB‐DU.****Proposal 9 Further study DL power control for PDCCH and PDSCH.** |

Based on the contributions, there is consensus that enhanced power control mechanisms may be helpful to address Rx power imbalance, Tx power imbalance, Tx power sharing, and self-interference mitigation.

Most companies propose to introduce enhancements to both DU’s DL and MT’s UL power control. A few companies suggest that power control may be handled by implementation within the existing power control framework. A few companies also raised concerns about IAB-node implementations that may have limited MT/DU power control capability.

Some companies propose an IAB-node may provide assisting information to help the parent-node with the parent-node’s DL and/or IAB-node’s UL Tx power adjustment. Some companies also suggest the coordination (e.g. in terms of max Tx power) can be done centrally (e.g. by CU).

**FL Proposal 4.1:**

**Introduce enhanced DL and UL Tx power control mechanism.**

* **FFS: DL/UL power control with assistance information from the child node**
* **FFS: DL power control with assistance information from the parent node**
* **FFS: Central power control coordination (e.g. semi-static max DL/UL Tx power limits)**

**Any power control mechanism should consider:**

* **existing base station design principles related to transmission power.**
* **network constraints in regard to transmitted reference signals.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Do you agree with FL Proposal 4.1?** | **Comments** |
| AT&T | Yes | Since the optimal Tx power/power control mechanisms may be highly correlated with the resource multiplexing case, coexistence of different power control mechanisms within an IAB node and across the network may need to be further considered as well:**FFS: Coexistence of different power control mechanisms within an IAB node and in the network** |
| Ericsson | Partially | This topic is also highly depending on what multiplexing cases are eventually agreed and is for that reason a bit premature to agree on. Further, we think FFS #2 is wrongly formulated since the parent node should have no role in controlling the IAB-DU’s DL transmit power. |
| Nokia  | Yes, partly  | It is not clear what we introduce when all sub-bullets are FFS.  We are ok to further study these, so wording should be changed.  FL Proposal 4.1: ~~Introduce~~ Further study requirement of enhanced DL and UL Tx power control mechanism considering the following,  * FFS: DL/UL power control with assistance information from the child node
* FFS: DL power control with assistance information from the parent node
* FFS: Central power control coordination (e.g. semi-static max DL/UL Tx power limits)

Note : Any power control mechanism should consider the following aspects * existing base station design principles related to transmission power.
* network constraints regarding transmitted reference signals.
 |
| Sharp | Yes, with clarification | We mostly agree with AT&T and Ericsson, but we think the involvement of the parent node in FFS #2 depends on clarifying exactly what the assistance information is, and that the involvement in the parent node in DL power control might involve solely transmission from CU as to configuration of TPC parameters and such via the parent node.  |