**3GPP TSG RAN WG1 #122 R1-2506230**

**Bengaluru, India, Aug 25th – 29th, 2025**

**Agenda Item: 9.13**

**Source: Moderator (AT&T)**

**Title: Summary of UE features for LTE based 5G broadcast Phase 2**

**Document for:** **Discussion/Decision**

# Introduction

This document presents the summary of email discussion [122-R19-UE\_features] during RAN1 #122. According to the Chair’s Notes:

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| [122-R19-UE\_features] Email discussion on Rel-19 UE features – Ralf (AT&T), Naoya (DOCOMO), Ralf (AT&T)   * To be used for sharing updates on online/offline schedule, details on what is to be discussed in online/offline sessions, tdoc number of the moderator summary for online session, etc |

The following was discussed during RAN1 #122 within the scope of [122-R19-UE\_features]. All proposals are based on the latest RAN1 UE features list for Rel. 19 in [1].

# Summary of Contributions Submitted to RAN1 #122

The following is the moderator’s summary of contributions submitted to RAN1 #122 in this agenda item.

## Time-interleaving

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| 3. LTE\_terr\_bcast\_Ph2 | 3-1 | Time-interleaving | 1. Support of PMCH transmission pattern, excluding MCCH and MSI, with time interleaving  2. Support of TBS determination for the scaled TB  3. Support of determining the starting point for reading from the circular buffer (k0) for each subframe | Support of fembmsDedicatedCell | Yes | N/A | UE is not able to support time-interleaving for LTE-based 5G broadcast | Per band | No | N/A | Note: One TB is mapped to N non-consecutive subframes. Two transmissions of the same TB are separated by (M-1) subframes.  Note: For each band, the UE can also indicate for which subcarrier spacing FG 3-1 is supported | Optional with capability signalling |

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| Company | Summary |
| Huawei/HiSilicon [2] | For UE capable of receiving time-interleaved broadcast, the soft buffer is shared with unicast reception. A scaling soft buffer factor for unicast reception when UE receives both unicast and broadcast should be supported to avoid the situation that UE constantly drops the unicast reception. If network is aware of UE expecting or prioritizing the broadcast transmission, it would rather be preferred for network to make UE receive a smaller soft buffer rate-matched unicast than UE drop the unicast at all. Therefore, UE can optionally report whether supporting scaling down soft buffer for unicast to have a chance for better unicast performance experience.  ***Proposal 1: UE reports the capability of scaling down soft buffer for unicast when UE receives both unicast and broadcast.***  ***Proposal 2: The FG3-1 Time-interleaving is updated as follows in red:***   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 3. LTE\_terr\_bcast\_Ph2 | 3-1 | Time-interleaving | 1. Support of PMCH transmission pattern, excluding MCCH and MSI, with time interleaving  2. Support of TBS determination for the scaled TB  3. Support of determining the starting point for reading from the circular buffer (k0) for each subframe  4. Support of the extended MSI periodicities.  5. Support of determining soft buffer size for one time-interleaved TB based on indicated referenced UE category and the scaling factor. | Support of fembmsDedicatedCell | Yes | N/A | UE is not able to support time-interleaving for LTE-based 5G broadcast | Per band | No | N/A | Note: One TB is mapped to N non-consecutive subframes. Two transmissions of the same TB are separated by (M-1) subframes.  Note: For each band, the UE can also indicate for which subcarrier spacing FG 3-1 is supported | Optional with capability signalling | | 3. LTE\_terr\_bcast\_Ph2 | 3-1a | Time-interleaving | 1. Support of cyclic shift for the bit sequence in Section 6.3.1 of TS 36.211 for the i^th subframe of the time-interleaved TB by X\_i bits | FG3-1 | Yes | N/A | UE is not able to support time-interleaving with the cyclic shift | Per band | No | N/A | Candidate values for is   * + *Alt 1: , with*      - *is the number of bits in the codeblock within a subframe (as defined in TS 36.212)*   + *Alt 2: , with*      - *denotes the number of OFDM symbols within a subframe*     - *denotes the number of CBs in the time-interleaved (scaled) TB*     - *is the number of bits in the codeblock within a subframe (as defined in TS 36.212)* | Optional with capability signalling | | 3. LTE\_terr\_bcast\_Ph2 | 3-1b | Time-interleaving | 1. Support of the soft buffer scaling factor for unicast reception. | FG3-1 | Yes | N/A | UE is not able to support simultaneously receiving unicast and time-interleaving MBMS. | Per band | No | N/A |  | Optional with capability signalling | |
| Samsung [3] | |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 3. LTE\_terr\_bcast\_Ph2 | 3-1 | Time-interleaving | Cyclic shift of PMCH | Support of time-frequency interleaving | Yes | UE is not able to support cyclic shift of PMCH | Per band | No |  | Optional with capability signalling | |
| Xiaomi [4] | |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 3. LTE\_terr\_bcast\_Ph2 | 3-3 | Cyclic shift for time-interleaving | Support cyclic shift for time-interleaving | 3-1 | Yes | N/A | UE is not able to support cyclic shift for time-interleaving | Per band | No | N/A | Note: For each band, the UE can also indicate for which subcarrier spacing FG 3-3 is supported | Optional with capability signalling | |
| Qualcomm Incorporated [5] | ***Proposal 1*: For the UE feature on time interleaving agreed in RAN1#121**   * **Based on the UE DL category, the UE indicates the maximum TBS supported in a TTI for MCH with time interleaving, from a set of candidate maximum TBSs.** * **The set of candidate maximum TBSs is based on Table 4.1A-1 in TS 36.306 and consists of the following values: {299856, 391656, 502624, 149776, 195816, 201936, 251640, 75376, 97896, 100752, 125808}**   **These proposals (as well as other proposed changes) are marked on the table using red font with yellow highlighting:**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 3. LTE\_terr\_bcast\_Ph2 | 3-1 | Time-interleaving | 1. Support of PMCH transmission pattern, excluding MCCH and MSI, with time interleaving for a set of PMCH numerologies  2. Support of TBS determination for the scaled TB up to a maximum TBS  3. Support of determining the starting point for reading from the circular buffer (k0) for each subframe | Support of fembmsDedicatedCell | Yes | N/A | UE is not able to support time-interleaving for LTE-based 5G broadcast | Per band | No | N/A | Note: One TB is mapped to N non-consecutive subframes. Two transmissions of the same TB are separated by (M-1) subframes.  For component 1, the UE indicates a bitmap [b15, b7dot5, b2dot5, b1dot25] where each bit indicates whether the UE supports time-interleaving for the corresponding numerology.  ~~Note: For each band, the UE can also indicate for which subcarrier spacing FG 3-1 is supported~~  For component 2, the UE indicates the maximum TBS supported in a TTI, from the candidate values: {299856, 391656, 502624, 149776, 195816, 201936, 251640, 75376, 97896, 100752, 125808} | Optional with capability signalling | |
| ZTE Corporation/Sanechips [6] | Firstly, the purpose of cyclic shift is to address the issue where the design of time-domain interleaving results in a localization in frequency (across the N subframes of a time-interleaved TB) for each codeblock of the TB. In the absence of time-domain interleaving, the cyclic shift mechanism serves no purpose. Therefore, cyclic shift should be regarded as a subordinate feature that operates within the framework of the time-domain interleaving functionality for UE.  Secondly, cyclic shift is a performance optimization scheme based on time-domain interleaving. A UE can independently support time-domain interleaving without supporting cyclic shift. As such, the related UE feature should be introduced as an independent UE feature under the time-domain interleaving feature.  Based on above analysis, we make the following proposal:  ***Proposal 1:*** *Introduce the following Rel. 19 UE feature:*   |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 3. LTE\_terr\_bcast\_Ph2 | 3-1a | 1.Support of cyclic shift of PMCH. | Support of Time-interleaving | Yes | N/A | UE is not able to support cyclic shift of PMCH. | Per band | No | N/A |  | Optional with capability signalling | |

## Frequency-interleaving

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| 3. LTE\_terr\_bcast\_Ph2 | 3-2 | Frequency-interleaving | 1. Support of frequency-interleaving for MCCH/MTCH/MSI | Support of fembmsDedicatedCell | Yes | N/A | UE is not able to support frequency-interleaving for LTE-based 5G broadcast | Per band | No | N/A | Note: For each band, the UE can also indicate for which subcarrier spacing FG 3-2 is supported | Optional with capability signalling |

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| Company | Summary |
| Huawei/HiSilicon [2] |  |
| Samsung [3] |  |
| Xiaomi [4] |  |
| Qualcomm Incorporated [5] | ***Proposal 2*: For the UE feature on frequency interleaving agreed in RAN1#121, the following correction should be made, in the light of the discussing in our RAN1 contribution [1]**   * **Frequency interleaving is not supported for MCCH.**  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 3. LTE\_terr\_bcast\_Ph2 | 3-2 | Frequency-interleaving | 1. Support of frequency-interleaving for ~~MCCH~~/MTCH/MSI for a set of PMCH numerologies | Support of fembmsDedicatedCell | Yes | N/A | UE is not able to support frequency-interleaving for LTE-based 5G broadcast | Per band | No | N/A | For component 1, the UE indicates a bitmap [b15, b7dot5, b2dot5, b1dot25] where each bit indicates whether the UE supports time-interleaving for the corresponding numerology~~.~~  ~~Note: For each band, the UE can also indicate for which subcarrier spacing FG 3-2 is supported~~ | Optional with capability signalling | |
| ZTE Corporation/Sanechips [6] |  |

# Discussion Items during RAN1 #122

After review of contributions submitted to RAN1 #122 in this agenda item, the following topics were identified by the moderator for discussion during RAN1 #122.

**General comments**

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| Company | Comments/Questions/Suggestions |
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## Time-interleaving

After review of contributions submitted to RAN1 #122 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3. LTE\_terr\_bcast\_Ph2 | 3-1 | Time-interleaving | 1. Support of PMCH transmission pattern, excluding MCCH and MSI, with time interleaving for a set of PMCH numerologies  2. Support of TBS determination for the scaled TB up to a maximum TBS  3. Support of determining the starting point for reading from the circular buffer (k0) for each subframe  4. Support of the extended MSI periodicities  5. Support of determining soft buffer size for one time-interleaved TB based on indicated referenced UE category and the scaling factor | Support of fembmsDedicatedCell | Yes | N/A | UE is not able to support time-interleaving for LTE-based 5G broadcast | Per band | No | N/A | For component 1, the UE indicates a bitmap [b15, b7dot5, b2dot5, b1dot25] where each bit indicates whether the UE supports time-interleaving for the corresponding numerology  For component 2, the UE indicates the maximum TBS supported in a TTI, from the candidate values: {299856, 391656, 502624, 149776, 195816, 201936, 251640, 75376, 97896, 100752, 125808}  Note: One TB is mapped to N non-consecutive subframes. Two transmissions of the same TB are separated by (M-1) subframes.  ~~Note: For each band, the UE can also indicate for which subcarrier spacing FG 3-1 is supported~~ | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
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**Proposal: Introduce the following Rel. 19 UE FGs (yellow highlighting, if any, shows text that’s not yet agreed)**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3. LTE\_terr\_bcast\_Ph2 | 3-1a | Cyclic shift of PMCH | 1. Support of cyclic shift for the bit sequence in Section 6.3.1 of TS 36.211 for the i^th subframe of the time-interleaved TB by X\_i bits | FG3-1 | Yes | N/A | UE is not able to support time-interleaving with the cyclic shift | Per band | No | N/A | Candidate values for is   * + Alt 1: , with     - is the number of bits in the codeblock within a subframe (as defined in TS 36.212)   + Alt 2: , with     - denotes the number of OFDM symbols within a subframe     - denotes the number of CBs in the time-interleaved (scaled) TB     - is the number of bits in the codeblock within a subframe (as defined in TS 36.212)   + Alt. 3: No component candidate values | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
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**Proposal: Introduce the following Rel. 19 UE FGs (yellow highlighting, if any, shows text that’s not yet agreed)**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3. LTE\_terr\_bcast\_Ph2 | 3-1b | Soft buffer scaling factor for unicast reception | 1. Support of the soft buffer scaling factor for unicast reception | 3-1 | Yes | N/A | UE is not able to support simultaneously receiving unicast and time-interleaving MBMS | Per band | No | N/A |  | Optional with capability signalling |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
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## Frequency-interleaving

After review of contributions submitted to RAN1 #122 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3. LTE\_terr\_bcast\_Ph2 | 3-2 | Frequency-interleaving | 1. Support of frequency-interleaving for ~~MCCH/~~MTCH/MSI for a set of PMCH numerologies | Support of fembmsDedicatedCell | Yes | N/A | UE is not able to support frequency-interleaving for LTE-based 5G broadcast | Per band | No | N/A | For component 1, the UE indicates a bitmap [b15, b7dot5, b2dot5, b1dot25] where each bit indicates whether the UE supports time-interleaving for the corresponding numerology  ~~Note: For each band, the UE can also indicate for which subcarrier spacing FG 3-2 is supported~~ | Optional with capability signalling |

# Conclusion

Agreements reached during RAN1 #122 as part of this agenda item are summarized in [ ].

# References

1. R1-2504676, Updated RAN1 UE features list for Rel-19 LTE after RAN1 #121, Moderators (AT&T, NTT DOCOMO, INC.)
2. R1-2505352, UE features for LTE based 5G broadcast Phase 2, Huawei/HiSilicon
3. R1-2505572, UE features for LTE broadcast, Samsung
4. R1-2505646, Discussion on UE features for LTE based 5G broadcast, Xiaomi
5. R1-2506205, UE features for LTE based 5G broadcast Phase 2, Qualcomm Incorporated
6. R1-2506258, Discussion on UE features for LTE based 5G broadcast, ZTE Corporation/Sanechips