RTT TECHNOLOGY TOPIC
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5G BLE
Friends or nightmare neighbours?

The publication of Version 5.0 of the Bluetooth specification last December marked another step in the evolution of Bluetooth as a closely coupled technical and commercial partner to 4GLTE and 802.11 Wi-Fi.

Most of us use Bluetooth every day whether it's our fitness tracker talking to our smart phone or hands free pairing in our car or listening to Spotify via a Bluetooth headset.

5.0 Bluetooth is significant for several reasons. It is the fourth iteration of Bluetooth Low Energy (BLE) first introduced as Version 4.0 in 2010 but it is the first time that BLE has been coupled with a long range (1600 metre) Bluetooth PHY and MAC option.

This is achieved through a combination of higher output power (+20 dBm/100 milliwatts), channel coding and optimised receiver design taking advantage of a feature called stable modulation index where the deviation of the GFSK deviation is reduced.

This opens up a whole new range of potential applications including long distance retail beaconing. My local speed camera now tells me when I am speeding which can only be via the (what I thought was disenabled) Bluetooth in my six year old basic Ford Ka.

Long distance Bluetooth can also be extended with the newly supported mesh protocol.
This brings Bluetooth into direct competition with a number of other radio systems including 802.15,4 based protocols such as Zigbee, LoRa, Wireless-M (for meter reading), Thread and 6 LowPAN (IPV6 over local area networks. 802.11 also has a mesh protocol and long distance ambitions including 802.11ah Wi-Fi in the 900 MHz ISM band. It also moves Bluetooth into the application space targeted by LTE NB IOT and LTE M though with range limitations.

There are some interesting design challenges implied by 5.0. The BLE specification is inherently less resilient to interference than Classic or EDR Bluetooth. This is because the legacy seventy eight X 1 MHz channels within the 20 MHz 2.4 GHz pass band are replaced with thirty nine two MHz channels with three fixed non hopping advertising channels in the middle and edge of the pass band.

These have to withstand high power 20 MHz LTE TDD in Band 40 (below the 2.4 GHz pass band) and high power 20 MHz LTE TDD in band 41 above the pass band (and Band 7 LTE FDD). This includes 26 dBm high power user equipment.

The coexistence of Bluetooth, Wi-Fi and LTE has been intensively studied and worked on for over ten years and is now managed with surprising effectiveness within a smart phone through a combination of optimised analogue and digital filtering (SAW and FBAR filters) and time domain interference mitigation based on a set of industry standard wireless coexistence protocols.

The introduction of high power Bluetooth however implies that this is no longer just a colocation issue but potentially a close location issue. Even managing Bluetooth to Bluetooth coexistence becomes a non-trivial task when you consider that +20 dBm transmissions will be closely proximate to -20 dBm or whisper mode -30 dBm transmissions and RX sensitivity of -93 dBm, potentially a dynamic range of 120dB. Though Bluetooth is a TDD system this isolation requirement will be challenging and vulnerable to ISI distortion.

More broadly there is a need to consider how '5G Bluetooth' couples technically and commercially with 5G including 5G IOT, the subject of this month's technology topic.

Read on

Superficially it might be considered that Bluetooth and indeed all 2.4 GHz ISM based systems would not need to be considered within the 5G standards and product definition process. After all much of the implementation focus is on Ka band at 26 GHz or 28 GHz.

However as we have seen with LTE-U, mission creep is a reality and the temptation to take over ISM spectrum is always a tempting prospect.

This is particularly true when you consider the recent FCC Notice of Inquiry into repurposing of spectrum adjacent to the 5GHz ISM band (the reallocation of 5.925-6.425 GHz spectrum) and the addition of substantial spectrum to the 60 GHz unlicensed band.

Arguably the ISM band at 2.4 GHz is so crowded that it will become increasingly unusable though people (including us) have been saying that for years and somehow it continues to work most of the time.

And as we pointed out in our introduction, the 2.4 GHz band is book ended by Band 40, Band 41 and Band 7. Sprint for example have stated an ambition (backed by closely managed demonstrations) to implement Gigabit LTE based on three 20 MHz aggregated channels at 'low band' (800 MHz) 'mid band' (1900 MHz) and 'high band' (Band 41).

Pragmatically it seems more than likely that 5G will become part of many mobile operators future refarming plans for sub 3GHz spectrum including Band 40 and Band 41. LTE for example has muscled out power inefficient 3G despite operator and vendor reluctance to write down hardware that is in some cases only a few years old.

It is also likely that there will be a requirement to deliver high power 5G user equipment including one watt and three watt handsets for public protection and disaster relief, scaling networks such as FirstNet and BT EE Emergency Services Networks (ESN) to higher bandwidth higher frequency shorter wavelength spectrum.

When you consider that existing LTE user equipment specified with a maximum output power of+23 dBm has a peak to envelope power envelope of at least +33 dBm then it seems obvious that there are likely to be significant coexistence issues between 5G sub 3 GHz radio systems and 2.4 GHz ISM including 5.0 Bluetooth and Wi-Fi in all its alphabetical glory.

It is also quite possible that the Bluetooth SIG could have ambitions to scale future standards (6.0 and beyond) into the 5 GHz and 60 GHz bands. As pointed out in previous technology topics, the extended 60 GHz ISM band will be immediately spectrally proximate to the proposed 5G E band duplex at 71 to 76 GHz and 81 to 86 GHz.

This would suggest a need to qualify the proposed modulation waveform candidates in terms of coexistence with existing and potential future ISM radio systems including Bluetooth.

It also seems myopic not to consider Bluetooth as a closely coupled partner in 5G wide area, local area, personal area and IOT vertical market use cases.

As always it is often worth stepping back and considering who is likely to move into the house next door and what they might do there. 5G is the real estate equivalent of moving into a bungalow and building a block of high rise flats clad in combustible insulation and having regular all night parties.

The answer is usually a combination of fences and hedges and trees, the real estate equivalent of protection ratios.

5.0 Bluetooth and 5G could potentially be happy neighbours but some thought needs to be applied to how they will live together and create mutual added value.

Ends

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More details here

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