**3GPP TSG RAN WG1 #100bis R1-** **200xxxx**

**e-Meeting, April 20th – 30th, 2020**

**Agenda item:** 6.2.4

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Email discussion [100b-e-LTE-TerrBcast-01]

**Document for:** Discussion and Decision

# Summary of issues

This document contains the discussion for the following:

[100b-e-LTE-TerrBcast-01] Email discussion/approval on reference signal aspects for 0.37 kHz numerology (antenna port definition; presence of RS; correction to MBSFN-RS generation) by 4/23; if necessary, followed by endorsing the corresponding TPs by 4/28 - Alberto (Qualcomm)

# Issue #1: Antenna port definition

In x1635, it is proposed to modify the text in TS 36.211 on antenna port definition as follows:

**<TP-1, TS 36.211, 6.2.1>**

- MBSFN reference signals are transmitted on antenna port. The channel over which a symbol on antenna portis conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols correspond to subframes of the same MBSFN area. For MBSFN reference signal pattern type 1 of 0.37 kHz subcarrier spacing, the channel over which a symbol on antenna port  is conveyed can be inferred from the channel over which another three symbols on the same port is conveyed only if the four symbols correspond to slots of the same MBSFN area. For MBSFN reference signal pattern type 2 of 0.37 kHz subcarrier spacing, the channel over which a symbol on antenna port  is conveyed can be inferred from the channel over which another symbol on the same port is conveyed only if the two symbols correspond to slots of the same MBSFN area.

This introduces the following changes:

* Use “slots” instead of subframes.
* Limit the coherency for four symbols / two symbols depending on the RS pattern.

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| **Company name** | **Comment** |
| Qualcomm | In general, the current specification should be enough, since the spec says “two symbols correspond to subframes of the same MBSFN area”, and, in the end, the 3 subframes of a slot belong to the same MBSFN area. If this needs to be made more clear, we suggest the following revision:  For subcarrier spacing other than 0.37kHz, the channel over which a symbol on antenna portis conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols correspond to subframes of the same MBSFN area. For subcarrier spacing of 0.37kHz, the channel over which a symbol on antenna portis conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols correspond to slots of the same MBSFN area  What we do not support is the limitation of another three symbols. In theory, if the channel is completely static, the UE should be able to run an infinite filter to keep improving the channel estimation. |
| ZTE | The intention of this TP is to address Issue#1 and Issue#2 together. Seems like companies have different understandings on whether the above TP could resolve Issue#2. In this case, we could focus on the Issue#1 here. The revision from Qualcomm for Issue#1 looks good to us. |
| Huawei/HiSilicon | We don’t think the TP here is needed. The antenna port definition is kept in the same description formatting across 211 or different releases. |
| ZTE | To further resolve Huawei/HiSilicon’s concern, we provide the following updated TP. The updated text is aligned with the one already agreed for TS36.214.  <---------------------------Other parts are omitted ------------------------------->  An antenna port is defined such that the channel over which a symbol on the antenna port is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed. For MBSFN reference signals, positioning reference signals, UE-specific reference signals associated with PDSCH, demodulation reference signals associated with SPDCCH, and demodulation reference signals associated with EPDCCH, there are limits given below within which the channel can be inferred from one symbol to another symbol on the same antenna port. There is one resource grid per antenna port. The set of antenna ports supported depends on the reference signal configuration in the cell:  - Cell-specific reference signals support a configuration of one, two, or four antenna ports and are transmitted on antenna ports ,, and , respectively.  - MBSFN reference signals are transmitted on antenna port. The channel over which a symbol on antenna portis conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols correspond to subframes (slots in case of 0.37 kHz subcarrier spacing) of the same MBSFN area.  - UE-specific reference signals associated with PDSCH intended for non-BL/CE UE are transmitted on antenna port(s) , , , or one or several of . The channel over which a symbol on one of these antenna ports is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols are within the same subframe and in the same PRG when PRB bundling is used or in the same PRB pair when PRB bundling is not used.  <---------------------------Other parts are omitted -------------------------------> |
| Qualcomm | Adding reference to TP so that it can be referred to in email discussion:  **<TP-1 Revision 1, TS 36.211, 6.2.1>**  - MBSFN reference signals are transmitted on antenna port. The channel over which a symbol on antenna portis conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols correspond to subframes (slots in case of 0.37kHz subcarrier spacing) of the same MBSFN area.  **<TP-1 Revision 1>** |

# Issue #2: Presence of RS

In x2626 and x2179, it is recommended to discuss the assumptions the UE can make regarding the presence of reference symbols outside a given PMCH slot. More precisely, the following observations are made:

* In x2626***: A UE implementing frequency-only channel interpolation for the PMCH numerology with Δf = 0.37 kHz and RS pattern with Dt = 4/2 only achieves a theoretical equalisation interval of 225/450µs.***
* In x2179: The following TP is proposed, along with some additional observations on the proposals:

**<TP-2, 36.211 6.10.2>**

6.10.2 MBSFN reference signals

MBSFN reference signals shall be transmitted in the MBSFN region of MBSFN subframes only when the PMCH is transmitted. MBSFN reference signals are transmitted on antenna port 4.

For a PMCH transmitted with 0.37 kHz subcarrier spacing in slot ,

- for MBSFN reference signal pattern type 1, the UE may assume that MBSFN reference signals associated with the same are present in the three preceding slots to slot .

- for MBSFN reference signal pattern type 2, the UE may assume that MBSFN reference signals associated with the same are present in the preceding slot to slot .

MBSFN reference signals are defined for extended cyclic prefix only.

**</TP-2>**

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| **Company name** | **Comment** |
| Qualcomm | Support this change. |
| Huawei, HiSilicon | Don’t support this change. This issue was discussed in the last meeting. The concerns from the last meeting were not fully addressed nor justified by necessary evaluations. |
| BBC | We support this TP.  As per our contribution to this meeting in R1-2002626 Observations 3 and 4 state the following:  **Observation 3: A UE implementing frequency-only channel interpolation for the PMCH numerology with *Δf* = 0.37 kHz and RS pattern with *Dt* = 2 only achieves a theoretical equalisation interval of 450µs, instead of 900µs.**  **Observation 4: A UE implementing frequency-only channel interpolation for the PMCH numerology with *Δf* = 0.37 kHz and RS pattern with *Dt* = 4 only achieves a theoretical equalisation interval of 225µs. The 300µs CP would therefore not be supported.**  We also note that the performance of the physical layer will be limited by the worst performing component. Hence, we do not think it is acceptable to end up with a system where the equalization interval does not even support the full extent of the CP. |
| Qualcomm 2 | As a compromise, maybe we can try to restrict this to MCCH + dedicated carrier. Here is the updated TP:  **<TP-2 Revision 1, 36.211 6.10.2>**  6.10.2 MBSFN reference signals  MBSFN reference signals shall be transmitted in the MBSFN region of MBSFN subframes only when the PMCH is transmitted. MBSFN reference signals are transmitted on antenna port 4.  For an MBMS-dedicated carrier, and for a PMCH transmitted with 0.37 kHz subcarrier spacing in slot which is indicated to contain MCCH by higher layer parameter *MCCH-Config:*  - for MBSFN reference signal pattern type 1, the UE may assume that MBSFN reference signals associated with the same are present in the three preceding slots to slot .  - for MBSFN reference signal pattern type 2, the UE may assume that MBSFN reference signals associated with the same are present in the preceding slot to slot .  MBSFN reference signals are defined for extended cyclic prefix only.  **</TP-2 Revision 1>** |
| Qualcomm | Based on the email exchange, TP2 is further revised as follows:  **<TP-2 Revision 2, 36.211 6.10.2>**  6.10.2 MBSFN reference signals  MBSFN reference signals shall be transmitted in the MBSFN region of MBSFN subframes only when the PMCH is transmitted. MBSFN reference signals are transmitted on antenna port 4.  For an MBMS-dedicated carrier configured with a single MBSFN area, and for a PMCH transmitted with 0.37 kHz subcarrier spacing in slot which is indicated to contain MCCH by higher layer parameter *MCCH-Config:*  - for MBSFN reference signal pattern type 1, the UE may assume that MBSFN reference signals associated with the same are present in the three preceding slots to slot .  - for MBSFN reference signal pattern type 2, the UE may assume that MBSFN reference signals associated with the same are present in the preceding slot to slot .  MBSFN reference signals are defined for extended cyclic prefix only.  **</TP-2 Revision 2>** |

# Issue #3: Correction to MBSFN-RS generation

In x2179, a potential issue with the MBSFN-RS generation for 0.37kHz SCS is presented. The current equation gives the following pattern for Td=4:

A close up of a sign

Description automatically generated

A TP is presented in x2179 as follows:

**<TP-3, 6.10.2.2.4>**

The reference-signal sequence in OFDM symbol shall be mapped to complex-valued modulation symbols with according to

where is the 3ms absolute slot number, defined as is the 3 ms slot number as defined in clause 4.1 and

- for MBSFN reference signal pattern type 1

* + For odd
  + For even

- for MBSFN reference signal pattern type 2

**</TP-3>**

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| **Company name** | **Comment** |
| Qualcomm | Support this change. If other companies find an easier way to write the equations, we would also be OK. |
| ZTE | Based on our understanding, it seems there is no need to include separate equations for odd and even number of RBs for RS pattern type1. One equation could cover both odd and even number of RBs and cover all potential numbers for RS pattern type1.  Thus, we propose the following TP, which looks simpler. Companies could further check whether our equation covers all the cases.  --------------------------------- ZTE’s TP ---------------------------------  The reference-signal sequence in OFDM symbol shall be mapped to complex-valued modulation symbols with according to  when  and where is the 3ms absolute slot number, defined as is the 3 ms slot number as defined in clause 4.1 and  - for MBSFN reference signal pattern type 1    - for MBSFN reference signal pattern type 2 |
| Qualcomm 2 | The proposed equation by ZTE has the issue that the tones are not exactly from the center of the sequence, but this may not be a big deal – if companies are OK, we can go with the simpler approach.  While reviewing the equation, we realized that there is an additional bug: the range of k should be  Instead of  Merging these two issues together, we have the following revised TP:  **<TP-3 Revision 2, 6.10.2.2.4>**  The reference-signal sequence in OFDM symbol shall be mapped to complex-valued modulation symbols with according to  when  and where is the 3ms absolute slot number, defined as is the 3 ms slot number as defined in clause 4.1 and  - for MBSFN reference signal pattern type 1  - for MBSFN reference signal pattern type 2  **</TP-3 Revision 2>** |
| Huawei, HiSilicon | The revised TP looks ok. |

# References

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| [R1-2001635](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2001635.zip) | Corrections to TS 36.211 for the 0.37kHz subcarrier spacing MBSFN | ZTE |
| [R1-2002179](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002179.zip) | Support of longer numerologies for rooftop reception | Qualcomm Incorporated |
| [R1-2002626](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002626.zip) | UE assumptions of MBSFN-RS for new PMCH numerology for support of rooftop reception | EBU, BBC, IRT |