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.

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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.*
* Option 1c. UE sends only one BSR MAC CE in one PUSCH transmission, but the UE may report the overall buffer sizes for one LCG with two buffer size values in the BSR MAC CE: the first buffer size value indicates a coarse value of the LCG’s buffer size, and the second BSR refines the first buffer size. *Without loss of generality, let us assume in this discussion that either of these two buffer size values 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) |
| Qualcomm | Option 1a | Regarding Option 1b:   * If only legacy BSR tables are used, the maximum quantization error of the first BSR is ~10%, then the use of 2nd BSR can reduce it down to 1%. According to SA4’s TR, at 4K and 90 fps, the range of burst size is 28~208 KB. 1% of that corresponds to 280B ~2KB, which is at most one full PDCP PDU. So we are not sure if such a fine resolution in reporting is necessary or not, especially considering the extra overhead it introduces. * If new BSR tables are introduced, then a single BSR can offer a sufficiently good performance. Using the example above again, if the new BSR table uses linear distribution of 256 code points, then the resulting quantization error is 109B~810B, which is smaller than that of using two BSRs.   Based on the above analysis, we can see that a single BSR with a properly designed new BSR table in Option 1a can offer sufficiently good performance or beats the performance of Option 1b that uses legacy tables. Moreover, Option 1a has less UL overhead and is easier for network to decode received BSRs. Therefore, in our view, it is a better option to consider. |
| Nokia | See comments | Maybe better to have separate discussions about whether to allow fallback to legacy table and whether to allow two BS for an LCG as they are different issues.  Fallback to legacy table is at least needed if the new table does not cover full range (depends on the answer to Q3).  Two BS for an LCG could be used to reduce quantization error on top regardless of which table is used since the quantization error always remains. |
| ZTE | 1b/1c | In our view, this provides a simple mechanism to ensure an upper bound on the quantization error regardless of the new table design.  Firstly a “properly designed” new BSR table considering just the most likely application data packet sizes may not be sufficient to minimize quantization errors because the buffered data also depends on past scheduled data and newly arriving data. This will unfortunately require optimisation across the entire BSR range. As such covering all ranges of data sizes (especially now that we go towards even higher data sizes) with a very fine granularity would be impractical.  The main point is that eventually there will be gaps in these tables and it can happen that UE’s buffered data falls in these gaps, there by leading to quantization errors. This quantization error can be reduced by increasing the number of tables, but there will still be worst case values which will result in high degree of over reporting.  So, we think the solution proposed here to reduce the quantization error, especially when the quantization error exceeds some threshold (chosen by the network), is a simple way of achieving the goal.  It should be noted that the second index need not be always present. But, if the error is high, by including very few bits, we can reduce it to almost zero. With this approach, we also think we don’t need to define a large number of additional tables. And we can also have a simple table design which just covers a few additional high data code points. |
| LGE | Option 1a | For option 1a, it is simpler if the new table is defined. If the new table is defined, the existing BSR operation could be reused, which simplifies the spec and UE operation.  For option 1b, if two BSR indices are used, the design of new table may not be needed, which simplifies the discussion of design new BSR table(s). However, it is not desirable with following reasons:   * Generating two BSR MAC CEs for each LCG causes additional UE complexity to generate BSR table(s) and transmit the corresponding BSR MAC CE(s) * Two BSR MAC CEs cause the additional overhead, since it needs multiple MAC subheaders. * It also changes the procedure text of BSR operation, since in the current text specifies that only one BSR MAC CE is transmitted for multiple BSR triggering events * it is ambiguous whether the transmission of BSR is allowed or not when UL grant(s) can accommodate one BSR MAC CE for transmission but is not sufficient to accommodate two BSR MAC CEs.   For option 1c, it looks better than option 2b since it does not need to tramsmit multiple MAC subheaders. However, given that new BSR table is defined with finer granularity, one Option 1a is simple and sufficient. |
| NEC | Either | Either option can equally work well, we can follow majority. Pros and cons are analysed as following:  Option1a:   * only one BS field per LCG * assuming to keep the 8bits BS field, generally, the overhead may be slightly increased comparing legacy BSR report due to potential BS table indication field and new eLCID(s) * likely introduce New BSR MAC CE with BS table indication * Must discuss how to pre-define or configure new BS table(s)   Option1b/1c (assume a BS threshold will be configured and used to trigger second BSR):   * When buffer size is lower than the threshold, all legacy MAC CE format/procedure/LCID can be reused without any change * When buffer size is higher than the threshold. the first BS can be same as legacy, the second BS is reported with same or different format. potentially, this means nearly doubled overhead. * Potentially, no need to introduce new BS table(s), if the second BSR also use the legacy table . (i.e., no need to discussion Q2-Q7) * Potentially achieve smaller quantization error but with more bits in total |
| CMCC | Option 1a | We think that with new BSR table, one BSR is sufficient for reducing quantization error. Therefore, there is no need to introduce a secondary BSR.  For Option 1b, we think using two BSR MAC CE will increase overhead since BSR can be very common. Considering Long BSR, it can be even worse. |
| Ericsson | 1a | Reporting one BSR table value is sufficient (for each LCG/delay group in LCG).  We see no reason to send multiple BSRs to provide the same information, e.g. buffer size, if this can be done by transmitting one BSR. |
| Quectel | 1a | Option 1a is simple. Although option 1b and 1c may lead less wireless overhead, the triggering condition and the configuration is too complex. |
| Sony | 1b/1c | We think both options of either one MAC CE or two MAC CEs could be supported. This may carry the value from legacy BSR table and a delta compared to this value. |
| Samsung | 1a first, then 1b/c | We prefer to discuss first whether the new BS tables are fixed or dynamically constructed. When constructed dynamically, potentially a single BS field is sufficient to reduce the quantization error to a satisfactory level, provided that the NW constructs a table with appropriate ranges. We also believe that 1b/c is some kind of additional optimization regardless of the new BS table issue, so we should focus on what we agreed on earlier, step by step. |
| Apple | 1c and 1a | Obviously both Option 1a and 1b are beneficial in terms of reducing quantization error, so we would like to comment on the cons of these options:   * For Option 1a, RAN2 may need to make a lot of efforts to decide how the new tables should be constructed, what are the value ranges etc. This would be time-consuming especially if RAN2 decides to introduce multiple new tables. * For Option 1b, the UE may need to generate two BSR MAC CEs for one MAC PDU, which increases UE complexity during LCP, as well as extra overheads such as LCID and LCG ID etc.   Therefore, we think Option 1c is a better compromise between these two, where we can enjoy the benefits of lower quantization error of Option 1b, while without having to break the “one BSR MAC CE per MAC PDU” rule we currently have in TS 38.321 like in Option 1a. Moreover, the efforts of defining new BS tables could be minimized as even legacy tables can provide good performance in our understanding.  The downside of Option 1c is that we may need to introduce new BSR formats to accommodate two BS values per LCG, but we think in Rel-18 introducing new BSR formats is anyway inevitable considering all the potential enhancements for BSR.  Note that we think the UE should only use BSR formats offering finer granularity of BS value when the quantization error is too large.  If Option 1c is not acceptable, then we are fine with Option 1a which is the baseline for legacy BSR anyway. |
| vivo | Option 1a | The pros of Option 1a compared to Option 1b:   * Option1a is more compatible with the existing BSR procedure, i.e. Option 1a may cause less changes to existing specification regarding BSR generation; * Option 1a needs smaller total size due to at least one MAC subheader can be saved.   In the meanwhile, it is not clear whether Option 1b has smaller quantization error than Option 1a.  Regarding option 1c, we need to define the trigger condition for each BSR. |
| Intel | Option 1a | We prefer Option 1a, to send a single BSR. The UE could use RRC configuration (e.g. per MAC entity) or a threshold condition based on the buffer size to determine when to use the new BS table (i.e. to determine which format for MAC CE to use) in order to provide finer granularity for larger BS value and reduce quantization error.  Option 1b could also work, however, we do not see a clear benefit for sending two BSR MAC CEs for the same buffer size. It also adds unnecessary complexity, e.g. the additional BSR MAC CE contains additional fine indexing for multiple LCGs at the same time, the BS calculation needs to change, and on top of that the new BS table(s) anyway have to be introduced. Overall, the solution seems to have higher signalling overhead and spec impact. |
| Lenovo | 1c/1b | We agree with ZTE, that a simple method to report the large quantization error value with several additional bytes is enough. We prefer 1c, 1b would be also acceptable.  As shown in our contribution R2-2303203, evaluating the typical data rates and frame rates, the quantization errors range from several hundred or several thousand. To avoid the need to introduce too many new BS tables, RAN2 should consider using a buffer size table that indicates the quantization errors.  @NEC  For option 1b/1c: we think the quantization error value may be compared against a threshold. It can help determine to include the second BS or not.  @LGE  For 1a: it depends on the number of new tables to be defined and when to (re)configure the tables. As mentioned before we think it will be difficult to have only a limited set of new buffer size tables which cover all the possible packet sizes to decrease the quantisation error. It increases UE complexity to maintain the different tables from time to time.  For 1c: Add a second BS field in one BSR MAC CE is not complex,  We can discuss the truncated BSR as a stage3 detail, e.g., reusing the legacy principle. |
| MediaTek | Option 1a | We prefer one single BSR as legacy, which introduce less impact and less overhead with similar quantization error (if configured properly) and less complexity |
| KDDI | Option 1a | Share the view with Qualcomm |
| Xiaomi | 1a | We see no reason to send multiple BSRs in 1b as option1b changed the existing BSR operation that only one BSR MAC CE is transmitted for multiple BSR triggering events.  option1c used a second index or more bit to reduce the quantization error while we think in option1a, a new BSR table can be defined with finer granularity by adding more code points. Seems not much difference between them.  So option 1a should be prioritized.  And we also think how UE chooses which BSR table to use is a separate question. |
| Fujitsu | 1a | We think that Option 1a is simpler than Option 1b/1c if the new BSR table is designed to make the quantization error acceptable. |
| Huawei | Option 1c (preferred), Option 1a, but only with pre-defined tables | For 1a, pre-defined BS tables based on existing encoding rates is sufficient, no need to support the RRC-configuration based BS table generation further. We should not for the uncertain future ask all today’s UEs to struggle with a complicated solution.  For 1b, it works, but we think no need to carry two BSRs in separate MAC CEs.  For 1c, quite similar to 1b, they two can achieve the same effect, 2 bits additional index can reduce the quantization error to be 1.5%, 3 bits can guarantee the error even lower than 1%. But 1c can save one MAC CE sub-header cost compared to 1b. Besides, for the second BS value, by using linear finer granularity within the buffer size range indicated by the first BS value, 1c can avoid the discussion and further standard efforts for Q2-Q4. |
| III | Option 1a | We think Option 1b/c is more complex, option 1a is sufficient. |
| TCL | 1c | For 1b, two MAC CE may be caused signaling overhead and increased the UE complexity.  For 1a, actually UE need also indicate which table it select as the additional information for the BSR index. |
| InterDigital | 1a/1b | The reduction in quantization error from Option 1a will depend on the sizes and the granularities of the BS values in the new BSR table(s). Going towards higher indices, 1b may further reduce quantization error (even with the new BSR tables). We can assess the quantization errors still present from the new BSR table and determine if further optimizations (with 1b) are needed. |
| OPPO | Option 1a in principle, but | We generally agree to send only one BSR per MAC PDU, similar to legacy. Including 2-level BSR in one MAC PDU will complicate the implementation.  On whether to report BS using the new table or the legacy table, we understand it depends on 1) whether it is the LCG that can (be configured to) use the new BS table. 2) whether the new table can cover the range of the legacy BS table. If yes, there is no need to fall back to using the legacy BS table, i.e. the UE only needs to use the new BS table for the associated LCG. Otherwise, the UE may need to use the legacy BS table when the data size buffered in the UE for the associated LCG is smaller than the minimum value of the new BS table. |
| ITRI | 1a | We think that only one BSR MAC CE with proper new BSR table in one PUSCH transmission is sufficient. Option 1a is preferred due to simplicity. |
| Google | 1c or 1a | Compared to legacy BSR, 1b reduces quantization error from ~10% to 1%. But if we go for 1a instead, 1a should have some advantages over 1b, such as reducing more quantization errors (e.g. less than 1%) or with lower implementation complexity.  For 1b, since current spec only allows 1 BSR MAC CE in a MAC PDU, the two BSR indices should be in the same MAC CE. Otherwise, there are some impact on MAC. |
| DENSO | Option 1a | In our understanding, two BSR MAC CEs (or two BSR indices in only one BSR MAC CE) cannot efficiently use the bit field which indicates UE’s buffer size. For example, if the first BSR indicates a lower index, the number of bits required for refinement would also be smaller because the quantization error is smaller. In this case, the second BSR can cause the additional overhead due to the extra bits that are not needed.  If a new BSR table with smaller quantization error is introduced, only one BSR is sufficient. |
| Futurewei | 1a | Agree with Qualcomm and LGE. |
| Spreadtrum | 1a | We prefer a simple solution. The BSR table can be well defined to reduce the quantization error. |
| FGI | Option 1a | 1a is straightforward and sufficient for the purpose of reporting buffer status to gNB. |
| CATT | Option 1a or 1c | Considering the large scope of packet sizes, especially for video services, we are not sure gNB can configure suitable BS value range for different services, as mentioned in some contributions. If gNB can configure suitable BS value range of the new BSR table, we prefer option 1a. If not, we think option 1c can achieve the purpose of reducing quantization error indeed. |

Summary

Among the 30 companies that have replied,

* 25 companies prefer Option 1a. Most of the proponents think that this is the preferred option because with new BSR table(s) (which is to be introduced according to the current agreement), one BSR is sufficient for reducing quantization error, especially if new BSR table(s) are RRC configured by network.
* 9 companies prefer or can support Option 1b or 1c (Note: The rapporteur, as well as the proponents of Option 1b/c, think that at stage-2 level these two options are essentially the same and hence can be considered together when compared with Option 1a). An advantage of this solution is that it can ensure an upper bound on the quantization error regardless of what the traffic is and the amount of buffered data.

Based on the comments made by both camps, it appears that the key question that can influence the decision is whether a low enough quantization error level (TBD what level is good enough) can be achieved by using new BSR table(s), with the constraint that only one BSR index per LCG is reported.

A clear majority (25 out of 30) of companies think that the objective can be achieved. If the majority view is indeed correct, then Option 1b does not have other advantages over Option 1a, e.g. it requires more overhead, creates more complexity in BSR MAC CE format, etc.

To the best of the rapporteur’s recollection, companies have not discussed what level of quantization error we should aim for the design of new BSR table(s). To help this downselection, as well as new BSR table design, it is desirable for companies to develop a common understanding of what it should be.

Based on the above observations, the rapporteur thus would like to make the following proposal.

**Proposal 1. (25/30) As a working assumption, at most one BSR index is reported by an LCG. This assumption can be revisited if new BSR table design cannot achieve a target level of quantization error. FFS what this target level should be.**

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 four options in your comment.

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| **Company** | **Your preference**  (Option 2a/b/c/d) | **Comments**  (e.g. Pros and cons of these options) |
| Qualcomm | Option 2a or 2c | From UE’s perspective, Option 2a is the simplest for UE to implement and yet serves the purpose well. Since new BSR table(s) only need to cover the size range of common XR encoding rates and frame rate, which are known, BSR tables can be predefined accordingly.  We understand that Option 2b can provide more flexibility for network. And if done right, it may be able to achieve lower quantization errors too. However, given the fact that the target range for new tables are known, we are not sure how much gain (e.g. in term of capacity improvement) Option 2b can offer and whether that would justify the extra implementation effort by UE. And the worst concern for UE implementation is that it is uncertain how much computing cycles it needs to budget for dynamic BSR table generation, because we don’t know how often network may ask UE to generate a new BSR table.  Therefore, Option 2c can be a good compromise for UE and network, because pre-defined BSR tables can help handle most of the scenarios and UE only needs to generate a new BSR table occasionally.  Option 2d can be an alternative to 2c if all the parameters of the reference table (e.g. min, max, distribution of its code points) can scale in the same way when encoding/frame rate changes. But that assumptions needs to be fully vetted before it can be considered. |
| Nokia | Option 2b or 2d | More flexible to cover all typical data rate and frame rate than 2a, without too much UE complexity.  No simplification for UE implementation with 2c compared to 2b since the UE would anyway need to implement both. |
| ZTE | Option 2a | We prefer a single additional table with focus on larger data packet sizes. |
| LGE | Option 2a  Acceptable for 2b  No for 2c and 2d | Option 2a is preferred since it minimizes the UE complexity using the new BSR table. If the UL XR traffic range can be covered using the several BSR tables, defining one or more fixed tables seems sufficient.  Option 2b is acceptable if it is the data volume range of UL XR traffic is diversified. In addition, no new BSR table would be needed in the future releases in order to support other types of traffic. The additional UE complexity depends on the details of the additional BSR table(s) (e.g., distribution of code points as in Q5).  Option 2c and Option 2d is not preferable since there is no additional benefits compared to option 2b. If the new BSR table(s) need to handle various range of data volume, option 2b seems sufficient. |
| NEC | Option 2b | Option2a has futureproof issue, and less flexible  Option2c basically specify two solutions for one issue, which is not the normal way we work in 3gpp  Option2d, with scaling factor, it means UE need to generate new table same as option2b. moreover, UE implementation may need to deal with non-integer values due to the scaling |
| CMCC | Option 2b | We think Option 2b can provide the least quantization error. UE or NW may trigger a BSR table update when it finding the quantization error between BSR table and actual buffer are too large.  For Option 2a, we think it has least impact on UE. However, XR can have multiple and/or unstable data rates, it’s difficult to the find all pre-defined BSR tables that suits for all or most XR applications.  For Option 2d, it’s easy for implementation as well, but it has the same problem as Option 2a, i.e., a suitable reference BSR table for XR service may not exist. |
| Ericsson | 2b | Configured/generated tables are really the only solution that is needed. This option gives the largest gain (shown to be close to the ideal case in simulations) and is a clean and easy to understand solution which is matching legacy operation of BSR reporting. It will have a low cost since the generation is only done when changes are needed (rare occasion if a few tables are generated from the start and selected from). Thus the benefit of introducing new pre-defined tables is hard to justify. Pre-defined tables will never be able to cover all the ranges that is needed and at same time keep the granularity high enough to get good gains. The range is shown (in simulations) to be dependent both on the traffic sizes and on the transmission sizes. Both are factors that will change with time and can't be known beforehand when defining the tables.  Legacy tables will always be an option for all solutions (those are of course pre-defined).  For option 2c we have done some comparison simulations on this option (of dividing/scaling every step size) and it seems to not be as good as the configurable table solution:    As can be seen with higher indexes the granularity is still low with the scaling solution, so it doesn’t actually solve the problem with low granularity for large sizes. And with increasing bitrates/transmission sizes the problem will only become larger. |
| Quectel | 2a/2b or 2c | Considering the difference character of XR sessions, it is benefit to predefine some tables, and let some space for gNB configuration. |
| Sony | 2a/2d | We think 2a is straightforward |
| Samsung | Option 2b | Option 2a causes another non-trivial issue that how to determine the range the new tables should cover, and how to design code points. Also, it has future-proof issue.  Option 2b is sufficient to provide enough flexibility and scalability considering current XR traffic pattern and its evolution in the future. We can discuss the way to handle UE complexity issue, if needed  Option 2c seems to impose higher burden on UE implementation.  Option 2d cannot fully resolve the quantization issue when the table is scaled to higher volume range, since the quantization error (the BS interval between two adjacent code points) is also scaled. |
| Apple | Option 2a, but … | As mentioned by some companies, Option 2a is simplest for UE implementation.  If we are going to use semi-static BS tables (e.g. Option 2b/2c/2d), since it is the UE who can directly observe the quantization error, as well as tracking the UE application activities, we think some we should allow the UE to express some preference and recommendations about the BS table parameters. |
| vivo | Prefer option 2a. | Option 2a has the following pros compared to the BSR tables specially optimized for certain XR traffic:   * It can be expected to be simplest among these options. * Fixed table(s) for common use is not sensitive to the rate adaptation of the XR traffics.   Given fixed table(s) of finer granularity is used, the additional quantization error reduction by further refining the BSR table for specific scenario, if there is, could be very marginal. It is not worthwhile to pursue the marginal additional gain at the cost of considerable implementation complexity and standardization effort increase. |
| Intel | Option 2a (preferred) or Option 2b (with comment) | Option 2a: This is our preferred option to have fixed BS table(s). We believe this option is the most straightforward approach where finer granularity can be easily achieved e.g. by having more number of bits in the BS field size (e.g. 10 bits to have 1024 codepoints). Such fixed table could cater to most cases for XR traffic since there are only a limited number of frame rates that need to be supported anyway.  Option 2b: This option of semi-statically RRC configured table (e.g. max, min and step size parameters) is acceptable to us if it is majority view. This could offer some flexibility and may be more forward compatible to other use-cases for XR in future releases (even if not required for Release 18).  Option 2c: This does not seem like a compromise since both approaches need to be specified. RAN2 will need to further discuss how the UE shall implement/support both kinds of tables (i.e. fixed and semi-static) e.g. this could depend on new/different UE capabilities. We don’t see the benefit of adding this complexity even with the understanding that in most cases only the fixed table(s) will be used.  Option 2d: We believe this is a subset of Option 2b, since the scaling factor is a configurable parameter. |
| Lenovo | Option 2a  Acceptable for 2b | We prefer 2a for simplicity. 2b may be also acceptable given that benefits can be proven. |
| MediaTek | 2b | 2b is more futureproof, 2a can’t support future XR services when its data rate is out of the new BSR range. |
| KDDI | Option2c | We understand that Option 2a can address some of the existing XR use cases, but it’s better to have option 2b also to address potential use cases. |
| Xiaomi | Option 2a | We prefer 2a as it is simpler and is feasible if the new BSR table is tailored particularly for XR traffic and the pre-defined BSR tables are sufficient to handle most of the scenarios. |
| Fujitsu | Option 2a | We think 2a has lower UE complexity and may reduce the signalling overhead of parameters configuration from network. |
| Huawei | If new BSR tables are deemed needed, then Option 2a | With the two-index solution it might be even possible not to specify any new BSR table, which is a big advantage of this solution. But if companies see this as needed, we think one or more pre-specified new BS tables can cover most of cases, if the quantization error is still too big, we can use an additional index to further alleviate the error.  Configurable BSR tables solution is an overkill to us and we are not sure how the network will know the traffic characteristics to set the table parameters. |
| III | Option 2a | Agree with Qualcomm. |
| TCL | 2a | Option 2a is the simplest and we can only focus on the case of the large buffer size. |
| InterDigital | 2b/2c | Option 2b is the most flexible/optimal. However, if some agreement can be made regarding a handful of BSR tables that can capture the most common XR traffic, option 2c could also be used for reduced signaling. |
| OPPO | 2a,  can accept 2b | 2a is simple.  2c is not acceptable since it requires the UE to implement the two ways(2a+2b) |
| ITRI | 2a | We prefer option 2a due to lower UE complexity, and think that option 2a can be the baseline for Rel-18. |
| Google | 2a/2b/2c | Option 2a is simple and straightforward. Option 2b offers greater flexibility and allows the gNB to configure the required parameters and a pre-defined formula can be specified to derive the BSR tables. This formula can be a simple linear formula, where the minimum, maximum, and step size are signaled from the gNB. Option 2c is also a good compromise between 2a and 2b. |
| DENSO | Option 2b | Option 2b can provide the least quantization errors by configuring the appropriate parameters for the current XR traffic and will be useful for other types of traffic in the future releases. |
| Futurewei | 2b, can accept 2d | 2a is simple but not future-proof.  2b is flexible and future-proof but not simple.  2c has no clear advantage over 2b.  2d may be a compromise between simplicity (2a) and flexibility (2b). |
| Spreadtrum | 2a | We prefer the option 2a as it is simple for UE implementation. We think new BSR tables for XR can cover most cases. |
| FGI | Option 2b,  Option 2d is acceptable with comment | Option 2b is futureproof. BSR tables for XR are expected to be semi-static, so frequent updating is not assumed.  Option 2d is acceptable if legacy BSR table is taken as the reference BSR table. |
| CATT | 2b | Agree with other supporting companies on the flexibility and future-proof. And complementary with legacy table. |

Summary

Among the 30 companies that have replied,

* 18 companies can support Option 2a. Among these 18 companies, 8 companies prefer only Option 2a, and 10 companies can support other options too. Among these 10 companies, 5 companies can also support Option 2b.
* 13 companies can support Option 2b. Among these 13 companies, 7 companies prefer only Option 2b, and 6 companies can also accept other options. Among these 6 companies, all of them can also support Option 2a.
* 6 companies support Option 2c. Among these 6 companies, 4 of them also support Option 2a, and 2 of them also support Option 2b.
* 5 companies prefer or can accept Option 2d. Among these 5 companies, no company prefers only Option 2d (i.e. all of them have selected multiple options).

Based on this outcome, the rapporteur thinks that perhaps Option 2d can be deprioritized, based on the fact that it has the least support and all of its proponents can accept other options too.

Similarly, Option 2c also has only low level of support. And most of its proponent can accept Option 2a or Option 2b. Hence Option 2c can also be deprioritized.

Between Option 2a and 2b, the views are equally split, mostly aligned with the divide between UE makers and infra vendors. Most of the comments from either camp have been made before:

* UE makers think Option 2a is the simplest for UE implementation. They have concerns with the extra implementation efforts required by Option 2b and have reservations on how much capacity gains can be attained.
* Infra vendors think Option 2b is more flexible and can cover all typical XR data/encoding/frame rates, as well as future one, than Option 2a. They also think Option 2b is more future proof than Option 2a.

The rapporteur is not able to come up with any good way-forward other than suggest companies to discuss further and think more about how to address each other’s concerns.

**Proposal 2a. (21/30) Deprioritize Option 2c (static + dynamic BSR tables) and Option 2d (reference table + scaling factor).**

**Proposal 2b. Have more discussions on Option 2a (static BSR tables) vs Option 2b (RRC configured BSR tables).**

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.

|  |  |  |
| --- | --- | --- |
| **Company** | **Your preference**  (Option 3a/b/c) | **Comments** |
| Qualcomm | Option 3b | We think there are two possible dimensions in reducing quantization errors: reduce the range of a table vs increase number of code points. Between these two choices, we think increasing number of code points is less desirable, because it will increase UL overhead and make the design of new BSR MAC CE more complicated. On the other hand, reducing the range of a table has much less overall impact on the current BSR framework. |
| Nokia | Option 3b | Finer granularity with narrower range. No need to cover full range as legacy table can be used for smaller buffered data, otherwise if with 3a it would have worse granularity for some code points than legacy table if to have finer granularity for others? |
| ZTE | Option 3b | As shown in our contribution, the problem is higher towards higher BSR indices (when there is more buffered data). This is because the code points are sparser in this region. So, targeting these regions seems to make sense. On top, if we have some fail-safe mechanism to ensure that the quantization error never exceeds a given value (like including second index if it exceeds), then the design can simply focus on the higher end of the buffer sizes (and typical frame sizes for XR traffic etc). If we have no such fail-safe mechanism, some more detailed analysis may be needed to see how to optimise over entire range. |
| LGE | 3c | It depends on the result of Q2.  If Option 2a is agreed, it should be determined based on the characteristic of XR traffic.  If Option 2b is agreed, it depends on the network configuration. |
| NEC | Option 3b | Optin3a (cover 0 to infinite) does not work well:   * With the same bits, quantification error is reduced in a certain buffer size range, while increase in other buffer size range   Or much more bits is required for BS report |
| CMCC | Option 3b | We think that this issue depends on the characteristics of XR traffic. Since XR traffic consists mainly of periodic Data bursts with finite size, a BSR table whose range covers Data burst seems fine |
| Ericsson | 3b/3c | The range of the tables depend on how the NW configures them and thus what is suitable for the traffic. This is not something we can decide on here.  It is likely that the configured tables will be narrower than legacy tables, to make possible for higher precision on some specific range, but it all depends on the bits/code points used. |
| Quectel | 3b |  |
| Sony | 3b |  |
| Samsung | Option 3c | It is NW implementation issue, if BS table is constructed based on NW configuration. If it is agreed to pre-define fixed new BS table(s), then Option 3b is more desirable. |
| Apple | Option 3b/3c | In general we believe a narrower range is sufficient, but we think we should leave it open for the time being. |
| Vivo | Option 3c | Of cause, finer granularity could obtained for narrower range. But this issue depends on the output from Q1 and Q2. Let’s discuss this issue when there is conclusion regarding Q1 and Q2. |
| Intel | Option 3a (if option 2a is agreed for Q2) or option 3b/3c (if option 2b is agreed for Q2) | We think different options for the range of buffer sizes may be applicable depending on how the BS table is defined (which is discussed separately in previous Q2).  **Approach 1: option 3a if BS table is predefined in spec. (i.e. option 2a is agreed in Q2).** Our preference in this case is option 3a with the following reasoning:  *Upper limit:* RAN2 uses the same upper limit Bmax (>81Mbytes) as in current BS table for the additional BSR table. For BS value of 81 Mbytes, with 2 bursts buffered and 60 fps packet arrival rate, the supported throughput can be calculated as 81/2 Mbytes \* 8 bit / Byte \* 60 / second = 19.44 Gbps, which seems sufficient for XR traffic.  *Lower limit:* We keep same lower limit Bmin (0kbytes), however, more code points are needed for finer granularity. The benefit in this case is that based on a threshold condition as explained in Q1, the UE can use the same new BS table for all LCGs within a BSR, and per LCG configuration is not needed.  **Approach 2: option 3b/3c if BS table is configured semi-statically via RRC (i.e. option 2b is agreed in Q2).** We could accept option 3b/3c for the case of RRC configured semi-static table with the following reasoning:  *Upper limit*: Same as legacy, for the reason explained above in approach 1).  *Lower limit*: Can have a higher lower limit (e.g., 20Mbytes). In this case the BS field size could be the same as legacy e.g. 8 bits. However, per-LCG table selection can be configured using semi-static RRC parameters.  Per-LCG table selection in Approach (2), which appears to be the majority companies’ view, seems more efficient, but we would like to point out that it will likely increase the decoding complexity of the MAC PDU carrying the BSR. Additionally, a new mapping table for per-LCG association to a BS table may be needed. On the other hand, Approach (1) of having uniform configuration of BS table across all LCGs in the BSR, especially if new BS table only uses 1 or 2 additional bits for the BS field size would have a comparable (or potentially lower) overhead. In summary, comparing these two approaches, we believe **Option 3a is straightforward without introducing much signalling overhead** (as the same range of BS values is used for both the new and legacy BS tables).  In summary, our preference is option 3a (as explained in our response to previous question Q2), although we also understand that there might be large support to provide some flexibility in which case option 3b is also acceptable to us. |
| Lenovo | Option 3b | Agree with ZTE. As shown in our contribution, the quantization errors range from several hundred to several thousand bits, a narrower range with a maximum BS value set to 10000 bits to cover the quantization error is sufficient. |
| MediaTek | Option 3b |  |
| KDDI | Option 3b |  |
| Xiaomi | Option 3b or Option 3a.  Prefer option3a. | Option3b has a good intention that the new BSR table is  based on the sizes of data bursts produced based on commonly used XR encoding rates and frame rates.  However, if we check carefully, it may leads to the same range of the legacy BSR table as intel’s calculation shows that the same upper limit Bmax (>81Mbytes) as in current BS table is sufficient for XR traffic.  And if we keep same lower limit Bmin (0kbytes), quantization error can still be reduced through techniques such as use of more code points or more efficient distribution of code points or more BSR tables.  And the UE can use the same new BS table for all LCGs within a BSR, and falling back to old BSR tables is not needed. |
| Fujitsu | Option 3b |  |
| Huawei | Option 3c | It depends on the results of Q1 and Q2, and it is not urgent to discuss the range of new BS tables at the current stage. |
| III | Option 3b |  |
| TCL | 3c | If only one BSR, we can reuse the same range of the legacy BSR table.  If more than one BSR, including two BSR MAC CE and two BSR size in one MAC CE,  for the the first BSR, we can also reuse the same range of the legacy BSR table,  for the second BSR, the narrow range is preferred. |
| InterDigital | 3b/3c (prefer 3b) | A narrower range including the common XR encoding rates could be considered for the new BSR tables (specifically for the fixed BSR tables, if we agree to define these). The smaller payload sizes can be excluded from the new BSR table since the legacy table can also be used. That being said, if the BSR tables are defined in a semi-static fashion via RRC, there is no need to put a limitation on the range, which can be left to network implementation. |
| OPPO | Option 3c | If 2b in Q2 is agreed, the BS range of the new BS table(s) depends on the gNB implementation. If 2a in Q2 is agreed, 3b is preferred (but we may need to consider how to report BS 0). |
| ITRI | 3b |  |
| Google | 3b | A narrow range introduces less quantization error. |
| DENSO | Option 3b | Option 3a would require more code points to reduce quantization errors, causing the additional overhead. |
| Futurewei | 3b with comment | The range depends not only on the size of data bursts but also on the maximal number of data bursts that can possibly be buffered at a given time. BSR is for the UL. UL video traffics (for AR) tend to have more relaxed PDB/PSDB requirement (30ms in TR 38.838) than DL video traffics for VR (10ms in TR 38.838). If the UL video frame refresh rate is 60 Hz, there could be up to two data bursts in the buffer at a given time (new burst arrives while the old one still being transmitted, both bursts still within their PSDB). Generally speaking, the maximal number of data bursts can be consider as ceil(PSDB/Traffic\_periodicity). |
| Spreadtrum | Option 3c | If Option 2a is agreed, a narrower range is sufficient.  If Option 2b is agreed, it depends on the network implementation. |
| FGI | Option 3c | The range should be determined by the network. |
| CATT | Option 3b |  |

Summary

Among the 30 companies replied,

* 2 companies prefer Option 3a if Option 2a is agreed;
* 22 companies prefer Option 3b. Most companies think narrower range is the approach for achieving lower quantization errors.
* 12 companies prefer Option 3c, because they think this issue depends on the outcome of Q1/2 and hence we should keep it open for now.

The rapporteur agrees that this issue, to some extent, does depend on outcome of the discussions on Q1/2. For example, if new BSR table(s) is RRC configured by network, then its range should be up to network. On the other hand, there are a considerable number of companies support to have narrower ranges for new BSR table(s). The rapporteur hence thinks that perhaps companies can try to agree in principle that designs/configurations for new BSR table(s) should be able to support of narrower ranges than the legacy.

**Proposal 3. (22/30) Design/configuration for new BSR table(s) should include support for narrower ranges than the legacy. Details can be discussed after an agreement on how UE obtains new BSR table(s) (e.g. pre-definition vs RRC configuration) is made.**

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)

|  |  |  |
| --- | --- | --- |
| **Company** | **Your preference**  (Option 4a/b/c) | **Comments** |
| Qualcomm | Option 4a | This choice is a tradeoff between performance and complexity. Theoretically, Option 4b probably has a better performance in reducing quantization errors than Option 4a, because tables with large ranges can benefit from having more code points. However, if network can configure different LCGs to use different BSR tables, then having different BS field lengths for different LCGs can make the format of the new BSR MAC CE much more complicated 🡪 not desirable for UE implementation. |
| Nokia | Option 4a | 8-bit table(s) are enough. |
| ZTE | 4a | We think just one additional table would be sufficient. |
| LGE | 4a | We prefer to define same size of BS field in order to simplify the new BSR MAC CE design, given that each LCG may use different BSR table(s) (related to Q6). Furthermore, the number of code points of BS field should be same as legacy BSR table (i.e., 8 bits for long BSR format), given that some LCGs may use the legacy BSR table. |
| NEC | Option4a | 8bits BS table.  it is likely that a long or long truncated BSR MAC CE includes some BS fields encoded based on a legacy 8bits BS table, and some other BS field encoded based on a new BS table, it would be easier to define the MAC CE format if we keep all the BS fields with same length. |
| CMCC | Option 4a | We think that using the same bit length has less complexity for implementation.  Besides, we think 8 bit is enough for XR, so Option 4b is less preferred. |
| Ericsson | Option 4b | There are mainly two aspects coming into this, how many bits and how many indexes that are used. Both of these can vary, e.g. we can have the same amount of bits as today or even less. Then what indexes are used is up to NW when deciding to configure the table, it may even decide to not use all indexes.  More bits/code points give higher precision and/or larger range, which may lower the number of tables needed. But fewer code points reduce overhead and can allow for reporting other information. This depends on what BSR formats that is selected to be used (e.g. new formats with other length than legacy may be introduced). |
| Quectel | 4a and 4b | For the predefined table, the code point is fixed. But for the RRC configured BSR table, the number of code point and the exact value depends on the configuration. |
| Sony | 4a |  |
| Samsung | Option4a with comment | Our preference is, potentially, if there are multiple new BS tables, they may have the same number of code points. But, we fail to see any constraints that longer than 8-bit BS field should be precluded for those new BS tables. As long as the byte align is achievable, e.g., with mixed 2-byte and 1-byte BS fields, a new BSR format can be designed decently, given the signalling on which BS table is used for a certain LCG. |
| Apple | It depends | For now, we tend to think it depends on what the “new table” is used for. For instance, if the new table is used for the second BSR or the second buffer size value in Option 1b/1c in Q1, probably we need fewer than 8 bits to indicate the differential BS value.  Therefore we prefer to keep the Option 4b open. |
| vivo | Option 4b | If new fixed BSR table is defined, it is better to have more code points than the legacy table. Since new BSR format MAC CE would be introduced anyway, it is not necessary to stick to 256 codepoints.  Option 4a is also acceptable with less implementation complexity. |
| Intel | Option 4a | Since this is possible, we don’t think the complexity of option 4b is needed which adds more variability and/or need for multiple new BSR MAC CE formats. |
| Lenovo | Option 4a | Agree with ZTE. A 5bit BS table for the second BS would be sufficient in our view. |
| MediaTek | Option 4a |  |
| KDDI | Option 4a |  |
| Xiaomi | Option 4a | If we increase the code points, which means new BSR format will be needed and LCGs using new BSR table will not be multiplexed with LCGs using old BSR tables which is not preferred. |
| Fujitsu | Option 4a | 8-bit for BS is preferred. |
| Huawei | Option 4c | If option 1a is adapted, all new BS tables should have the same number of code points for a clean BSR MAC CE design.  If option 1c is adapted, in fact we can understand the additional index does not belong to any BS table, it’s more like an equal division indicator, depends on how many bits designed for the additional index. For example if it is 2 bits, then within the range indicated by the 1st index, the additional index indicates how many parts there are of the four divisions. |
| III | Option 4a |  |
| TCL | 4a |  |
| InterDigital | 4a/4b | Option 4a is a simpler design, and maybe the most suitable for fixed BSR tables. However, we see no need to put a limitation on this in the case of semi-static BSR that is defined via RRC. |
| OPPO | Option 4a | Similar view as Qualcomm. |
| ITRI | 4a | We prefer to define same size of BS field for the new BSR MAC CE design in order of less complexity. |
| Google | 4a | With the same number of code points for all new tables, it is easier to design BSR MAC CE. |
| DENSO | Option 4a |  |
| Futurewei | 4a | 8-bit table should be the baseline. However, we are open to 5-bit, if in stage-3, it can be shown to save one octet comparing to 8-bit. (Saving one octet increases the chance that the BSR can be sent as a padding BSR.) |
| Spreadtrum | 4a |  |
| FGI | Option 4a | 8-bit table(s) are enough. |
| CATT | Option 4a |  |

Summary

Among the 30 companies that have replied,

* 26 companies prefer Option 6a (all new BSR tables have the same number of code points). Most companies have mentioned simplicity as one of the reasons behind their preference. Some companies also have mentioned that length different from the legacy 8 bits can also be considered for the buffer size field.
* 4 companies prefer Option 6b (different new BSR tables can have different number of code points), because they think that can be either up to network configuration or be left open for now as it may depend on other design aspects (e.g. whether Option 1a or 1b is adopted).

The rapporteur hence would like to suggest the following proposal.

**Proposal 4. (26/30) If more than one new BSR table are introduced, all of them have the same number of code points. FFS the number of code points.**

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.

|  |  |  |
| --- | --- | --- |
| **Company** | **Your preference**  (Option 5a/b/c/d) | **Comments** |
| Qualcomm | Option 5a and 5b | In our understanding, exponential distribution is better suited for a large range (e.g. across several orders of magnitude), whereas linear distribution is better suited for a small range. Hence different new BSR tables may benefit from using different distributions.  Our understanding on truncated Gaussian distribution is that it is just a model used in RAN1’s evaluation study. It needs to be vetted whether it matches well with actual XR traffic generated by different codec algorithms and how forward compatible it can be. |
| Nokia | Option 5b or 5c | Depends on the option adopted for question 2.  5b with linear distribution is simpler for 2b with formula-based calculation.  5c could match with the traffic distribution better for 2d with scaling on top of the reference table without the need to define the Gaussian formula. |
| ZTE | 5a | Some exponential distribution optimising for higher data sizes would be suitable. |
| LGE | Depends on Q2;  (5a/5b for Option 2a,  5b for Option 2b) | If the new BSR table is generated by UE using formula (i.e., Option 2b in Q2), it should follow the linear distribution, in order to minimize the additional UE complexity.  If the new BSR table is specified (i.e., Option 2a in Q2), we are okay with option 5a and 5b. However, if the new table can be used other than XR services (related to Q8), the option 5c is not needed, since the benefits of option 5c would be limited to video traffics. |
| NEC | Option 5b | Option5b is simple and enough. NW can configure the (min, max ) properly to guarantee the quantization error is low |
| CMCC | Option 5c | For Option 5c, there are serval studies and simulations show that the size of video frame follows truncated Gaussian distribution. In AR/MR, video frames consist most of uplink data.  And for other information in uplink (e.g., pose, controller, audio) are not really sensitive to quantization error, therefore the need for BSR enhancement is mainly driven by video frames.  So Truncated Gaussian distribution should be introduced.  Option 5b is also acceptable for us, it can be utilized for pose and control information, they are relatively fixed in size. |
| Ericsson | 5b/5d | Linear distribution seems to be the simplest choice (and is found in simulations to be working well) for generation and configuration. However, if there is shown that there is a benefit to have other distributions (and the complexity to generate those is not a concern) then such distribution may also be considered. |
| Quectel | 5b | Since the new table only prefer a limited scope, 5b is enough. |
| Sony | 5b |  |
| Samsung | Option 5b | It is sufficient to have exponentially distributed legacy BS table, which already covers entire range of buffer size. For new BS table(s), we should focus on a certain range of buffer size tailored for the application of interest. With this in mind, linear distribution is an efficient way to manipulate quantization level, and easy to implement compared to other options. |
| Apple | Option 5b | We would like to keep it simple. |
| Vivo | Option 5a | For XR, there are much more P-frames than I-frames, and the total traffic volume for P-frame could be very much larger than that for the I-frames. With exponential distribution, the smaller burst corresponding to P-frames gets better granularity, which can reduce the quantization error in statistics.  Again, this is also related to the questions we discussed above in Q1 and Q2. |
| Intel | Option 5a (if option 2a is agreed for Q2) or option 5b (if option 2b is agreed for Q2) | Different options can be considered depending on the outcome of previous questions. For example:  Option 5a (preferred): if same range of BS values as legacy is used with additional bits i.e. extended BS field size, for example using 10 bits rather than 8 bits.  Option 5b: can be used if BS values of new table is over shorter range than legacy when using semi-statically configured BS table(s) in Q2.  Option 5c: We are not sure of the benefit of using a gaussian distribution since range of BS values in the new table(s) will be deterministic (predefined or semi-statically configured). |
| Lenovo | 5a/5b | We prefer 5a. If there’s shown there is gain when using 5b for the second BS in 1c/1b, then it may also be considered. |
| KDDI | 5b | If we go with a narrower range, then simple option 5b is enough. |
| Xiaomi | 5b/5c | Option5b is simple while 5c more match’s XR’s traffic as the size of video frame follows truncated Gaussian distribution. |
| Fujitsu | 5a or 5b | We think the quantization error in 5a or 5b may be acceptable depending on the range of the new BS table. |
| Huawei | Option 5a or 5b | If option 1a adapted, both option 5a and 5b ok, that mainly depends on the range of new BS table. For a wider range new BS table, option 5a is preferred, better to follow today’s rule. But if the new BS table has a narrower range, option 5b is preferred.  If option 1c adapted, option 5b is preferred, the indicated range by the 1st index is already narrow, the 2nd index follows a linear distribution seems sufficient for a narrow range and easier. |
| III | Option 5b |  |
| TCL | Option 5a or 5b | If only one BSR, Option 5a is preferred.  If more than one BSR, including two BSR MAC CE and two BSR size in one MAC CE,  for the the first BSR, Option 5a is preferred.  for the second BSR, Option 5b is preferred.. |
| InterDigital | 5a/b/c | Whichever distribution allows tailoring for the XR frame rates/encoding rates. |
| OPPO | 5b | 5b is simple especially if we use a narrow range for the new BS table. |
| ITRI | 5a/5b | We agree with Qualcomm. |
| Google | 5b | We prefer a simple solution. |
| DENSO | Option 5b or 5a | Option 5b is sufficient if new BSR table(s) have a narrower range. |
| Futurewei | 5b for new tables (fixed or configurable) | One reason for using exponential in the legacy tables is to cover the higher range with fewer number of codepoints, e.g., for MBB use cases (such as FTP file or video uploading). The time-insensitiveness in these use cases allows the large quantization errors in the higher range be suppressed when additional padding BSRs can be sent to update the remaining buffer size, with a smaller quantization error.  However, unlike in streaming video, video traffics in XR are quite time-bounded (i.e., obsolete PDU Sets are discarded and no longer counted for). With up to only a few frames buffered at a given time, we are probably looking at 1 (or even sub-1) Mbit being the upper bound. So, there are no clear advantages but a few drawbacks (such as complexity and less uniform distribution of quantization errors) for using exponential for XR. |
| Spreadtrum | 5a or 5b |  |
| MediaTek | 5b |  |
| FGI | Option 5d | We don’t have preference between option 5a and 5b, and even option 5c. The decision can be left for network. It is assumed that the network has the capability to configure the BSR table(s) suitable for a specific XR application. |
| CATT | Option 5b | With the narrow range of Option 3b, linear distribution is simple and efficient. |

Summary

Among the 30 companies that have replied,

* 13 companies think Option 5a (exponential distribution) can be considered;
* 25 companies think Option 5b (linear distribution) can be considered;
* 4 companies think Option 5c (truncated Gaussian) can be considered;
* 2 companies think other distributions can be considered but did not provide any specific distributions.
* 3 companies also have mentioned that the choice may depend on Q2 or whether new BSR table(s) may be used by any UEs.

The rapporteur hence suggest we consider the following proposal.

**Proposal 5. (25/30) At least linear distribution is used for generating code points in new BSR table(s). FFS (13/25) whether exponential distribution can be considered too.**

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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| --- | --- | --- |
| **Company** | **Your preference**  (Option 6a/b/c) | **Comments** |
| Qualcomm | Option 6a | Different LCGs can have different data rates and different burst sizes. It hence makes sense to configure BSR table on a per LCG basis. |
| Nokia | Option 6a | Per LCG makes sense as not all the LCGs are for XR and different LCHs/LCGs might have different data rate. |
| ZTE | Option 6c | We prefer that any new BSR mechanism would be per LCG (same as legacy). Perhaps this could be agreed as an independent agreement regardless of other enhancements.  But considering that the buffer size cannot be predicted accurately, which BSR table(s) is used should be selected based on the Buffer size to be reported.  And the table used is identified by the LC-ID. |
| LGE | Option 6a with comment | Regarding the granularity of BSR table, it should be configured per LCG since each LCG has different range of data volume.  However, we think network can also configure to use “both legacy and new BSR tables” for an LCG. Then, depending on the size of the buffered data, UE can decide the appropriate BSR table. |
| NEC | See comment | This question is a bit confusing.  Two possible aspects needs discussion:   1. whether new BS table is configured per LCG or per UE(same for all LCG ) 2. whether UE has to switch to use new BS table for all LCG once configured   **For aspect 1: 6b.** we are not sure if there will be two LCG requires new and different BS tables (i.e., support two XR service at the same time). so per UE may be enough, but per LCG (6a) is acceptable  **For aspect 2: 6c, UE choose**  Option6a cannot work, since the buffer size may fall out of the new BS table’ coverage, legacy BS table has to be used.  Option6b cannot work, since some LCG will never need new BSR table  Option 6c: UE use new BS table if the buffer size fall in the size range (min,max) of new BS table, otherwise ,use legacy BS table. |
| CMCC | Option 6a | When different QoS flows are mapped into different LCGs, BSR table configured per LCG can provide the least quantization errors compared to Option 6b. |
| Ericsson | 6a/6c | NW configures which table(s) that are applicable for each LCG. When reporting the BS, the UE should select the table and index which results in lowest inaccuracy (i.e. lowest difference between the max and min value of the index). If the configured tables do not contain an index covering the current buffer size, then UE should use legacy tables and BSR.  This also means that the same table cannot be used for all LCGs as they may have different buffer sizes and thus fit different table ranges. An example of what happen if you don’t use the suitable table for the buffer range is shown below, where an LCG is configured to only use a new configured table. It is clearly worse than using the adaptive approach, i.e. selecting the legacy table when outside of the new table range.  image |
| Quectel | 6a | The gNB shall configure it based on the XR session feature. |
| Sony | 6a |  |
| Samsung | 6c | NW configures which LCG(s) can (is permitted to) use new BS table(s). The selection of suitable BS table for the configured LCG(s) when reporting buffer size should be determined per LCG based on actual buffer size. |
| Apple | Option 6a and Option 6c | In general we agree BSR table should be LCG-specific to accommodate different traffics.  However, even for XR traffics, when the amount of buffered data is low enough, legacy BS tables could be sufficient. So we think table selection may also depend on the volume of buffered data. |
| vivo | Option 6a | The motivation to introduce the new BSR table is to reduce the quantization error for large data burst of XR traffic. For other traffic/signalling, there is no quantization error issue identified with the legacy BSR table. In such sense, it is preferred that the new BSR table can be configured for the LCG which requires better granularity. |
| Intel | Option 6b (if option 2a is agreed for Q2) or option 6a (if option 2b is agreed for Q2) | Our preference is option 6b (all LCGs in a BSR MAC CE use the same BSR table) considering that our preference in Q2 is to use a new table that extends current BS field size by few bits only.  As also explained in Q3 above, per-LCG table selection will likely increase the decoding complexity of the MAC PDU carrying the BSR and a new mapping table for per-LCG association to a BS table may even be needed. We believe uniform use of fixed new BS table (over legacy range and additional bits for BS field) across all LCGs in a BSR may be more straightforward with comparable (or potentially less) signalling overhead in comparison to per-LCG configuration.  We are okay with Option 6a if RAN2 decides (in Q2) to use RRC configured table(s) that could be of variable size instead of fixed new table(s). |
| Lenovo | 6a | A configuration per LCG is sensible since not all the LCGs are used for XR traffic/services and different LCHs/LCGs might have different data rates. It is OK for us the further discuss whether network can also configure to two BS tables for an LCG and UE decides the appropriate BSR table. |
| MediaTek | Option 6a |  |
| KDDI | 6a/6c | We share the view with Ericsson, it’s better to specify a mechanism which enables UEs to select the appropriate table among the multiple configured BSR tables. |
| Xiaomi | Option 6a | Considering currently UE indicates the buffer size per LCG in BSR format, it is better to configure UE whether to used legacy BSR tables or the new BSR tables Per LCG. |
| Fujitsu | Option 6a |  |
| Huawei | Option 6a/6c | We agree the BSR table to be used can be indicated by the network per LCG. Then which LCGs use a new BSR format and which should use legacy MAC CEs is another issue which can be discussed in future as it depends on other decision which we still need to make (number of code points, whether and how many new tables to have etc). |
| III | Option 6a |  |
| TCL | 6b |  |
| InterDigital | 6a | The association between the BSR table and LCG can be configured by the NW. |
| OPPO | 6a | We need to further decide if an LCG can use both the legacy BS table and the new BS table. |
| ITRI | 6a | Since DRBs have similar XR traffic requirements are grouped into one LCG, it is beneficial for different LCGs to use different BSR tables. |
| Google | 6a or 6c | It depends on Q2. If new tables are pre-defined, UE can choose which tables to use for a LCG. If the new tables are not pre-defined, network needs configure UE with BS tables for a LCG. |
| DENSO | Option 6a |  |
| Futurewei | 6a |  |
| Spreadtrum | Comment | We think we need to discuss the BSR is per LCG or LCH or PDU set first.  If the BSR is per LCG, then we prefer 6a. |
| FGI | Option 6c, or Option 6a with comment | To sync with Option 1a, we think UE should be allowed to select the suitable BSR table. So our opinion is: “*Network can configure which BSR table(s) (either legacy or new) an LCG MAY use*”, which is modified from option 6a. |
| CATT | 6a | We agree with LGE that network can also configure to use “both legacy and new BSR tables” for an LCG. |

Summary

Among the 30 companies that have replied,

* 25 companies prefer Option 6a, i.e. network can configure which BSR table(s) an LCG should use, because different LCGs can have different types of traffic and different data rates.
* 1 company prefers Option 6b, i.e. all LCGs in a BSR MAC CE must use the same BSR table;
* 8 companies prefer Option 6c. They selected Option 6c because they think the choice of BSR table should also depend on buffer size, i.e. if network configures an LCG to use a new BSR table and that LCG’s buffer size is within the range of the configured BSR table, then UE uses the new BSR table. Otherwise, UE uses legacy BSR table;
* 1 company also has mentioned that it may depend on the Q2.

The rapporteur thinks that companies that selected Option 6a and Option 6c both have valid points. And this split of views is probably because of the ambiguous wording of the question by the rapporteur. The rapporteur thus would like to suggest combining the two options into a single proposal as follows.

**Proposal 6. (29/30) Network can configure which BSR table(s) an LCG is eligible to use. UE determines which one of those BSR tables the LCG should use based on its buffer size. FFS details of this determination.**

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.

- Option 7e. Introduce new BSR formats to accommodate new BSR table(s).

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| **Company** | **Your preference**  (Option 7a/b/c/d) | **Comments** |
| Qualcomm | Option 7a | First, we think it is useful to keep the 2B short BSR MAC CE. For small bursts, the current short BSR table is sufficient, because its distribution of code points has fine resolution at the low end.  To cover the case where a single LCG has a large burst, we think RAN2 should agree that UE is allowed to use long BSR in that case. Then new BSR table(s) designed for long BSR can be used for to provide better resolution for large bursts, if needed. |
| Nokia | Option 7a | Long BSR provides finer granularity since it provides a lot more code points compared to short BSR, leading to minimizing the quantization error. |
| ZTE | 7a |  |
| LGE | Option 7a with comment | We think that the new BSR table for long BSR should be defined first.  Not sure about the new table for short BSR. We discuss later. |
| NEC | Option 7d or 7a with Comment | We can increase BS field bits for short BSR, as same as for long BSR. Then same set of BS table(s) can be used by both short BSR, long BSR, short/long truncated BSR.  7a is also fine with us, but it would mean short/short truncated BSR will not use new BS table and keep the quantization error as today |
| CMCC | Option 7d | We think Short and Long BSR should have the same performance on quantization errors, therefore there is no need to just configure new BSR table for short or long BSR.  Besides, Long BSR for reporting single LCG is less preferred since it has to transfer an 8-bit LCG map instead of 3-bit LCG ID. |
| Ericsson | 7e | There is no need to limit this. New tables can be used for any BSR format. New BSR formats can be introduced with different lengths. |
| Quectel | 7e |  |
| Sony | 7a |  |
| Samsung | Comment | We think what we should discuss here are two separate issues:   1. Whether we need to define new BS tables for a) 5-bit BS field, b) 8-bit BS field, c) longer than 8-bit BS field. 2. Whether we should use longer than 5-bit BS field when only one LCG having data.   For 1), we don’t think it is necessary to define new BS table for 5-bit BS field.  For 2), we think it is worth considering using longer than 5-bit BS field when only one LCG having data. |
| Apple | 7a and 7e | While we think long BSR should be considered, we must point out that many potential BSR enhancements would need RAN2 to define new BSR formats anyway. Thus, we think new BSR formats should be taken into account together.  (In our understanding, if new BSR table is used in existing long BSR, then it is still considered as a new BSR format due to e.g. new LCID.) |
| vivo | Option 7d. | Short BSR could be more frequently used than the long BSR since typically only single LCG has data when the UE only has XR traffic. Considering this, it is preferred that both short BSR and long BSR should use the same new BSR table with more codepoints. This would result in the size increase of short BSR. But it is a minor cost considering the large data volume of XR traffic. |
| Intel | Option 7a | Since the main motivation is to reduce quantization error, we believe long BSR is sufficient as short BSR carries minimal information for a single LCG, with maximum BS value <1Mbytes in the legacy BS table, which may not be the usual case for XR traffic. |
| Lenovo | 7d/7e/7a | Supporting second BS field in 1C needs to define new format. The quantization error can happen in case of a single LCG having XR large bursts, therefore it’d better to also support it for short BSR. |
| MediaTek | Option 7a |  |
| KDDI | Option 7a |  |
| Xiaomi | 7d/7a | Both Short and Long BSR can use the new BSR table for reporting.  Besides, we do not want Long BSR for reporting single LCG. |
| Fujitsu | Option 7a |  |
| Huawei | Option 7e | We should firstly discuss the BS table design, if it needs 8 bits index, we can call it long BSR format, if it is finally 4 bits for example, we can design a new BSR MAC CE for that. |
| III | Option 7a |  |
| TCL | 7a |  |
| InterDigital | 7e | We understand why long BSR can be prioritized since it offers higher granularity but we also think that enhancements to short BSR can be useful when the UE has data in only one LCG. |
| OPPO | Option 7e/  Option 7a with comments | As RAN2 agrees to introduce data volume information associated with delay information (e.g. remaining time) in a MAC CE, we wonder if the delay info would be reported in another MAC CE, otherwise new BSR MAC CE format seems needed (i.e. option 7e).  While, if the question is just to check whether the new BS table is to be designed with a 5-bit and/or 8-bit BS field, we understand the 8-bit BS field is good as starting point (i.e. option 7a). |
| ITRI | 7d | Both long BSR and short BSR have the explicit need for quantization error, so we agree with CMCC and prefer option 7d. |
| Google | 7e | If we define a new BSR format for the new tables, there is no need to reuse short/long BSR format. Whether short/long BSR can be reused can be discussed later after new tables are defined. |
| DENSO | Option 7d/7e | We think the quantization errors need to be reduced even when only one LCG has data. New BSR table(s) can be used regardless of the number LCGs having data. |
| Futurewei | 7a as baseline | We believe that the question is more related to the length of the field, than which MAC CE to use.  As we said in our response to Q4, we are open to 5-bit. But let’s work out the details of 8-bit first. |
| Spreadtrum | 7a |  |
| FGI | 7e | Similar view with Apple, legacy BSR format cannot accommodate XR’s need. |
| CATT | Option 7a or 7e |  |

Summary

Among the 30 companies that have replied,

* 19 companies prefer Option 7a, i.e. new BSR table(s) are only relevant to long BSR;
* 7 companies prefer Option 7d, i.e. the same new BSR tables(s) can be used by both long and short BSRs;
* 11 companies think that we should introduce a new BSR MAC CE format to use new BSR table(s).

Regarding the comments by the last group of companies, the rapporteur thinks that there are two separate issues being discussed here: (1) whether new BSR table may be used only when long BSR is to be reported (i.e. a BSR is triggered when more than one LCG has buffered data). (2) whether a new BSR MAC CE has to used if new BSR table(s) is to be used. The first one is the original intention of the question. Based on the comments by the first group of companies, the rapporteur’s impression is that it is also their understanding. Hence the rapporteur would suggest that we focus on the first issue for now and discuss the second issue when the design of new BSR table(s) becomes more clearer or complete.

**Proposal 7a. (19/30) As a baseline, new BSR table(s) can be used only when a long BSR is to be reported (i.e. UE triggers a BSR with more than one LCG has buffered data). FFS (7/24) whether the same new BSR table(s) can also be used when a short BSR is to be reported.**

**Proposal 7b. (11/30) Whether a new BSR MAC CE format is needed can be discussed after new BSR tables are designed.**

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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| --- | --- | --- |
| **Company** | **Your preference**  (Option 8a/b) | **Comments** |
| Qualcomm | Option 8b | We do not see any strong reasons why a new BSR table cannot be used by UEs not supporting XR services. Moreover, use of new BSR tables is fully under network control, i.e. if network does not want a UE to use a new BSR table, it can simply not enable or configure that BSR table for the UE. |
| Nokia | Option 8a for now | We can start with 8a when designing the parameters/values for the new table(s).  It can be discussed later if need to apply to other UEs. |
| ZTE | 8b | As normal, we assume the UE will indicate support for these and if supported, the network can configure the UE to use these whenever it is appropriate. Whether an XR service is running at this point or not may be irrelevant (what matters is the configuration that the UE receives). |
| LGE | Option 8b | It is up to the network configuration. |
| NEC | Discuss later | We can discuss this later stage when we discuss capability. This would be a question not only for BSR enhancement but also for other enhancements |
| CMCC | Option 8b | For traditional service like live streaming and electronic games, new BSR table is more suitable compared to legacy BSR table, therefore new BSR table should be available to all UEs |
| Ericsson | 8b | The feature may mostly be useful for XR services, but it is not necessarily limited to XR and can be used for other services if such benefit is seen. It is depending on UE capabilities and network decision to configure new tables. |
| Quectel | 8b |  |
| Sony | 8b | Based on UE capability |
| Samsung | Option 8b | Our preference is based on the understanding that ‘any UEs’ means any UEs supporting new BS table capability. The fundamental question should be whether we allow the capability of supporting new BS table to be a standalone capability apart from XR service. |
| Apple | 8b | This is anyway UE capability discussion. |
| Vivo | Option 8b | Given fixed BSR table for common use is defined, it is not necessary to restrict the table for XR traffic only. One capability indicator can be defined to indicate if the UE supports the new BSR table or not, and it depends on the NW to configure whether/how to use the new BSR table. |
| Intel | Option 8b | Even though new BS table(s) may only be used by XR services, we don’t think such service-based restriction is needed from RAN2 point of view. |
| Lenovo | 8b | It is not necessary to restrict this to only UEs supporting XR services. The new table can be enabled to use by NW according to UE capability. |
| MediaTek | Option 8b |  |
| KDDI | Option 8b |  |
| Xiaomi | Option 8b | It is based on UE capability and gNB’s configuration. |
| Fujitsu | Option 8b | This depends on UE capability. |
| Huawei | Option 8b | Anyway the UE shall have a new capability, and the network can have some control parameters to indicate the UE whether the new BS table can be used or not, no matter the BS table is pre-defined or RRC configured. As long as UE reports such capability, and network indicated the UE can use, then the UE should be able to use the new BS table, even if the UE is not a XR UE. |
| III | Option 8b |  |
| TCL | 8b |  |
| InterDigital | 8b | The new BSR table will be adapted to XR encoding/frame rates and most useful to XR UEs but we see no point in restricting it to XR UEs. |
| OPPO | Option 8b | We interpret 8b as any UE that supports the new BS table. |
| ITRI | 8b |  |
| Google | 8b | Quantization error is not an issue specific to XR so new tables should be available to any UE. |
| DENSO | Option 8b |  |
| Futurewei | 8b | The use of the new BSR table should be under the control of the NW, provided that the UE supports it. |
| Spreadtrum | 8b | This is based on the UE capability. We can discuss this later. |
| FGI | Option 8b | It depends on UE capability. For the purpose of BSR, network only need to know whether the UE supports new/network-configured BSR table(s). |
| CATT | Option 8b |  |

Summary

Among the 30 companies that have replied,

* 29 companies prefer Option 8b, i.e. new BSR table(s) can used by any UEs;
* 11 companies mention in their comments that the answer also depends on UE capability;
* 1 company thinks that we should start with Option 8a when designing the parameters/values for the new table(s) and discuss later if the new table(s) may be used by other UEs.

Based on all these comments, the rapporteur suggests that we design new BSR table(s) based on XR specific requirements, because after all that is our initial objective, and a more focused objective can help progress more efficiently. After the design is complete, then based on the preference of majority of the companies, we make the new table(s) available to other UEs that support such capability.

**Proposal 8. (29/30) New BSR table(s) can be used by any UEs that support such a capability. However, design of the new BSR table(s) should be based on XR-specific use cases and requirements.**

# **Conclusions**

The rapporteur would like to suggest the follow set of ***proposals for agreement***:

**Proposal 1. (25/30) As a working assumption, at most one BSR index is reported by an LCG. This assumption can be revisited if new BSR table design cannot achieve a target level of quantization error. FFS what this target level should be.**

**Proposal 2a. (21/30) Deprioritize Option 2c (static + dynamic BSR tables) and Option 2d (reference table + scaling factor).**

**Proposal 3. (22/30) Design/configuration for new BSR table(s) should include support for narrower ranges than the legacy. Details can be discussed after an agreement on how UE obtains new BSR table(s) (e.g. pre-definition vs RRC configuration) is made.**

**Proposal 4. (26/30) If more than one new BSR table are introduced, all of them have the same number of code points. FFS the number of code points.**

**Proposal 5. (25/30) At least linear distribution is used for generating code points in new BSR table(s). FFS (13/25) whether exponential distribution can be considered too.**

**Proposal 6. (29/30) Network can configure which BSR table(s) an LCG is eligible to use. UE determines which one of those BSR tables the LCG should use based on its buffer size. FFS details of this determination.**

**Proposal 8. (29/30) New BSR table(s) can be used by any UEs that support such a capability. However, design of the new BSR table(s) should be based on XR-specific use cases and requirements.**

The rapporteur would like to suggest the following set of ***proposals for more discussion***:

**Proposal 2b. Have more discussions on Option 2a (static BSR tables) vs Option 2b (RRC configured BSR tables).**

**Proposal 7a. (19/30) As a baseline, new BSR table(s) can be used only when a long BSR is to be reported (i.e. UE triggers a BSR with more than one LCG has buffered data). FFS (7/24) whether the same new BSR table(s) can also be used when a short BSR is to be reported.**

**Proposal 7b. (11/30) Whether a new BSR MAC CE format is needed can be discussed after new BSR tables are designed.**

# 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.