**3GPP TSG RAN Meeting #90e RP-20xxxx**

**Electronic Meeting, December 7- 11, 2020**

**Agenda item:** 9.8.10

**Source:** Qualcomm Incorporated (Moderator)

**Type:** Report

**Title:** Moderator's summary for email discussion [90E][29][IAB\_DC]

**Document for:** Approval

**Release:** Rel-17

# Introduction

The discussion handles:

|  |
| --- |
| Email thread on finding a way forward on DC scenarios in IAB.  Goal: Generate an agreeable way forward.  Input contributions covered:  2533, 2626, 2672.  Moderator: Georg Hampel. |

The contributions RP-202533, RP-202626 and RP-202672 discuss the support for intra-carrier DC in Rel-17 IAB. All three contributions propose that TSG RAN preclude support for intra-carrier DC for Rel-17 IAB since not enough time would be available within present TU budgeting to handle the technical issues. One contribution claims that intra-carrier DC would not be supported by the Rel-17 IAB WID.

RAN#89e already had a discussion on this topic (RP-202083). In the discussion, 8 out of 15 companies were in favor for intra-frequency DC, 5 companies were opposed while 1 company needed more information. No agreement was reached. There was further no agreement if intra-carrier DC for IAB was compliant with the WID or not.

In this follow-up discussion in RAN#90e, the moderator would like to make further progress. The following is proposed:

**On compliance of intra-carrier DC with Rel-17 WID:** The RAN#89 discussion already indicated that the Rel-17 IAB WID was not sufficiently clear on the support of intra-carrier DC for IAB. For that reason, we will not spend further time on discussing the wording of the Rel-17 WID.

**On the size of the specification effort for intra-carrier DC for IAB:** In the prior discussion, some companies claimed that only little work was needed while others believed it was a major effort. The discussion did not try to scope the effort. We will therefore use the RAN#90 follow-up discussion to identify the main issues that need to be addressed for intra-carrier DC for IAB by each RAN WG. This exercise will provide a better understanding on what needs to be done, and it might make it easier to converge on this topic for Rel-17.

To keep focus, the following assumptions are made:

* Inter-carrier DC is supported in Rel-17 IAB.
* Intra-carrier DC is not supported in Rel-16 IAB.
* The discussion only focuses on intra-carrier DC for IAB, not for UEs.

The contributions to RAN#90e raised the following issues related to intra-carrier DC for IAB:

**RP-202533** claims that there is no verification on the feasibility of intra-carrier DC for IAB. The contribution does not discuss any issues that would need to be handled.

**RP-202626** made the following claims:

* Dynamic scheduler coordination between parent IAB-nodes would be necessary. No details were giving on what this would entail and which WG would be involved.
* For FR2, DC synchronization requirements would imply severe, if not impossible, restrictions in the IAB-deployment.No details were given on what such FR2 DC synchronization requirements would have to entail and why this would be severe or impossible.
* Implementation of intra-carrier DC would require extensive work that was not accounted for in the present time budgeting. No details were given on what this work would include.

**RP-202672** claims that the following issues would need to be addressed by RAN1:

* Revisiting IAB-MT assumptions on DL synchronization and UL timings,
* Parent nodes sending conflicting D/U/F indications in DCI 2\_0 for same IAB-MT resource,
* Parent nodes sending conflicting soft resource availability in DCI 2\_5 for same IAB-DU resource on IAB-node’s child link,
* Parent nodes indicating different number of guard-symbols in MAC-CE.

The contributions further claimed that the following issues would have to be addressed by RAN3:

* Resource coordination between gNBs for topology redundancy scenarios, where MCG and SCG links are controlled by different (donor or non-donor) gNBs.

The contribution further claims that RAN4 would need to investigate the potential impact of intra-carrier DC. No details were giving on what this would involve.

# Discussion

## Initial discussion: Issues to be handled for intra-carrier DC for IAB

The following aim to identify the main issues to be addressed by the individual RAN WGs. For each issue, we need to understand:

1. The underlying problem to be solved,
2. The main aspects to be addressed by each WG to solve the problem,
3. The adverse effects an implementation-only solution might have, e.g., on performance, inter-vendor interoperability, etc.

The questions below are based on the issues raised in contributions to RAN#90e. Companies are invited to discuss additional issues as well.

**Q1: In your view, what needs to be done for inter-parent-node scheduler coordination to support intra-carrier DC for IAB? Please explain the problem to be solved, aspects to be addressed by each WG, and impact if done via implementation only.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| AT&T | “Scheduler coordination” is a broad term, but at a fundamental level this would require ensuring that the scheduling of the two parent links does not 1) violate the duplex constraint within the IAB node (i.e. half duplex or full duplex) and 2) does not violate the half duplex constraint within the backhaul link (i.e. simultaneous DL Rx and UL Tx by the MT function). This can be done on a semi-static basis and requires some specification effort to support inter-vendor IAB deployments. In our understanding this work would first be carried out in RAN1 to define the requirements and general framework for the coordination and RAN3 would determine what updates (if any) to the existing DU resource coordination signaling would be required (e.g. to support intra vs. inter donor operation). In our view, the scope of scheduler coordination for intra-carrier DC is similar to what would be required for inter-carrier DC, at least when it comes to ensuring the duplex constraint at the IAB node is not violated, since even in Rel-16 it is possible to indicate different multiplexing capabilities for different DU/MT carriers (e.g. half duplex may still be required even for inter-band operation between parent nodes). |
| vivo | For resource scheduling coordination between MCG and SCG, the scheme discussed in multi-TRP transmission can be baseline. In Rel-17 multi-TRP enh., it has been discussed that UE can camp on a single carrier and connect to two BSs, the related solution can simply be reused for IAB intra-carrier DC.  For resource management of DU, the TDD/resource type indication should be coordinated as well. However, this issue should be addressed for intra-band inter-carrier DC as well.  Therefore, we think no specific issue needs to be addressed regarding resource management for intra-carrier DC. |
| NTT DOCOMO | When IAB operate with Carrier A (including Frequency resource A-1+A-2), while IAB-MT is allocated Frequency resource A-1 from Parent node 1 and Frequency resource A-2 from Parent node 2, scheduler coordination may be necessary since A-1 and A-2 may or may not be able to overlap without causing mutual interference. However, tight scheduler coordination to appropriately handle resource overlapping would be complex. |
| Huawei | Our understanding is that dynamic scheduler coordination are not possible for both intra-carrier and inter-carrier DC. However, the problems that needs be solved are similar for inter-carrier intra-band DC and intra-carrier intra-band DC.  For inter-carrier intra-band DC, the IAB-MT needs to handle **scheduling collisions due to half duplex constraint** on the backhaul link if the IAB-MT is scheduled to Tx in one CG and Rx in the other CG simultaneously. The scheduling collision can be resolved by prioritizing the scheduling from MCG. However, this may not be sufficient if there is no coordination between the MCG and SCG. In the worst case, the SCG does not get any opportunity for Tx/Rx which defeats the purpose to configuring DC. Semi-static coordination across MCG and SCG should be supported such that the above scheduling confliction can be avoided. One possibility is to configure available/schedulable resources for the IAB-MT on a given CC such that the IAB-MT can understand which CG is prioritized in case of scheduling collision. This problem would need some more discussions in RAN1 and RAN3 may also need to be involved for the case of inter-donor operation to check whether any coordination between CU is needed.  Similar to inter-carrier intra-band DC, for intra-carrier intra-band DC, the IAB-MT needs to handle scheduling collisions due to half duplex constraint if the IAB-MT is scheduled to Tx in one CG and Rx in the other CG on the same CC. The solutions proposed to resolve the scheduling conflict for Case 2 can be applied for Case 3 as well. |
| Samsung | Regarding the analysis on RP-202533 by moderator, it may mislead about our view on intra-carrier DC. As discussed in the tdoc, our intention was to point out there is no common understanding on how intra-carrier DC operates because dual connectivity in 3GPP has always assumed the use of separate carriers since LTE. One example which is unclear to us would be how to coordinate scheduler decision between MCG and SCG for intra-carrier DC because there is no such coordination for inter-carrier DC so far. It is one of aspects which needs group’s common understanding if the intra-carrier DC is feasible. On the other hand, even if intra-carrier DC is deemed feasible, whether or not it is something beneficial to support in Rel-17 IAB is a separate matter which has not been estimated by any evaluations. |
| Ericsson | Duplexing coordination is just the very beginning of resource coordination and must be assumed to reflect duplexing capabilities. If parent nodes share time-frequency resources that can't be used simultaneously, of course inter-parent-node scheduler coordination is required. In inter-band DC, this is implicitly not necessary. Any already specified form of intra-carrier transmission from multiple nodes has requirements on coordination and/or timing. Furthermore, different to existing schemes, IAB is missing inter-DU connectivity for such coordination. |
| Nokia | Scheduler coordination in intra-carrier DC can be identified under two main cases:   1. No/less coordination between parent DUs, and IAB MT may have to handle resource conflict scenarios. 2. Some coordination between parent DUs, and IAB MT does not expect to have resource conflict scenarios.   RAN1 shall prioritize the first case, where some discussion of resource multiplexing rules is needed, and the impact on other WGs is minimal. In general, we see that intra-carrier DC can be still handled within the existing TU allocations for RAN1.  For the second case, coordination is only necessary in scenarios where configured and available resources overlap between both DUs. One option is to leave such coordination to implementation.  Another option is to have a joint solution with CLI/Interference handling for IAB. In scenarios where potential collisions can occur, existing interference management techniques (e.g., CLI/RIM) may be extended to assist in avoiding collisions. RAN1 could strive for single solution for such extension of coordination considering both intra-carrier DC and IAB CLI/interference avoidance (which is anyways ongoing discussion in RAN1). We expect that minimal discussion will be needed in RAN3 to address coordination. |

**Q2: In your view, what needs to be done for the coordination of DCI 2\_0 signaling for D/U/F indication among parent nodes to support intra-carrier DC for IAB? Please explain the problem to be solved, aspects to be addressed by each WG, and impact if done via implementation only.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| AT&T | The problem is similar to Q1 except instead of involving the donor nodes to resolve the conflicts, it is just the IAB nodes themselves which determine the slot indication on a dynamic basis instead of semi-static basis (but with the same goal of avoiding scheduling conflicts which violate the duplex constraint). RAN1 could handle this objective by itself and define child/parent node behavior to avoid or handle potential conflicts (within the framework already provided by the semi-static coordination addressed in Q1). Again as in Q1, ensuring that duplex constraints are not violated by the multiple parents is a common objective for both intra-carrier and inter-carrier DC. |
| vivo | Even for inter-carrier intra-band scenario, indication from DCI 2\_0 may incur troublesome TDD conf. Considering that UE may be subject to HD constraint as well for inter-carrier intra-band case, this is not specific issue for intra-carrier DC.  It is noted that such issue is already under discussion in RAN1. |
| NTT DOCOMO | When IAB-DU operate with Carrier A (including Frequency resource A-1+A-2), while IAB-MT is allocated Frequency resource A-1 from Parent node 1 and Frequency resource A-2 from Parent node 2, single TDD pattern should be applied to Carrier A for the IAB-node. On the other hands, each of two parent nodes can indicate D/U/F dynamically with DCI 2\_0 for the IAB-node, and different D/U/F indication for Carrier A may happen. Therefore, a mechanism on how to handle the D/U/F indication for Carrier A with two parent nodes needs to be considered. |
| Huawei | DCI format 2\_0 is used to indicate the slot format of a given serving cell. In case of intra-carrier DC, it is possible that the MCG or SCG indicate two different slot formats for the same CC. Note that it is not always feasible to coordinate the signaling of DCI format 2\_0 between the MCG and SCG considering the signaling delay between the two parent nodes.  Overall, in addition to the issue in Q1, i.e. the IAB-MT may need to handle scheduling conflict due to half duplex constraint on the backhaul link, the IAB-MT needs to handle the slot format indication conflict from the MCG and SCG. More discussion is needed in RAN1. |
| Samsung | It seems Q2 assumes a coordination with DCI format 2\_0 for intra-carrier DC is needed. Our view is that it should be first checked whether or not the coordination with DCI 2\_0 signaling is required based on common understanding on how to operate intra-carrier DC. |
| Ericsson | Multi-parent scenarios without proper coordination of DCI format 2\_0 between parent cannot work. This is also valid for inter-carrier, intra-band and solutions can be equally applied. The question on coordination needs for DCI format 2\_0 is very much connected to what kind of multiplexing is assumed between parent node, or not, and is therefore not entirely addressable at this point. |
| Nokia | As mentioned under Q1, RAN1 can assume two cases.  First case,   * Problem: Coordination between parent nodes for dynamic signaling (e.g. DCI 2-0) is not possible/feasible to avoid resource conflicts at IAB-MT. * Solutions for resource multiplexing shall be addressed only in RAN1. RAN1 shall define the resource multiplexing rules for receiving DCI 2-0 via both parent nodes that support intra-carrier DC.   Second case,   * Problem: Some coordination between parent nodes for dynamic signaling to avoid conflicts at the IAB MT. * Solutions for receiving DCI 2-0 from both parents or via single parent without conflicts and applying that for both parent links shall be defined in RAN1. If coordination handled by specification, some work is expected from RAN3.   As the work and scope is straightforward, the workload is not significant. Therefore, no additional TUs are required in WG1 or WG3 to address DCI\_2.0 operation. |

**Q3: In your view, what needs to be done for the coordination of DCI 2\_5 signaling for soft-resource-availability indication among parent nodes to support intra-carrier DC for IAB? Please explain the problem to be solved, aspects to be addressed by each WG, and impact if done via implementation only.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| AT&T | Similar scope as Q3, however it should be noted that soft resources are not strictly essential for IAB. As in Rel-16, RAN1 may not need to specify all aspects of the determination of the availability of soft resources at the child node and leave potential optimizations up to implementation. |
| vivo | Similar as DCI 2\_0, the issue exists both for inter-carrier and intra-carrier scenarios, which is under discussion in RAN1. |
| NTT DOCOMO | When IAB-DU operate with Carrier A (including Frequency resource A-1+A-2), while IAB-MT is allocated Frequency resource A-1 from Parent node 1 and Frequency resource A-2 from Parent node 2, single configuration of H/S/NA is indicated by CU for Carrier A of IAB-DU. On the other hands, although dynamic indication of IA/INA with DCI 2\_5 can be indicated by each of two parent nodes, single soft resource availability should be determined for a soft resource. Therefore, a mechanism on how to handle the availability of Soft IAB-DU resource based on DCI 2\_5 indication with two parent nodes needs to be considered. |
| Huawei | DCI format 2\_5 is used to indicate the availability of IAB-DU soft resources. Since the content of DCI format 2\_5 is configured semi-statically, it is possible to configure availability indication of IAB-DU soft resources for different IAB-DU cells from MCG and SCG in a non-overlapping manner, i.e. the availability indication from MCG and SCG are for different IAB-DU cells. Even if there is an overlap, i.e. availability indication is from two CGs, it may be sufficient to define a rule to determine the availability of IAB-DU soft resource, e.g. IAB-DU can Tx or Rx on a soft resource only if it is indicated as available from both MCG and SCG. More discussions in RAN1 is required as agreed in RAN1#103-e.  **Agreement**  The explicit indication of soft resources by DCI Format 2\_5 is supported for multi-parent scenarios in Rel-17.   * FFS: Whether additional enhancements over the Rel-16 solution are needed   In summary, the issue of DCI format 2\_5 may not specific for intra-carrier DC. |
| Samsung | Similar to Q2, our view is that it should be first checked whether or not the coordination with DCI 2\_5 signaling is required based on common understanding on how to operate intra-carrier DC. |
| Ericsson | DCI format 2\_5 is addressing a different dimension of the problem in controlling DU resources through parent nodes. Where DCI format 2\_0 controls whether a certain resource is D/U/F, DCI format 2\_5 has a more dynamic property and is not suitable for DU coordination. |
| Nokia | Dynamic DCI 2\_5 signaling per parent link may be used to communicate availability of resources. Discussion on DCI 2\_5 is more critical than DCI 2\_0 if we are to efficiently use resources within IAB network.  Similar to Q2, we shall discuss two possible cases.  First case,   * Problem: Coordination between parent nodes for dynamic signaling (e.g. DCI 2-5) is not possible/feasible to avoid conflicting resource indication for IAB-DU. * Solutions for deriving availability of DU soft resources shall be defined if the IAB MT expecting different indications from parent nodes. RAN1 shall define the rules for receiving DCI 2-5 via both parent nodes that support intra-carrier DC.   Second case,   * Problem: Some coordination between parent nodes for dynamic signaling to avoid conflicts of using soft resource at the IAB DU. * Solutions for receiving DCI 2-5 from both parents or via single parent without conflicts and applying that at IAB DU shall be defined in RAN1. If coordination handled by specification, some work is expected from RAN3. RAN3 only need to provide a means for loosely coordinating parent DUs to avoid overlapping resources.   The first case mentioned above is anyway needing some discussion for the IAB MTs that support multi-DCI based multi-TRP operation (which support non-ideal BH conditions where dynamic coordination is not feasible). Given the commonalities with MIMO multi-TRP and intra-carrier DC, the same solution may be considered for both multi-TRP and other intra-carrier DC scenarios with very little additional definition. |

**Q4: In your view, what needs to be done for parent-to-child timing synchronization to support intra-carrier DC for IAB? Please explain the problem to be solved, aspects to be addressed by each WG, and impact if done via implementation only.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| AT&T | The timing requirements are both a function of deployment considerations (distance between parent nodes) and IAB node implementation (shared or common hardware at the MT for the MCG/SCG links). In our view, specification work is not essential for this objective (other than documenting requirements). Optimizations are certainly possible, but just as T\_delta in Rel-16 is a helpful “tool in the toolbox” for achieving OTA-based timing alignment, they would not be required for DC with IAB. |
| vivo | In Rel-17, such issue can be left to NW deployment. It can be assumed that the distances from IAB node to the two parent nodes are comparable. If enh.is needed, it can be captured in later release. |
| NTT DOCOMO | When IAB-DU operate with Carrier A (including Frequency resource A-1+A-2), while IAB-MT is allocated Frequency resource A-1 from Parent node 1 and Frequency resource A-2 from Parent node 2, IAB node may receive TA1/T\_delta1 from Parent node 1 and TA2/T\_delta2 from Parent node 2. Since the IAB node needs to derive a single DU Tx timing based on TA and T\_delta, a mechanism on how to derive DU Tx timing with two parent nodes needs to be considered. |
| Huawei | Our understanding is main specification effort is that RAN4 needs to define the timing synchronization requirement for intra-carrier DC deployment. However, we do understand 3us cell phase error requirement among IAB-nodes may put some limitations to the practice usage of intra-carrier DC in FR2. |
| Samsung | In case of inter-carrier DC, there are RAN4 requirements (e.g., TS38.133 for UE) for a relative receive timing difference (MRTD) and a relative transmission timing difference (MTTD) between MCG and SCG. Especially, minimum MRTD requirements for synchronous cases are the following: 33us in case of inter-band synchronous EN-DC and 3us in case of intra-band synchronous EN-DC. Also, 33us for inter-band synchronous NE-DC and 8us (for both MCG and SCG on FR2) in case of inter-band synchronous NR-DC. In our view, it should be checked how to operate DC in a same carrier taking into account the RAN4 requirements. |
| Ericsson | A DU is required to be synchronized with its neighbor DUs to an accuracy of 3 µs. GNSS synchronization will typically result in a higher but still limited accuracy; nevertheless, there are no requirements for such improved accuracy. At the same time, intra-carrier DC will require an accuracy of <0.6µs (FR2) in order to fit both parent transmissions within the CP. Different parent-node ISDs would further decrease that margin. With these inaccuracies and having imperfect BH connectivity (different to m-TRP or co-located DC), it is not possible to guarantee operation for any difference in parent node ISD. |
| Nokia | Each IAB DU must already meet gNB synchronization requirements to remain transparent to legacy R15 UEs. No additional synchronizations requirements are envisioned for IAB intra-frequency DC. Simultaneous SDM or FDM transmission form both parent DUs is not anticipated in R17 IAB.  No further work would need to be done for timing in WG1 provided that SDM or FDM operation is limited to one parent DU at a time.  If the parent-to-child timing synchronization assume T\_delta signaling via multiple parents, that discussion is not only restricted to the intra-carrier DC case as inter-carrier DC case may also have to consider that. Anyway, Rel-16 discussed that already, and left to IAB node implementation to select one or both parent T\_delta indications to adjust DL Tx timing. |

**Q5: In your view, what other issues need to be addressed to support intra-carrier DC for IAB? Please explain the problem to be solved, aspects to be addressed by each WG, and impact if done via implementation only.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| AT&T | We want to highlight that the critical need from an operator perspective, is for multi-parent support in Rel-17 which aligns with **practical deployment** scenarios for IAB. Requiring that different carriers or frequency bands are assigned for different parents diminishes the usefulness of the feature by limiting the backhaul capacity and creates an undesirable tradeoff in the network between performance and robustness. In our assessment, intra-carrier DC is the shortest path to achieving this objective – but we can understand that working on optimizations for different corner cases may also take up valuable WG time. Our suggestion for a compromise is to identify a subset of requirements/restrictions (i.e. FR2 only, assumptions on network timing synchronization, reusing inter-carrier DC features as the baseline) that can keep the workload to the bare minimum and deliver a solution for the intra-carrier scenario in Rel-17, which is the most relevant scenario for early IAB deployments, instead of pushing it out into the future. |
| Huawei | Our understanding is that at least RAN4 needs to be involved to define DC band combinations. Besides, some RRM and RF requirements needs to be defined for intra-carrier DC and specification effort should be carefully assessed. |
| Ericsson | Even if there are seemingly simple solutions to some of the problems addressed above, there is no consensus about those agreements. Neither is there a consensus about IAB architecture for a possible intra-carrier operation, also is evident by other companies’ comments. In conclusion, a seemingly “simple” specification effort will soon consume a substantial effort.  Furthermore, we do not share the view that intra-carrier DC will be more efficient than inter-carrier DC utilizing the same spectrum. Considering the limitations being discussed above, scheduler coordination, and resource utilization will be substantially worse in comparison to the intra-carrier case. Additionally, it would only require no/very limited specification impact.  Given the constraint of intra-carrier operation, a more attractive solution would be multi-MT, *disregarding any interference between the multiple MTs*. Multi-MT was discussed and not agreed in the last plenary meeting. However, that discussion concerned general dual parent operation why companies may have different views on the usefulness of multi-MT for the intra-carrier case. Additionally, in order to simplify specification work, and to eliminate the uncertainty of support for intra-band, inter-carrier DC, which is per RAN1 agreement conditioned on reusing solutions for inter-carrier inter-band DC, multi-MT could be selected for all intra-band dual parent operation.  Finally, we think specification of multi-MT is more realistic and more in line with Rel-17 TU allocations. |
| Nokia | The primary effort for intra-carrier DC shall be first on agreeing the assumptions on coordination. As mentioned in Q1-Q3, required specification enhancements shall also consider the case of no coordination between IAB parents, and only RAN1 work is expected here to solve open issues of intra-carrier DC.  If some coordination is assumed, then as mentioned under Q1-Q3, there would be some impact in both RAN1 and RAN3, but that is expected to be minimal.  In any case, we believe that these features may be addressed within the existing TUs allocated per WG. Most of the discussions on multiplexing rules or conflict handling are directly related to Rel-16 discussions and there is nothing new that RAN1 shall define rather than extending certain discussions.  Finally, we tend to agree with the additional points made by AT&T that highlights the importance of the intra-carrier DC where splitting resources for multiple parents (inter-carrier DC) will impact the capacity achievable for the BH link. |
|  |  |

## Intermediate discussion: Aspects to be handled for intra-carrier DC for IAB

…

## Final discussion: Aspects to be handled for intra-carrier DC for IAB

…

# Conclusion

…

# References

|  |  |  |
| --- | --- | --- |
| [**RP-202533**](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_90e/Docs/RP-202533.zip) | On the support of intra-carrier DC in Rel-17 IAB | Samsung |
| [**RP-202626**](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_90e/Docs/RP-202626.zip) | Support of DC scenarios in Rel-17 enhanced IAB | Ericsson |
| [**RP-202672**](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_90e/Docs/RP-202672.zip) | Discussion on NR DC operation for IAB | ZTE Corporation |