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Tri Fi

The addition of 60 GHz means that Wi Fi will be available as a tri band/Tri Fi device supporting user data rates of more than a gigabit.

In this month's technology topic we look at how the combination of new spectrum, new technology and improved authentication and roaming may finally mean that Wi Fi can be made to work as a useful part of the mobile broadband service proposition.

The story so far

In 1985 the FCC allowed the use of the 2.4 GHz band for unlicensed low power communication. The allocation was linked to the proposed use of spread spectrum techniques to provide interference resilience to and from other devices and machines used in the band. In 1997 the first version of the 802.11 standard was finalized with first generation products delivering data rates of 1 or 2 Mbps. Although modest by today's standards such data rates were an order of magnitude higher than contemporary cellular radio networks.

Cellular networks however could do lots of other clever stuff including 35 kilometer radius cells and seamless handover – a range rather than rate proposition. Fifteen years on the latest iterations of the 802.11 standard deliver data rates of more than 100 Mbps. Cellular networks struggle to deliver 10 Mbps. This ten to one ratio for headline data rates remains constant over time.

Putting WiFi and cellular together therefore seems like a good idea. Most smart phones now include WiFi so you could say this has already happened. However a seamless wide area 'best connect' user experience remains elusive. This is partly because defining 'best connect' can be difficult. 'Best connect' for an operator may not be the same as 'best connect' for a user. The user connectivity experience is inconsistent. Automatic search algorithms flatten batteries. Manual network selection is not as easy as it could be or should be. What is changing and will it work?

New technology

Actually it is not new technology, but more of the same. The underlying trends are well understood

At baseband – the availability of more clock cycles, faster, cheaper memory and improved clock accuracy (allowing guard intervals to be reduced).

At RF - improved phase noise performance, efficient gain at high frequencies and improved linearity.

These trends are equally applicable to wide area LTE but Wi Fi needs less dynamic range - it doesn't go as far so it is easier at baseband to process wider operational bandwidths and easier to realise reasonable RF performance at higher frequencies.

New spectrum and updated standards

This has meant that the 5 GHz band and more recently the 60 GHz band could be added to the original 80 MHz of unlicensed 2.4 GHz spectrum.

In the 5 GHz band, 802.11 ac supports RF channel bandwidths of 160 MHz using 256 QAM modulation to deliver data rates of 1 gbps. It is backwards compatible with 802.11n. First product certification is scheduled for 2013. The target market is for high speed home routers.

In the 60 GHz band, 802.11 ad uses simpler modulation but supports four 2.16 GHz channels. Peak data rates are 7 gbps. The systems are intended as a wireless replacement for next generation HDMI, SDIO and USB interfaces. There is a competing standard for 60 GHz delivering uncompressed HD video. It is however not compatible with existing IEEE 802.11 standards.

Authentication and roaming

802.11 ac and ad are designed to be used for high data rate private network home and office environments but there is no reason why public network access could not be included provided suitable authentication and roaming protocols are in place.

A start was made in 3GPP Release 8 which defined how user equipment connects to an evolved packet core using a non 3GPP access point. Release 10 developed this to support user equipment that connects **simultaneously** to 3GPP and non 3GPP access points. This in turn is part of the SAE (system architecture evolution) process which is part of the HETNET (**heterogeneous network**) proposition that some but not all infrastructure vendors are promoting.

Authentication and roaming is being addressed by the snappily titled Extensible Authentication Protocol Method for GSM Subscriber Identity Module (EAP-SIM) which avoids the need for a pre-established password between a client and AAA server. The equally prosaic 3GPP Access Network Discovery and Selection Function (ANDSF) is supposed to look after roaming between LTE/HSPA/GSM networks and HotSpot2 public access gateways. At least theoretically this should work with IEEE 802.u protocols which address access point discovery. This supports roaming consortiums that are not necessarily related to mobile network operators.

Operator cash constraints and delivery cost provides additional motivation

At this point you might decide that this is too technically and commercially complicated to ever work. The shift from voice to data has however genuinely changed things particularly for operators who are cash constrained.

Historically the cellular industry has been cash generative and profitable. For fiscal engineers this means that it has been relatively easy to borrow money. As that is what they are good at that is what they do. This has meant that some operators are highly geared. Our colleagues at The Mobile World highlight a Tier 1 operator with 64 billion euros of debt equivalent to six times present annual EBITDA. This has coincided with infrastructure vendor consolidation which has reduced the scope for vendor backed network financing.

At the same time operators are expected to bid for new spectrum irrespective of whether they are able to afford the infrastructure required while at the same time upgrading existing networks to deliver additional capacity and coverage and meet future service obligations.

The UK as an example is just about to launch a 4G auction following in the footsteps of Germany by licensing and auctioning Band 20 (LTE800). This involves raising money for good causes not necessarily related to the telecommunications industry. '100,000 affordable homes from £3 billion 4G windfall' was a headline from one of the UK party political conferences in October. The LTE 1800 network launch this week in the UK is being aggressively marketed on the basis of ultra-fast downloads and an interactive and streamed multimedia experience.

The assumption is that operators need additional licensed spectrum in order to meet these present and future user expectations. In practice there may be lower cost ways in which this can be achieved at least in terms of additional capacity and user throughput.

Some operators and vendors consider LTE can provide wide area and local area connectivity with higher data rates delivered by using higher order modulation, channel bonding, high order MIMO and multi user MIMO techniques. These requirements are captured in 3GPP Release 10, 11 and 12 but are already implemented in 802.11 ac and ad.

Other operators and some infrastructure vendors perceive LTE/WiFi integration as a combined approach which will yield improved ROI though a combination of an improved user experience delivered at lower

operational and capital cost. In practice neither option needs to be mutually exclusive. Wi Fi has global scale and provides access to 9 GHz of low cost or no cost spectrum. LTE delivers wide area performance that Wi Fi cannot emulate.

Time to try Tri Fi Wi Fi?

Many operators remain cautious about Wi Fi. First generation Hot Spots failed to reduce operational cost, failed to reduce capital cost and failed to realize additional value.

This was based on the assumption that it would be possible to make money out of other people's real estate which involved adding value to that real estate. This proved to be a false hope with potential benefits outweighed by commercial negotiation cost and conflicting interest.

As a network operator it makes more sense to look at how next generation Wi Fi can add value to your own rather than someone else's real estate.

There is no technical or commercial reason why an e node B cannot include an 802.11 ac and ad transceiver. For a cost of a few dollars in a handset and a few tens of dollars in a base station the operator gets to offer greater than a gigabit data rates on 9 GHz of low cost or no cost spectrum.

Putting some of the backhaul on to 802.11 ac and ad bearers might be a neat idea as well – the 802.11 ac and ad beam forming function developed from 802.11 n makes point to point and point to multipoint easy.

So dust of that 4 G business model and add Wi Fi back in to the mix. This time it might finally work.

Ends

Additional resources

An Agilent webinar run on the 25th October provides a comprehensive survey of LTE work items.

Follow the link to view the slide deck.

[3GPP LTE Standards Update: Release 11, 12 and Beyond](#)

Wi Fi/LTE integration is one of the topics addressed in RTT's latest book '[Making Telecoms Work- from technical innovation to commercial success](#)' available from the [RTT book shop](#).

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Contact RTT

[RTT](#), the Jane Zweig Group and [The Mobile World](#) are presently working on a number of research and forecasting projects in the mobile broadband, two way radio, satellite and broadcasting industry. If you would like more information on this work then please contact

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