**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-02]

**Document for:** Discussion and Decision

# Summary of issues

This document contains the discussion for the following:

[100b-e-LTE-TerrBcast-02] Email discussion/approval on other aspects of new numerologies (corrections to TS 36.214; TP for 36.201; text for TBS scaling) by 4/24; if necessary, followed by endorsing the corresponding TPs by 4/29 - Alberto (Qualcomm)

# Issue #1: Corrections to TS 36.214

In x1636, it is proposed to modify the text in 36.214 to clarify that measurements are made in “slots” in which the UE receives the new numerology with 0.37kHz SCS. The change is as:

**<TP-1. TS 36.214>**

5.1.17 MBSFN Reference Signal Received Power (MBSFN RSRP)

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| **Definition** | MBSFN Reference signal received power (MBSFN RSRP), is defined as the linear average over the power contributions (in [W]) of the resource elements that carry MBSFN reference signals within the considered measurement frequency bandwidth.  For MBSFN RSRP determination the MBSFN reference signals R4 according to TS 36.211 [3] shall be used.  The reference point for the MBSFN RSRP shall be the antenna connector of the UE.  If receiver diversity is in use by the UE, the reported value shall not be lower than the corresponding MBSFN RSRP of any of the individual diversity branches. |
| **Applicable for** | RRC\_IDLE intra-frequency,  RRC\_IDLE inter-frequency,  RRC\_CONNECTED intra-frequency,  RRC\_CONNECTED inter-frequency |

NOTE 1: The number of resource elements within the considered measurement frequency bandwidth and within the measurement period that are used by the UE to determine MBSFN RSRP is left up to the UE implementation with the limitation that corresponding measurement accuracy requirements have to be fulfilled.

NOTE 2: The power per resource element is determined from the energy received during the useful part of the symbol, excluding the CP.

NOTE 3: The measurement is made only in subframes or slots corresponding to 0.37 kHz subcarrier spacing and on carriers where the UE is decoding PMCH.

**<Unchanged parts are omitted>**

5.1.18 MBSFN Reference Signal Received Quality (MBSFN RSRQ)

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| **Definition** | MBSFN Reference Signal Received Quality (RSRQ) is defined as the ratio N× MBSFN RSRP/(MBSFN carrier RSSI), where N is the number of RBs of the MBSFN carrier RSSI measurement bandwidth. The measurements in the numerator and denominator shall be made over the same set of resource blocks.  MBSFN Carrier Received Signal Strength Indicator (MBSFN carrier RSSI), comprises the linear average of the total received power (in [W]) observed only in OFDM symbols containing reference symbols for antenna port 4, in the measurement bandwidth, over N number of resource blocks by the UE from all sources, including co-channel serving and non-serving cells, adjacent channel interference, thermal noise etc.  The reference point for the MBSFN RSRQ shall be the antenna connector of the UE.  If receiver diversity is in use by the UE, the reported value shall not be lower than the corresponding MBSFN RSRQ of any of the individual diversity branches. |
| **Applicable for** | RRC\_IDLE intra-frequency,  RRC\_IDLE inter-frequency,  RRC\_CONNECTED intra-frequency,  RRC\_CONNECTED inter-frequency |

NOTE 1: The measurement is made only in subframes or slots corresponding to 0.37 kHz subcarrier spacing and on carriers where the UE is decoding PMCH.

**<Unchanged parts are omitted>**

5.1.19 Multicast Channel Block Error Rate (MCH BLER)

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| **Definition** | Multicast channel block error rate (MCH BLER) estimation shall be based on evaluating the CRC of MCH transport blocks. The BLER shall be computed over the measurement period as the ratio between the number of received MCH transport blocks resulting in a CRC error and the total number of received MCH transport blocks of an MCH. The MCH BLER estimation shall only consider MCH transport blocks using the same MCS. |
| **Applicable for** | RRC\_IDLE intra-frequency,  RRC\_IDLE inter-frequency,  RRC\_CONNECTED intra-frequency,  RRC\_CONNECTED inter-frequency |

NOTE 1: The measurement is made only in subframes or slots corresponding to 0.37 kHz subcarrier spacing and on carriers where the UE is decoding PMCH.

**<TP-1. TS 36.214>**

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| **Company name** | **Comment** |
| Qualcomm | In general, the current specification should be enough, since the slots are comprised of 3 subframes. If this needs clarification, we suggest the following:  NOTE 1: The measurement is made only in subframes (slots in case of 0.37 kHz subcarrier spacing) and on carriers where the UE is decoding PMCH. |
| ZTE | We believe the TP is needed.  Regarding Qualcomm’s suggestion, we prefer to keep our original wording since there is no definition of subframe in case of 0.37 subcarrier. |
| Qualcomm 2 | In our understanding, one subframe is still 1ms for all numerologies, and one slot comprises 3ms (i.e., 3 subframes). With respect to the original wording, we think it can be confusing (the part “corresponding to 0.37kHz SCS” can be read to apply also to subframes). But if there is a majority view that wants to go with the original wording, we can be OK. |
| Huawei, HiSilicon | We think QC’s suggested TP seems clearer to us. |
| ZTE 2 | Thanks for the clarification, we could go with the majority view for this issue. |
| BBC | We think that the current wording proposed in TP-1 can be interpreted as if the measurements are only applicable to the PMCH numerology with 0.370 kHz subcarrier spacing. Hence, a wording as proposed by Qualcomm (where the clarifications for 0.370 kHz subcarrier spacing numerology are placed between brackets) is clearer in our opinion. |

# Issue #2: TP for 36.201

In x2601, a TP for introducing the new numerologies to 36.201 is presented as follows:

**<TP-2, TS 36.201>**

## 4.2 General description of Layer 1

### 4.2.1 Multiple access

The multiple access scheme for the LTE physical layer is based on Orthogonal Frequency Division Multiplexing (OFDM) with a cyclic prefix (CP) in the downlink, and on Single-Carrier Frequency Division Multiple Access (SC-FDMA) with a cyclic prefix in the uplink and sidelink. To support transmission in paired and unpaired spectrum, two duplex modes are supported: Frequency Division Duplex (FDD), supporting full duplex and half duplex operation, and Time Division Duplex (TDD).

The Layer 1 is defined in a bandwidth agnostic way based on resource blocks, allowing the LTE Layer 1 to adapt to various spectrum allocations. A resource block spans either 12 sub-carriers with a sub-carrier bandwidth of 15kHz or 24 sub-carriers with a sub-carrier bandwidth of 7.5kHz each over a slot duration of 0.5ms, 72 sub-carriers with a sub-carrier bandwidth of 2.5kHz each over a slot duration of 0.5ms, 144 sub-carriers with a sub-carrier bandwidth of 1.25kHz over a slot duration of 1ms, or 486 sub-carriers with a sub-carrier bandwidth of approximately 0.37kHz over a slot duration of 3ms. Narrowband operation is also defined, whereby certain UEs may operate using a maximum transmission and reception bandwidth of 6 contiguous resource blocks within the total system bandwidth; for narrowband operation, sub-resource-block operation may also be used in the uplink, using 2, 3 or 6 sub-carriers.

For Narrowband Internet of Things (NB-IoT) operation, a UE operates in the downlink using 12 sub-carriers with a sub-carrier bandwidth of 15kHz, and in the uplink using a single sub-carrier with a sub-carrier bandwidth of either 3.75kHz or 15kHz or alternatively 3, 6 or 12 sub-carriers with a sub-carrier bandwidth of 15kHz.

The radio frame structure type 1 is only applicable to FDD (for both full duplex and half duplex operation) and has a duration of 10ms and consists of 20 slots with a slot duration of 0.5ms. Two adjacent slots form one sub-frame of length 1ms, except when the sub-carrier bandwidth is 1.25kHz or approximately 0.37kHz, in which case one slot forms one sub-frame or a time duration of 3ms, respectively. When the sub-carrier bandwidth is 15kHz, a slot can be further subdivided into three subslots of length 2 or 3 OFDM or SC-FDMA symbols for reduced latency operation.

The radio frame structure type 2 is only applicable to TDD and consists of two half-frames with a duration of 5ms each and containing each either 10 slots of length 0.5ms, or 8 slots of length 0.5ms and three special fields (DwPTS, GP and UpPTS) which have configurable individual lengths and a total length of 1ms. A subframe consists of two adjacent slots, except for subframes which consist of DwPTS, GP and UpPTS, namely subframe 1 and, in some configurations, subframe 6. Both 5ms and 10ms downlink-to-uplink switch-point periodicity are supported. Further details on the LTE frame structure are specified in [2]. Adaptation of the uplink-downlink subframe configuration via Layer 1 signalling is supported.

The radio frame structure type 3 is only applicable to LAA secondary cell operation. It has a duration of 10ms and consists of 20 slots with a slot duration of 0.5ms. Two adjacent slots form one subframe of length 1ms. Any subframe may be available for downlink or uplink transmission. For downlink transmission, the eNB shall perform the channel access procedures as specified in [4] prior to transmitting. A downlink or uplink transmission may start at the subframe boundary or later, and may end at the subframe boundary or earlier. For uplink transmission, the UE shall perform the channel access procedures as specified in [4] prior to transmitting.

To support a Multimedia Broadcast and Multicast Service (MBMS), LTE offers the possibility to transmit Multicast/Broadcast over a Single Frequency Network (MBSFN), where a time-synchronized common waveform is transmitted from multiple cells for a given duration. MBSFN transmission enables highly efficient MBMS, allowing for over-the-air combining of multi-cell transmissions in the UE, where the cyclic prefix is utilized to cover the difference in the propagation delays, which makes the MBSFN transmission appear to the UE as a transmission from a single large cell. Transmission on a dedicated carrier for MBSFN is supported, as well as transmission of MBSFN on a carrier with both MBMS transmissions and point-to-point transmissions using time division multiplexing. In addition to the 15kHz sub-carrier bandwidth, the sub-carrier bandwidth of 7.5kHz with a longer CP, the sub-carrier bandwidth of 2.5kHz with a long CP (100µs), the sub-carrier bandwidth of 1.25kHz with very long CP (200µs), and the sub-carrier bandwidth of approximately 0.37kHz with a long CP (300µs) are all supported on dedicated MBSFN carriers, whereas MBSFN subframes that are time-multiplexed on the same carrier with non-MBSFN subframes may be configured with the 2.5kHz, 1.25kHz, or approximately 0.37kHz sub-carrier bandwidth. Transmission of PDSCH also in MBSFN subframes that are not used for MCH is supported.

Transmission with multiple input and multiple output antennas (MIMO) are supported with configurations in the downlink with up to 32 transmit antenna ports and eight receive antennas, which allow for multi-layer downlink transmissions with up to eight streams and beamforming in both horizontal and vertical dimensions. Multi-layer uplink transmissions with up to four streams are supported with configurations in the uplink with up to four transmit antenna ports and four receive antennas. Multi-user MIMO, i.e. allocation of different streams to different users is supported in both UL and DL.

Coordinated Multi-Point (CoMP) transmission and reception are supported, including the possibility to configure a UE with multiple Channel State Information (CSI) feedback processes.

Aggregation of multiple cells is supported in the uplink and downlink with up to 32 serving cells, where each serving cell can use a transmission bandwidth of up to 110 resource blocks and can operate with either frame structure type 1 or frame structure type 2. Dual connectivity to groups of serving cells that belong to two different eNode-Bs is also supported.

Sidelink transmissions are defined for ProSe Direct Discovery and ProSe Direct Communication between Ues. The sidelink transmissions use the same frame structure as uplink and downlink when the UEs are in network coverage; however, the sidelink transmissions are restricted to a sub-set of the uplink resources. V2X communication between UEs is supported via sidelink transmissions or via the eNB.

**</TP-2>**

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| **Company name** | **Comment** |
| Qualcomm | The update looks OK to us. |
| ZTE | We support this TP. |
| Huawei, HiSilicon | We support the TP. |
| BBC | We would like to make the following comments and suggestions to TP-2:  *Second paragraph:*  The Layer 1 is defined in a bandwidth agnostic way based on resource blocks, allowing the LTE Layer 1 to adapt to various spectrum allocations. A resource block spans either 12 sub-carriers with a sub-carrier bandwidth of 15kHz or 24 sub-carriers with a sub-carrier bandwidth of 7.5kHz each over a slot duration of 0.5ms, 72 sub-carriers with a sub-carrier bandwidth of 2.5kHz each over a slot duration of 0.5ms, 144 sub-carriers with a sub-carrier bandwidth of 1.25kHz over a slot duration of 1ms, or 486 sub-carriers with a sub-carrier bandwidth of approximately 0.37kHz over a slot duration of 3ms. Narrowband operation is also defined, whereby certain UEs may operate using a maximum transmission and reception bandwidth of 6 contiguous resource blocks within the total system bandwidth; for narrowband operation, sub-resource-block operation may also be used in the uplink, using 2, 3 or 6 sub-carriers.  *Fourth paragraph*:  The radio frame structure type 1 is only applicable to FDD (for both full duplex and half duplex operation) and has a duration of 10ms and consists of 20 slots with a slot duration of 0.5ms. Two adjacent slots form one sub-frame of length 1ms, except when the sub-carrier bandwidth is 1.25kHz or approximately 0.37kHz, in which case one slot forms one sub-frame or a time duration of 3ms, respectively. When the sub-carrier bandwidth is 15kHz, a slot can be further subdivided into three subslots of length 2 or 3 OFDM or SC-FDMA symbols for reduced latency operation.  *Seventh paragraph:*  To support a Multimedia Broadcast and Multicast Service (MBMS), LTE offers the possibility to transmit Multicast/Broadcast over a Single Frequency Network (MBSFN), where a time-synchronized common waveform is transmitted from multiple cells for a given duration. MBSFN transmission enables highly efficient MBMS, allowing for over-the-air combining of multi-cell transmissions in the UE, where the cyclic prefix is utilized to cover the difference in the propagation delays, which makes the MBSFN transmission appear to the UE as a transmission from a single large cell. Transmission on a dedicated carrier for MBSFN is supported, as well as transmission of MBSFN on a carrier with both MBMS transmissions and point-to-point transmissions using time division multiplexing. In addition to the 15kHz sub-carrier bandwidth, the sub-carrier bandwidth of 7.5kHz with a longer CP, the sub-carrier bandwidth of 2.5kHz with a long CP (100µs), the sub-carrier bandwidth of 1.25kHz with very long CP (200µs), and the sub-carrier bandwidth of approximately 0.37kHz with a long CP (300µs) are all supported on dedicated MBSFN carriers, whereas MBSFN subframes that are time-multiplexed on the same carrier with non-MBSFN subframes may be configured with the 2.5kHz, 1.25kHz, or approximately 0.37kHz sub-carrier bandwidth. Transmission of PDSCH also in MBSFN subframes that are not used for MCH is supported. |
| Qualcomm | Trying to capture David’s suggestions in the revised TP:  **<TP-2 Revision 1, TS 36.201>** 4.2 General description of Layer 14.2.1 Multiple access The multiple access scheme for the LTE physical layer is based on Orthogonal Frequency Division Multiplexing (OFDM) with a cyclic prefix (CP) in the downlink, and on Single-Carrier Frequency Division Multiple Access (SC-FDMA) with a cyclic prefix in the uplink and sidelink. To support transmission in paired and unpaired spectrum, two duplex modes are supported: Frequency Division Duplex (FDD), supporting full duplex and half duplex operation, and Time Division Duplex (TDD).  The Layer 1 is defined in a bandwidth agnostic way based on resource blocks, allowing the LTE Layer 1 to adapt to various spectrum allocations. A resource block spans either 12 sub-carriers with a sub-carrier bandwidth of 15kHz or 24 sub-carriers with a sub-carrier bandwidth of 7.5kHz or 72 sub-carriers with a sub-carrier bandwidth of 2.5kHz each over a slot duration of 0.5ms, 144 sub-carriers with a sub-carrier bandwidth of 1.25kHz over a slot duration of 1ms, or 486 sub-carriers with a sub-carrier bandwidth of approximately 0.37kHz over a slot duration of 3ms. Narrowband operation is also defined, whereby certain UEs may operate using a maximum transmission and reception bandwidth of 6 contiguous resource blocks within the total system bandwidth; for narrowband operation, sub-resource-block operation may also be used in the uplink, using 2, 3 or 6 sub-carriers.  For Narrowband Internet of Things (NB-IoT) operation, a UE operates in the downlink using 12 sub-carriers with a sub-carrier bandwidth of 15kHz, and in the uplink using a single sub-carrier with a sub-carrier bandwidth of either 3.75kHz or 15kHz or alternatively 3, 6 or 12 sub-carriers with a sub-carrier bandwidth of 15kHz.  The radio frame structure type 1 is only applicable to FDD (for both full duplex and half duplex operation) and has a duration of 10ms and, for numerologies other than 1.25kHz and approximately 0.37kHz, consists of 20 slots with a slot duration of 0.5ms. Two adjacent slots form one sub-frame of length 1ms, except when the sub-carrier bandwidth is 1.25kHz or approximately 0.37kHz, in which case one slot forms one sub-frame or it has a time duration of 3ms, respectively. When the sub-carrier bandwidth is 15kHz, a slot can be further subdivided into three subslots of length 2 or 3 OFDM or SC-FDMA symbols for reduced latency operation.  The radio frame structure type 2 is only applicable to TDD and consists of two half-frames with a duration of 5ms each and containing each either 10 slots of length 0.5ms, or 8 slots of length 0.5ms and three special fields (DwPTS, GP and UpPTS) which have configurable individual lengths and a total length of 1ms. A subframe consists of two adjacent slots, except for subframes which consist of DwPTS, GP and UpPTS, namely subframe 1 and, in some configurations, subframe 6. Both 5ms and 10ms downlink-to-uplink switch-point periodicity are supported. Further details on the LTE frame structure are specified in [2]. Adaptation of the uplink-downlink subframe configuration via Layer 1 signalling is supported.  The radio frame structure type 3 is only applicable to LAA secondary cell operation. It has a duration of 10ms and consists of 20 slots with a slot duration of 0.5ms. Two adjacent slots form one subframe of length 1ms. Any subframe may be available for downlink or uplink transmission. For downlink transmission, the eNB shall perform the channel access procedures as specified in [4] prior to transmitting. A downlink or uplink transmission may start at the subframe boundary or later, and may end at the subframe boundary or earlier. For uplink transmission, the UE shall perform the channel access procedures as specified in [4] prior to transmitting.  To support a Multimedia Broadcast and Multicast Service (MBMS), LTE offers the possibility to transmit Multicast/Broadcast over a Single Frequency Network (MBSFN), where a time-synchronized common waveform is transmitted from multiple cells for a given duration. MBSFN transmission enables highly efficient MBMS, allowing for over-the-air combining of multi-cell transmissions in the UE, where the cyclic prefix is utilized to cover the difference in the propagation delays, which makes the MBSFN transmission appear to the UE as a transmission from a single large cell. Transmission on a dedicated carrier for MBSFN is supported, as well as transmission of MBSFN on a carrier with both MBMS transmissions and point-to-point transmissions using time division multiplexing. In addition to the 15kHz sub-carrier bandwidth, the sub-carrier bandwidth of 7.5kHz with a longer CP, the sub-carrier bandwidth of 2.5kHz with a long CP (100µs), the sub-carrier bandwidth of 1.25kHz with very long CP (200µs), and the sub-carrier bandwidth of approximately 0.37kHz with a long CP (300µs) are all supported on dedicated and mixed MBSFN carriers. Transmission of PDSCH also in MBSFN subframes that are not used for MCH is supported in mixed MBSFN carriers.  Transmission with multiple input and multiple output antennas (MIMO) are supported with configurations in the downlink with up to 32 transmit antenna ports and eight receive antennas, which allow for multi-layer downlink transmissions with up to eight streams and beamforming in both horizontal and vertical dimensions. Multi-layer uplink transmissions with up to four streams are supported with configurations in the uplink with up to four transmit antenna ports and four receive antennas. Multi-user MIMO, i.e. allocation of different streams to different users is supported in both UL and DL.  Coordinated Multi-Point (CoMP) transmission and reception are supported, including the possibility to configure a UE with multiple Channel State Information (CSI) feedback processes.  Aggregation of multiple cells is supported in the uplink and downlink with up to 32 serving cells, where each serving cell can use a transmission bandwidth of up to 110 resource blocks and can operate with either frame structure type 1 or frame structure type 2. Dual connectivity to groups of serving cells that belong to two different eNode-Bs is also supported.  Sidelink transmissions are defined for ProSe Direct Discovery and ProSe Direct Communication between Ues. The sidelink transmissions use the same frame structure as uplink and downlink when the UEs are in network coverage; however, the sidelink transmissions are restricted to a sub-set of the uplink resources. V2X communication between UEs is supported via sidelink transmissions or via the eNB.  **</TP-2 Revision 1>** |

# Issue #3: Text for TBS scaling

In x2179, it is proposed to modify the text for TBS scaling, since the current text may not be clear:

**<TP-3, TS 36.213. 11.1>**

The UE shall then follow the procedure in Subclause 7.1.7.2.1 to determine the transport block size, assuming is equal to. For PMCH with  the UE shall scale the derived transport block size by , then round to the closest valid transport block size in the union of Table 7.1.7.2.1-1 and Table 7.1.7.2.4-1 by including, in the rounding procedure, only the TBS entries in Table 7.1.7.2.1-1 with and the entries in 7.1.7.2.4-1 for which the TBS\_L1 is present in Table 7.1.7.2.1-1 with if the UE is configured by higher layers to decode the PMCH based on QPSK, 16QAM, 64QAM, and 256QAM; and only the TBS entries in Table 7.1.7.2.1-1 with and the entries in 7.1.7.2.4-1 for which the TBS\_L1 is present in Table 7.1.7.2.1-1 with otherwise. In case the scaled TBS has the same distance to two valid transport block sizes, it is rounded to the larger transport block size. The UE shall set the redundancy version to 0 for the PMCH.

**</TP-3>**

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| **Company name** | **Comment** |
| Qualcomm | Support this change |
| ZTE | We support this TP. |
| Huawei, HiSilicon | The TP is ok to us. |
| BBC | We support this TP. |

# References

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| [R1-2001636](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2001636.zip) | Text proposal for new numerology in TS 36.214 | 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 |
| [R1-2002601](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002601.zip) | Text proposal for new numerology in TS 36.201 | Huawei, HiSilicon |
| [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 |