**3GPP TSG-RAN WG3 Meeting #111-eR3-211005**

**Online, January 25th – February 4th 2021**

Agenda Item: 13.3.1

Source: Ericsson (moderator)

Title: Summary of Offline Discussion on IAB Congestion Mitigation

Document for: Approval

# Introduction

This is the SoD for the following comeback: **CB: # 38\_IABcongestionMitigation**

The deadline for providing replies to Phase 1 is **Thursday, January 28th at 23.59 UTC.**

Relevant papers:

1. R3-210220 Discussion on CP-based and UP-based congestion mitigation in Rel-17 IAB (Samsung)
2. R3-210350 Enhancements to congestion control for IAB (Qualcomm Incorporated)
3. R3-210388 Congestion Indication to CU-CP (Intel Deutschland GmbH)
4. R3-210460 Discussion on CP-based approach for DL and UL congestion mitigation in IAB networks (Fujitsu)
5. R3-210490 Analysis on Congestion mitigation (Nokia, Nokia Shanghai Bell)
6. R3-210550 Discussion on IAB E2E flow control (Huawei)
7. R3-210614 Discussion on congestion mitigation for IAB (Lenovo, Motorola Mobility)
8. R3-210718 Discussion on DL E2E flow and congestion control in R17-IAB (ZTE)
9. R3-210724 Congestion Mitigation in IAB Networks (Ericsson)
10. R3-210781 IAB End-to-End Flow Control Feedback’ (Ericsson)
11. R3-210781 Issues on CP-based approach for DL congestion mitigation (LG Electronics)

# For the Chairman’s Notes

**TBW**

# Discussion

At the RAN3#109-e and RAN3#110-e meeting the following was agreed:

**UP-based and CP-based approaches for DL congestion mitigation in IAB networks are complementary.**

**In IAB DL end-to-end flow control, the access node sends feedback to the donor-CU-UP.**

**Discuss the improvements to DDDS for IAB UP-based congestion mitigation (e.g. packet marking, highest PDCP SN received from parent node, receiving data rate, received data volume).**

**The measures taken by the donor-CU-CP based on the CP-based approach are up to implementation.**

**End-to-end UL flow control is deprioritized in Rel17.**

**An IAB node at the parent side of a congested backhaul link may send a congestion indication to the IAB-donor-CU-CP.**

**Discuss the information to be reported to the IAB-donor-CU-CP in the congestion indication; To be continued...**

**So far the following solutions for IAB DL end-to-end flow control are on the table:**

**- Highest PDCP SN received from parent node;**

**- Bitmap of PDUs transmitted to lower layers out of sequence;**

**- Packet marking;**

**- Received volume and Receiving data rate.**

**- “do nothing” option, i.e. use current DDDS as it is**

**Downselection is expected at the next meeting; no more options are expected**

## CP-based congestion mitigation

Contributions [1]-[9] and [11] discuss CP-based congestion mitigation. The issues that can be derived from the contributions are:

**Issue 1:** Granularity of congestion reporting, i.e. per: Child link, BH RLC channel, BAP routing ID, configurable?

***Q1-1: What should be the granularity of congestion reporting?***

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**Issue 2:** F1AP procedure used: GNB-DU Status Indication, F1AP Notify, a new F1AP procedure?

***Q1-2: Which F1AP procedure should be used for CP-based congestion reporting?***

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**Issue 3:** Support for DL only or both UL and DL?

***Q1-3: Should CP-based congestion reporting be supported only on DL or on both UL and DL?***

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| **Company** | **Answer and motivation** |
| Ericsson | **Q1-1:** we think that reporting per child IAB node or per BAP routing ID is enough.  **Q1-2:** we proposed GNB-DU Status Indication, but we can consider other alternatives, as well.  **Q1-3:** only DL congestion indication should be supported.  Regarding the UL indication, we do not see a practical need for it. Also, an implication of the RAN3#110-e agreement that ‘An IAB node at the parent side of a congested backhaul link may send a congestion indication to the IAB-donor-CU-CP.’ is that DL-only congestion indication is supported. If UL congestion indication is to be supported, should the parent send the indication? |
| Intel | **Q1-1:** Child IAB node and BAP routing ID. Make it configurable  Q2-2: We are open  Q1-3: DL indication is sufficient |
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**Issue 4:** Congestion report triggering: Threshold-based, polling based, reporting rate set by donor CU-CP, up to implementation?

***Q1-4: Should the report triggering be controlled by the donor CU-CP (threshold-, polling-, maximum rate-based) or up to IAB-DU implementation?***

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**Issue 5:** Additional information in the congestion indication

***Q1-5: Should the following be reported:***

* ***Degree of congestion?***
* ***“Congestion over” indication?***

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| **Company** | **Answer and motivation** |
| Ericsson | **Q1-4:** We should not standardize any thresholds or triggers. When the reporting is activated, the IAB-DU should be able to report when it thinks it is necessary, since it has the best knowledge of its own situation. This is the principle followed in legacy DUs. So, our answer is: **up to IAB-DU implementation.**  **Q1-5:** disagree to “degree of congestion” indication; in legacy DUs we only have indication of congestion (i.e. DU overload), so the same reasons apply here. For IAB, in Q1-1 we are discussing additional granularity of reporting, and that should be enough to cover the gap between the legacy DU and IAB-DU. “Congestion over” indication is acceptable, as something similar is supported in the legacy already. |
| Intel | **Q1-4:** We think the CU should be able to control the reporting  **Q1-5:** “Congestion over” indication seems sufficient |
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**Summary**: TBW

## UP-based congestion mitigation

Contributions [1]-[2] and [5]-[10] discuss UP-based congestion mitigation. The set of potential solutions includes:

* **Opt1:** Highest PDCP SN received from parent node;
* **Opt2:** Bitmap of PDUs transmitted to lower layers out of sequence;
* **Opt3:** Packet marking;
* **Opt4:** Received volume and Receiving data rate.
* **Opt5:** “do nothing” option, i.e. use current DDDS as it is

With respect to the above options, submitted papers propose the following:

* Paper [1] proposes to consider the reporting of **received date volume** and **received data rate**.
* Papers [2] and [9] propose **marking of DL packets that experience an increasing queuing delay** at intermediate nodes.
* Paper [5] proposes that, if needed, **for UM mode, the DDDS is enhanced with a bitmap of PDUs transmitted to lower layers out of sequence**.
* Paper [6] proposes an **indication of the highest PDCP SN received from parent** node.
* Papers [7] and [8] propose the “do nothing” option.

***Q2: Please state your preference with respect to Opt1-5.***

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| **Company** | **Answer and motivation** |
| Ericsson | We support Opt3 i.e. **packet marking**.  Packet marking is **the only candidate solution that**:   * **Keeps buffer levels low**, and thus prevents congestion from happening. All other approaches are reactive. * Is **stable to traffic rate variations** (which may be intensive in short periods of time). * Is **resilient to DDDS delay**, since the indication is provided way before congestion occurs.   Regarding the **concerns** raised by some companies regarding:   * Specification impact *(“it is a cross-layer solution”):* the impact on BAP is only header 1 bit. BAP is the only layer that is accessible by intermediate nodes and is hence the only tool for the intermediate nodes to provide indications to the access node. * *How to set a delay threshold*? This is up to implementation of an IAB-DU. **It is funny that this same group of people is discussing CP-based congestion indication, but yet no one asks how to define a threshold for congestion.** * *“Cannot reflect the real-time congestion”*: the intention is not to detect real-time congestion, but to identify a trend in queuing delay increase in intermediate nodes, which is an early sign of potential congestion.   Regarding the remaining solutions:  **Received volume and Receiving data rate:** the rate varies all the time, so these indications bring no informational value to the donor. Moreover, the delivery of DDDS to the donor CU will take some time, during which both the received rate and the received data volume may change significantly, meaning that the reported information is outdated by the time it reaches the donor.  **Indication of the highest PDCP SN received from parent node:** today in DDDS we have the NR-U SN that indicates the delivery status on the transport network. The delta with respect to NR-U SN needs to be clarified. This approach is essentially reactive.  **Bitmap of PDUs transmitted to lower layers out of sequence**: the reporting and processing bitmap-based indications is computationally expensive. This approach is essentially reactive. |
| Intel | We like packet marking, since it is the only one that provide the earliest feedback to CU regarding congestion.  We are also fine with no changes. |
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**Summary**: TBW