3GPP TSG-RAN2 Meeting #121bis-e R2-2204394

eMeeting, 17~26 April 2023

Agenda Item: 7.5.4.1

Source: Qualcomm

Title: Summary of [AT121bis-e][212][XR] BSR solutions (Qualcomm)

Document for: Discussion and Decision

# **Introduction**

This report provides a summary of the following at-meeting email discussion:

* [AT121bis-e][212][XR] BSR solutions (Qualcomm)

 Scope: Attempt to find out which among the BSR table solutions have most support and preclude those with least support (if possible). Should discuss pros and cons of each solution and determine which are acceptable to companies (and why). Can also discuss other general details (e.g. how the BSR tables are used).

 Intended outcome: Discussion report in [R2-2304394](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2304394.zip).

 Deadline: Deadline 2

During the online discussion on Monday, three solutions for BSR table enhancements were discussed:

* [1] proposes that a basic set of BSR tables can be pre-defined to support common use cases. But it also allows network to RRC configure additional BSR tables on demand, e.g. based on UE’s traffic characteristics.
* [2] proposes that UE generates a new BSR table by applying a scaling factor to a pre-defined reference BSR table. The scaling factor is RRC configured by network.
* [3] proposes that UE can send up to two BSR MAC CEs in single PUSCH transmission for a pending BSR. The first BSR MAC CE indicates a coarse value of UE’s buffer size, and the second BSR MAC CE refines the value reported by the first BSR. The two BSRs may or may not use different BSR tables.

Although these three solutions share the same goal of reducing quantization errors of BSR, they do differ in various ways and have their own advantage and disadvantages. In the following, we first discuss their pros and cons, on aspects such as whether they are efficient in reducing quantization error (e.g. weighing their achievable levels of quantization error vs overhead they introduce), their impacts on network’s flexibility in scheduling and complexity of UE implementation, etc. In the second half of this discussion, we then discuss other general but related issues for new BSR tables.

# **Contact information**

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# **Discussion**

One key difference between [3] and [1][2] is their overall approach in reducing quantization error. [3] uses more bits (up to two BSRs) to encode buffer size. Whereas [1][2] always sends only one BSR but UE may use a new BSR table with smaller quantization error.

**Q1. Which of the following two options do you prefer for reducing quantization error in BSR?**

* Option 1a. UE always sends only one BSR. UE may use either the legacy BSR table or a new BSR table with smaller quantization error. UE chooses which BSR table to use based on its buffer size, e.g. use a new BSR table if its buffer size is within the range of the new BSR table or use the legacy BSR table instead.
* Option 1b. UE may send up to two BSR MAC CEs in one PUSCH transmission. These two BSRs are coupled, i.e. the first BSR indicates a coarse value of UE’s buffer size, and the second BSR refines the value reported by the first BSR. *Without loss of generality, let us assume in this discussion that either of these two BSRs can be based on either the legacy or a new BSR table.*

In addition, the rapporteur suggests companies to discuss the pros and cons of these two options in the comments, e.g. whether it is more efficient than the other in reducing quantization error, its impact on network’s flexibility in scheduling and complexity of network’s UE implementation, etc.

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| **Company** | **Your preference**(Option 1a/b) | **Comments**(e.g. Pros and cons of these two options) |
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Summary

(to be added later)

There have been different proposals on how new BSR tables may be introduced. For example, they may be pre-defined in specifications, generated on demand based on parameters configured by RRC, or a combination of these two approaches.

**Q2. Which of the following option(s) do you prefer for introducing the new BSR table(s)?**

* Option 2a. They are pre-defined in the spec;
* Option 2b. They are generated on demand based on a pre-defined formula whose parameters are RRC configured by network;
* Option 2c. Option 2a + 2b, i.e. a basic set of BSR tables can be pre-defined in the spec to cover common use cases, but network can configure additional BSR tables using one of the methods in Option 2b.
* Option 2d. They are generated based on a reference BSR table and a scaling factor RRC configured by network.

You may choose more than one option from the above in your reply. If possible, please also include your analysis on the pros and cons of these three options in your comment.

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Summary

(to be added later)

To either pre-define or RRC configure a new BSR table based on a formula, one needs to decide on three factors: the range of buffer sizes in a table, number of code points, and the distributions of code points within the range. Some of these factors may need to be considered together. For example, the choice in number of code points may affect the choice on the range of a table, and vice versa. Or the choice in the distribution of code points may depend on the choice in the range or number of code points, and vice versa. We discuss these issues in the following.

For the range, the rapporteur thinks that there can be at least two possible options: either reuse the same range of the legacy BSR table or define a narrower range, e.g. based on the sizes of data bursts produced based on common XR encoding rates and frame rates. In the first option, quantization error can be reduced through techniques such as use of more code points or more efficient distribution of code points.

**Q3. What range of buffer sizes should new BSR table(s) have?**

* Option 3a. Reuse the same range of the legacy BSR table;
* Option 3b. A narrower range, e.g. based on the sizes of data bursts produced based on commonly used XR encoding rates and frame rates
* Option 3c. It depends on other options. No need to impose anything for now.

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Summary

(to be added later)

For the number of code points, the rapporteur thinks that there can be at least two possible options (for both RRC configured and predefined tables): all new BSR tables have the same number of code points or different new BSR tables may have different number of code points. The first option would simplify the design and implementation of the enhanced BSR MAC CE, whereas the second option maximizes the flexibility in defining/configuring new BSR tables.

**Q4. Which of the following is your preferred option for the number of code points in a new BSR table?**

* Option 4a. All new BSR tables have the same number of code points;
* Option 4b. Different new BSR tables can have different number of code points (e.g. depending on their ranges);
* Option 4c. Other (Please provide details in your comment)

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Summary

(to be added later)

For the distribution of code points, three options have been proposed in contributions: exponential (as in legacy, the ratio between a step size and its associated buffer size is a constant across all code points), linear (step size for each code point is a constant), and truncated Gaussian [2]. A sensible choice in the distribution of code point may depend on factors such as range and number of code points of a BSR table, as well as traffic characteristics (e.g. size distribution of data burst).

**Q5. Which of the following is your preferred option for the distribution of code points for new BSR table(s)?**

- Option 5a. Exponential distribution, i.e. The same as in legacy;

- Option 5b. Linear distribution, i.e. equal interval between any two consecutive code points;

- Option 5c. Truncated Gaussian distribution;

- Option 5d. Other (Please provide details in your comments).

You may choose more than one option from the above. In that case, please provide the criteria for each selected option in your comment.

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Summary

(to be added later)

There are a number of contributions on the granularity for using new BSR table(s). Most of them have proposed that network can configure on a per LCG basis which BSR table(s) UE should use, e.g. LCG #1 may use the legacy BSR table but LCG #2 may use one of the new BSR tables, and so on. On the other hand, it is also possible that in some solutions, it may be simpler for all LCGs in a BSR MAC CE to use the same BSR table.

**Q6. Which of the following is your preferred granularity for using new BSR table(s)?**

- Option 6a. Network can configure which BSR table(s) (either legacy or new) an LCG should use;

- Option 6b. All LCGs in a BSR MAC CE use the same BSR table;

- Option 6c. Other (Please provide details in your comment)

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Summary

(to be added later)

In legacy, short BSR and long BSR use different BSR tables, because they use different number of code points. If we are going to introduce new BSR tables, then we need to discuss whether/how new BSR tables should be designed for them.

**Q7. Which of the following is your preferred option for introducing new BSR table(s) for short/long BSR?**

- Option 7a. Only long BSR need to have new BSR table(s);

- Option 7b. Only short BSR needs to have new BSR table(s);

- Option 7c. Both short BSR and long BSR can have their own new BSR table(s), which are defined/configured separately;

- Option 7d. The same set of new BSR table(s) are used by both short BSR and long BSR.

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Summary

(to be added later)

Last but not least, there was discussion near the end of the online session on whether new BSR table(s) is available only to XR UEs or to any UEs. Let us continue that discussion here to collect more views.

**Q8. Do you think new BSR table(s) is available only to UEs supporting XR services or to any UEs?**

- Option 8a. Only UEs supporting XR services;

- Option 8b. Any UEs

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Summary

(to be added later)

# **Conclusions**

(To be added later)

# References

1. R2-2302515, BSR enhancements for XR, Qualcomm Incorporated.
2. R2-2303862, BSR enhancements for XR, Nokia, Nokia Shanghai Bell.
3. R2-2302851, BSR enhancements for XR, ZTE Corporation, Sanechips.