



RTT TECHNOLOGY TOPIC May 2018

5G, Satellite and Wi-Fi Spectrum, Standards, Scale

In last month's Technology Topic, [Beam Radio](#), we reviewed the role of beam forming as a mechanism for delivering bandwidth efficiency and power efficiency in long distance, wide area and local area radio systems with short wave beam radio as a 1928 example and 5G and Satellite and Wi-Fi as contemporary (2018) examples.

This month we review the role of Wi-Fi as a facilitator of 5G and satellite technical and commercial integration highlighting the touch points and tension points between the Wi-Fi and mobile broadband community and the emerging role of Wi-Fi and satellite in low cost rural and urban wide area and local area connectivity as a complement to 5G - the 5G Trilogy.

Read on

4G and 5G standards for LTE in Unlicensed Spectrum as a Wi-Fi and 5G Tension Point

Standards work on the deployment of LTE in unlicensed spectrum is one obvious tension point. The assumption, which may be right or wrong, is that 80% of future traffic will be indoors. However this is 80% by volume not value. Inconveniently for mobile operators, most of us expect indoor connectivity, specifically indoor connectivity by Wi-Fi, to be free.

The idea of deploying 4G and 5G radio into unlicensed spectrum at 2.4 GHz, 5 GHz and 60 GHz is therefore contentious. The idea is either to have LTE deployed directly into these bands (LTE-U) with a multiplex at IP level using an IP SEC security tunnel or licensed assisted access (LAA) which couples unlicensed spectrum to an anchor in licensed spectrum. CAT 12 and CAT 16 LTE modems for example are specified to support LAA. Qualcomm also has a product offer known as MulteFire.

For 5G New Radio, the introduction of mini slots at the physical layer, a minimum of two symbols in each one millisecond time frame, originally intended and still intended for Ultra Reliable Low Latency Communication (URLLC) also enables Listen Before Talk (LBT) to be supported. This makes it easier to replicate and co-exist with a Wi-Fi PHY and MAC layer.

In terms of target spectrum, the 3GPP standards work divides into unlicensed bands below and above 6 GHz up to 52.6 GHz and unlicensed bands above 52.6 GHz which includes the 15 GHz of spectrum in the 60 GHz ISM band.

One issue to be resolved is how beam forming could be integrated with LBT without introducing expensive beam forming processing overheads created by the requirement to detect other 5G devices and Wi-Fi devices co sharing the spectrum.

The relevant standards documents are 3GPP TR 36.889, 3GPP TS 22.368 and 3GPP TS 36.322.368 together with study item outputs by Huawei (R4-151641), Nokia Networks (R4 - 151537), Intel(R4-152178), LG(R4-152126), ZTE (R4-151912) and Qualcomm (RP-170828 and RP-151542).

Related standards work includes Enhanced Packet Core (EPC) integrated Wi-Fi known as Vo-Wi-Fi which in theory at least makes it possible to deliver voice (and enhanced voice) seamlessly over

Voice Over LTE (VoLTE) and or Wi-Fi channels and parallel standards work on video over LTE (ViLTE) as part of the 4G and 5G Rich Communication Service offer.

Wi-Fi Standards Evolution as a 5G/ Wi-Fi tension point

Wi-Fi standards are going in the opposite direction with work items on long distance Wi-Fi. This is made more feasible by the proposed introduction of FDD into the Wi-Fi physical layer within the 802.11ax standards process. FDD Wi-Fi was originally intended and is still intended to facilitate high density access point coexistence. For example, deploying Google Home and Amazon Echo into a domestic home could result in upwards of 50 access points and FDD would make coexistence easier to achieve.

FDD however would also make it easier to realise high power Wi-Fi access points and user terminals with improved receive sensitivity, two of the requirements for long distance Wi-Fi along with fractional beam forming (0.5 to 1.5 degree beam width antennas). This opens up the possibility that Wi-Fi could be deployed into LTE spectrum in larger cell topologies.

Spectrum Touch Points between Wi-Fi and Satellite and 5G

By contrast, evolving Wi-Fi standards and satellite service offers are complementary and increasingly common. Examples include L band terminals for Iridium with inbuilt Wi-Fi and the use of Wi-Fi to deliver satellite low cost access to rural communities, Coca-Cola and OneWeb in Africa for example, and for in building coverage.

A number of satellite operators also have frequency allocations immediately adjacent to Wi-Fi spectrum and or existing LTE/5G spectrum.

Globalstar for example has a frequency allocation between 2483.5 MHz and 2500 MHz supporting a 22 MHz pass band configured as a 10.5 MHz ISM pass band (channel 14) and 11.5 MHz licensed band. The ISM band is immediately above the 2.4 GHz pass band and the licensed band is immediately below Band 7 (FDD LTE) and Band 41 (TDD LTE). An FCC Part 25 ruling in December 2016 authorised the use of this spectrum for Terrestrial Low Power Service within specified US markets.

Inmarsat has an S band allocation between 2179 and 2200 MHz immediately above the mobile receive pass band for Band 1 LTE (2110-2170 MHz) and is the proposed pass band for the Inmarsat /Deutsche Telekom European Aviation Network supporting integrated LTE and geostationary satellite connectivity.

Verizon and America Aerospace Technology have trialled LTE base stations installed in aircraft, a different interpretation of sky based connectivity. Other initiatives include the provision of Wi-Fi from High Altitude Platforms, Google Loon for example and low altitude platforms including drone based Wi-Fi transceivers for emergency response or special event connectivity.

Some countries are auctioning 2.3 GHz spectrum immediately below the 2.4 GHz Wi-Fi band for 5G, the UK being a recent example (ex MOD spectrum) but whether this can scale globally is open to question.

Collaborative Connectivity as the best way forward

The moral of this particular tale is that a collaborative approach to connectivity is likely to yield a net financial gain to all parties including high added value subscribers and low income user communities.

Satellite connectivity can scale from a cell size of 3 kilometres to a cell diameter of 3000 kilometres or more (a continent sized cell for example).

LTE and 5G base stations scale between 30 metres and 30 kilometres

Wi-Fi cells scale from 3 metres to 30 metres (though long distance Wi-Fi could extend this)

Adding 802.11ad 60 GHz Wi-Fi transceivers to smart phones is now becoming more commonplace and suggests an evolving pragmatic approach to harnessing the power of Wi-Fi to add value and margin to the 4G and 5G service offer. A similar argument can be made for the role of Wi-Fi as a facilitator of 5G and satellite convergence. We return to this theme in future technology topics.



The Coca Cola and OneWeb initiative delivering low cost Wi-Fi and satellite enabled internet access (and a drink) to remote rural communities in Africa.

With thanks to the Coca-Cola Corporation

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Satellite Session at this year's CWIC Conference

The role of the satellite industry in 5G mobile broadband is being debated in the satellite session at this year's **Cambridge Wireless International Conference (CWIC)**

We are delighted to have Meir Moalem, CEO of SAS and Dan Mercer VP EMEA & Russia of Iridium presenting their vision of the future of the satellite industry and providing an update on constellation upgrades (Iridium) and Cube SAT innovation(SAS).

Iridium will complete in 2018 the fastest and largest ever seamless refresh of a space constellation, having so far successfully placed fifty new satellites into low earth orbit (ten per launch) using Space X Falcon 9 reusable rockets, and has just hit it's 1,000,000th Iridium subscriber.

SAS has a remarkable constellation programme based on small satellites with big capabilities including autonomous station keeping. Kieran Arnold from the Satellite Catapult will be chairing a discussion session.

For more information, follow the link

<https://www.cambridgewireless.co.uk/events/cwic-2018/>

New Book - 5G and Satellite Spectrum, Standards and Scale

We are delighted to announce that our new book, **5G and satellite spectrum, standards and scale** is now available for pre order from Artech House. Follow the link to take advantage of the pre-publication discount.

<http://uk.artechhouse.com/5G-and-Satellite-Spectrum-Standards-and-Scale-P1935.aspx>

If you apply promotional code VAR30, an additional discount applies which brings the price down to £88.90 (list price £127). There is also a bundle discount promotional code VARRALL5G which allows you to order a copy of our previous book, 5G Spectrum and Standards. The two books together cost £177.80 including free shipping.

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