Efficient and Fair Medium Sharing Enabled by a Common Preamble

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Abstract: A Co-Existence mechanism between 3GPP (LTE) and IEEE (802.11) for the unlicensed 5GHz frequency band is currently defined in release 13 of 3GPP LTE standard. It utilizes listen-before-talk (LBT) access mechanism to gain the control of the medium before transmitting any data. The LBT mechanism uses energy detection (ED) to perform clear channel assessment (CCA) in order to avoid collisions and to fairly use the unlicensed wireless medium. FCC has recently issued an NPRM to make the 6 GHz band available for unlicensed use. With the opening of 6 GHz band in sight, it has become critical to address the co-existence issues between 3GPP and IEEE for this frequency band.

IEEE has recently decided that 6 GHz band will mainly be utilized by 11ax and onward releases. No HT and VHT devices will be allowed to operate in the 6 GHz band. Similarly, 3GPP seems to be allowing only the NR based unlicensed use in the 6 GHz band. With such a fresh start in the 6 GHz band, both of the standardization bodies can redefine the co-existence rules for the 6 GHz band in such a way that benefits both bodies alike. One such example is the possibility of defining a common preamble for any unlicensed use in the 6 GHz band. With a common preamble any unlicensed device can not only perform the energy detection for channel sensing but can also perform the preamble detection (PD) to differentiate between the packets of certain type and generic noise. In 11ax there can be users with lot less link power than is required by the ED limit and if PD is not performed then any unlicensed device can be aggressive in taking control of the channel, resulting in the interference and congestion of the network. Therefore, it is of utmost importance to define a common preamble for any unlicensed use of the 6 GHz band.

However, in order to be able to perform PD, all unlicensed devices need to be able to detect the type of packet, which in 802.11 is typically done through its preamble. Since NR has no preamble like structure, we propose to use the 802.11a based "legacy" preamble to be prepended to NR communications for unlicensed use as well. Inclusion of 802.11a based common preamble for unlicensed access in 6 GHz can actually help both standards in mitigating the interference problem and increasing the fairness in access of the wireless medium.

6 GHz – Band of Interest

As mentioned before, the main frequency band of interest for the co-existence between 3GPP and IEEE is the 6 GHz band. In USA, Federal Communications Commission (FCC) is the regulatory authority which administers the frequency spectrums. For the 6 GHz, FCC has issued notice of proposed rule making (NPRM) in October 2018. In this NPRM, FCC proposed to open up 1200 MHz of band, starting from 5925 – 7125 MHz, for unlicensed access. The details of this NPRM are out of the scope of this paper and interested readers can get more details about it in this link.

Similar to USA, in Europe the biggest regulatory authority (European Commission) is considering opening up 500 MHz of 6 GHz band (5925 – 6425 MHz) for unlicensed access (ECC Report 302). Both of these developments towards obtaining more frequency band for unlicensed use has stirred the interest of all unlicensed players to share this band and thus there is a strong need to co-ordinate on the rules of sharing this spectrum.

Co-Existence and Common Preamble

Co-existence in 6 GHz is going to be of critical importance. There has been an effort of co-existence for 5 GHz band in the past which resulted in the 3GPP release 12 as Licensed-Assisted Access (LAA). In LAA, primarily due to the lack of available time and less experience of such activity, there were few critical points left un-attended. Due to those un-attended points co-existence between 3GPP and IEEE in 5 GHz not only seem to be unfair but also less efficient due to the avoidable collisions. Such point is having a common preamble for both IEEE and 3GPP.

With the presence of the common preamble, both IEEE and 3GPP nodes can perform not only the energy detection (ED) but also the preamble detection (PD). The issue with the ED only is that it looks only for a certain amount of energy on the medium and anything below it is considered as noise. This level of ED for 11ax based transmission is around -72 dBm for 20 MHz bandwidth. Please note that 11ax based receivers are able to detect their signals at much lower received signal strength than -72 dBm. This is receiver performance dependent and if any 3GPP node is not able to apply PD in addition to the ED then it would assume that any signal received below -72 dBm is noise and it will start transmission. This will lead to the collisions and due to these collisions, none of the signal would be decodable at each of the intended receiver. This severely affects the performance of the shared medium and is not in the benefit of either 3GPP or IEEE.

With the inclusion of common preamble, both types of nodes (3GPP and IEEE) can detect the signals at their designated levels and this can help reduce the collisions and congestion over the network for the access of the shared medium.

Next, important question is that what type of common preamble is suited best for this kind of situation? There can be many preamble designs, but we believe that IEEE 802.11a based preamble might be the best suited for the task as this preamble has simple structure, requires less computations, has high x-correlation properties and is already widely used across the globe. Therefore, we propose to use the IEEE 802.11a based preamble for its simplicity and ease for increasing the fairness and efficiency of the shared medium.