**3GPP TSG-RAN WG2 #121 R2-2302156**

**Athens, Greece, 27th February – 3rd March, 2023**

Agenda Item: 8.1.2

Source: Huawei, HiSilicon

Title: Report of [AT121][707][NCR] MAC-design (Huawei)

Document for: Discussion and Decision

# 1 Introduction

This document aims at summarizing the following offline discussion:

* [AT120][702][NCR] MAC-design (Huawei)

 Scope: Discuss RAN2 MAC design issues which can be agreed (i.e. not pending RAN1 decisions)

 Intended outcome: discussion with agreeable proposals in R2-2302156

 Deadline: Friday CB

# 2 Contact information

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# 3 Discussion

For the side control information of beamforming, RAN1 has the following agreements related to using MAC CEs to indicate semi-static beam indication for backhaul link and to indicate semi-persistent beam indication for access link:

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| **Backhaul link*** **The semi-static beam indication for backhaul link** is supported as:
	+ If the beam indication framework in Rel-15 is used for NCR-MT
		- The DL beam is indicated by MAC CE to select one of TCI state ID from the RRC-configured list of beams for C-link
		- The UL beam is indicated by SRI on C-link via MAC CE.
	+ If the beam indication framework in Rel-17 is used for NCR-MT
		- The DL and UL beam are indicated by MAC CE to select one of TCI state ID from the RRC-configured list of beams for C-link
* The following pre-defined rules are applied to determine the beam for backhaul link:
* In the time domain resource with simultaneous downlink reception or uplink transmission in C-link and backhaul link, the beam of backhaul link is the same as the beam of C-link regardless whether there is beam indicated by the dedicated signal for backhaul link.
* In the time domain resource without simultaneous downlink reception or uplink transmission in C-link and backhaul link, if the NCR does not support capability with the new signalling for backhaul beam indication or if no beam is indicated for backhaul link by the dedicated signal,
	+ When Rel-15/16 beam indication framework is used for C-link,
		- The beam determined by QCL assumption for CORESET with the lowest ID and spatial relationship for PUCCH with lowest PUCCH resource ID in the C-link is applied for the DL and UL of backhaul link, respectively.
	+ When Rel-17 beam indication framework (i.e., unified TCI framework) is used for C-link, the indicated unified TCI for C-link DL and UL is applied for the DL and UL of backhaul link, respectively.

Otherwise, the beam indicated by the dedicated signalling is applied for backhaul link.**Access link*** **For semi-persistent beam indication:**
	+ RRC configures $Y$ list of forwarding resource, the $y$th list is consist of $Z\_{y} \left(1\leq Z\_{y}\leq Z\_{max}\right)$ forwarding resources, and each forwarding resource is defined by {beam index, time resource}.
		- The periodicity and reference SCS is configured as part of the RRC signaling for each list of forwarding resource
	+ MAC-CE activate/de-activate one of Y list, and all the $Z\_{y}$ forwarding resources in this list are selected.
	+ MAC-CE can optionally provide update for Zy beam index
* Note: The value of $ Z\_{max}$ ($1\leq Z\leq Z\_{max}$) is 128, where $ Z\_{max}$ refers to the maximum beams indicated in one indication.
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In this offline, we will focus on the MAC CE design for the related beam indications.

## 3.1 Semi-static backhaul link beam indication

The RAN1 agreement states that the format of beam indication varies for the UL/DL directions and Rel-15/Rel-17 frameworks. For DL, the TCI state ID is used for both Rel-15 and Rel-17; for UL, the SRI is used for Rel-15 and the TCI state ID is used for Rel-17. Since the Rel-15/Rel-17 frameworks are not simultaneously configured by NW at a time, the NCR-MT can tell from RRC configuration which framework should be used. So there is no need to define different MAC CEs for Rel-15 and Rel-17 frameworks. In fact, as a baseline, one MAC CE for the UL backhaul beam and one MAC CE for the DL backhaul beam are sufficient.

Of course, one may further consider using only one MAC CE for both DL and UL beam indication. However, this means more fields are needed to further differentiate between only DL beam, only UL beam and DL&UL beams cases, which will add more complexity for the design. It would be simple to use different eLCIDs for DL and UL beam indications as the space for eLCIDs shouldn’t be a problem. Then it works like this:

Firstly, the NCR-MT knows whether the beam is indicated using Rel-15 or Rel-17 framework based on the RRC configuration, and secondly the NCR-MT knows whether the beam indication is for DL or UL transmission by the eLCID. In this case, the MAC CE will include the field of TCI state ID for downlink beam indication and the field of either TCI state ID or SRI for uplink beam indication (depends on the framework). Specifically, according to RRC specs:

* for Rel-15 DL beam , it should be a TCI state ID which needs 7 bits;
* for Rel-17 DL beam, it should be a TCI state ID which needs 7 bits;
* for Rel-15 UL beam, it should be an SRI which needs 4 bits.
* for Rel-17 UL beam, it should be a TCI state ID which needs 6 bits;

Therefore, the DL beam ID field length is set as 7 bits; the UL beam ID field length is set as 6 bits, and for SRI, 4 bits are used and the remaining 2 bits are reserved. The formats of MAC CEs are given as follows:

 

(a) downlink beam (b) uplink beam

Figure 1. NCR semi-static backhaul link beam indication MAC CEs.

The fields in the MAC CEs are illustrated as follows:

* **Downlink TCI state ID:** This field contains *TCI-StateId* (comprising all 7 bits), as specified in TS 38.331 [5], of a TCI State, which is used as the downlink beam indication for backhaul link transmission.
* **Uplink TCI state ID or SRI:** This field contains *TCI-UL-State-Id* (comprising all 6 bits) of a TCI State, which is used as the uplink beam indication for backhaul link transmission, if the *ul-TCI-StateList* is configured, as specified in TS 38.331 [5]; otherwise, this field contains an SRI (contained in the 4 rightmost bits) and 2 reserved bits.

**Q1: Do companies agree with the above MAC CE formats for semi-static backhaul link beam indication?**

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| **Company** | **YES/NO** | **Comments** |
| Samsung | See comment | We agree with the principle (and definitely agree with discussion rapporteur that 3 MAC CEs are NOT needed, since an NCR-MT will never be configured with both Rel-15 and Rel-17 approaches simultaneously), but we think we should go a step further and design a single MAC CE. First bit could indicate whether this is information to be applied to DL or UL, and then if it’s for DL, the second bit could indicate whether we are sending TCI state ID or SRI, as per design above.  |
| Huawei, HiSilicon | YES | From our point of view, two MAC CEs should be the starting point. It would be simple and flexible to use different eLCIDs for DL and UL beam indications as the space for eLCIDs shouldn’t be a problem. Use one MAC CE would also work but would need an extra field in the MAC CE. |
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**Summary:**

There seems not much difference about the contents of the MAC CE. The only divergent point is whether UL beam and DL beam should be indicated in the same MAC CE. So we suggest to discuss:

**Proposal 1: RAN2 to discuss whether to define an UL/DL indication field in the MAC CE (i.e. same MAC CE for UL beam and DL beam) or just use different eLCIDs (i.e. two MAC CEs for UL beam and DL beam separately) to indicate whether the MAC CE is for UL beam or DL beam for semi-static backhaul link.**

## 3.2 Semi-persistent access link beam indication

According to the latest RAN1 agreements, ,as a baseline, one MAC CE is to indicate the activation/deactivation of one forwarding resource set among multiple forwarding resource sets configured by RRC signaling for Semi-persistent access link beam. Optionally, the MAC CE can also be used to update the beam index(es) in the activated resource set, i.e. only beam indexes of the activated resource set are to be updated.

In this sense, the following MAC CE is given as follows:



Figure 2. NCR semi-persistent access link beam indication MAC CEs

The fields in the MAC CE are illustrated as follows:

* **A/D:** This field indicates whether this MAC CE is used to activate/deactivate a forwarding resource set. The length of the field is 1 bit.
* **Forwarding Resource Set ID:** This field indicates the ID of the forwarding resource set to activate/ deactivate. (*Note: The field length depends on the max number of the forwarding resource sets, which is FFS in RAN1.*)
* **Forwarding Resource ID:** This field indicates the ID of the forwarding resource whose beam index is to be updated. The length of the field is 7 bits
* **Beam Index:** This field indicates the updated beam index in the corresponding forwarding resource. (*Note: The field length depends on the max number of beams the NCR-fwd is configured to use, which is FFS in RAN1.*).

**Q2: Do companies agree with the above MAC CE formats for semi-static access link beam indication?**

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| **Company** | **YES/NO** | **Comments** |
| Samsung | See comments | There is no need to have forwarding Resource ID field. As agreed in RAN1, if a forwarding Resource Set ID is activated/deactivated, all the forwarding resource associated with the Set will be activated/deactivated. It is natural that the first activated forwarding resource corresponds to the first beam index field; and the second activated forwarding resource in the forwarding resource set corresponds to the second beam index field; and so on.Another aspect is that there is a need for a presence field (1 bit), for example, if the field is set to 0, beam index fields are not present; if the field is set to 0, beam index fields are present. In this way, the indication of beam index can be optional (otherwise, the beam index field is not optional). |
| Huawei, HiSilicon | YES | From RAN1 agreement, the MAC CE has two purposes:* One is to activate one Forwarding Resource Set from the list
* The other is to update the beam indexes within one Forwarding Resource Set.

The Forwarding Resource ID field and the beam index field are both used for update the beam indexes:* **Forwarding Resource ID:** This field indicates the ID of the forwarding resource whose beam index is to be updated.
* **Beam Index:** This field indicates the updated beam index in the corresponding forwarding resource.
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**Summary:**

From comments received via email and via this documents, there seems some mis-understandings about RAN1 agreement. Suggest to take the above MAC CE format as baseline and further discuss if anything is missing.

**Proposal 2: Take the MAC CE below as baseline and further discuss if any update is needed:**



## 3.3 Other

**Q3: Other MAC CEs, if any?**

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| **Company** | **YES/NO** | **Comments** |
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# 4. Conclusion

**Proposal 1: RAN2 to discuss whether to define an UL/DL indication field in the MAC CE (i.e. same MAC CE for UL beam and DL beam) or just use different eLCIDs (i.e. two MAC CEs for UL beam and DL beam separately) to indicate whether the MAC CE is for UL beam or DL beam for semi-static backhaul link.**

**Proposal 2: Take the MAC CE below as baseline and further discuss if any update is needed:**

