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| 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 sub-carrier bandwidths 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 cases one slot forms one sub-frame or 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 mixed 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 a very long CP (200µs), and the sub-carrier bandwidth of approximately 0.37kHz with a very long CP (300µs) are all supported on both dedicated and mixed MBSFN carriers. Transmission of PDSCH also in MBSFN subframes that are not used for MCH is supported on 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>** |