RTT TECHNOLOGY TOPIC
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Taller Towers

In our August Technology Topic we explored the delivery economics of DVB T and ATSC and TV/LTE coexistence in the UHF band.

Terrestrial broadcast radio and TV continues to be a formidably efficient mechanism for delivering one way content to large geographic areas.

The delivery efficiency is achieved through a combination of dominant towers and repeater and relay infill sites.

Being British we are busy listing some of these towers as historic monuments.

http://consumers.ofcom.org.uk/tv-radio/television/how-tv-transmitters-transformed-and-towered-over-the-uk/

The Russians are doing the same.

http://www.dezeen.com/2014/08/19/moscow-shukhov-tower-saved-from-demolition/

Within the LTE mobile broadband community significant attention is being given to finding ways to reduce delivery cost. It is relatively easy to produce high EBITDA returns from high ARPU markets, the US being a significant example. It is harder to produce high EBITDA returns from low ARPU markets particularly in countries with low population density.

Even relatively densely populated countries like the UK are struggling to improve data reach and would sooner avoid massive network upgrades based on gross densification.

The use of dominant macro sites combined with repeaters and relays is part of the solution.

Repeaters and to a lesser extent relays are trickier to implement in a two way network (transmitting and receiving in two directions).

In this month's technology topic we discuss the challenges and opportunities of realising these network topologies in LTE multi-band multi-channel networks, the related opportunities for LTE/TV integration and the economic and technical case for taller towers.

Read on

LTE repeaters and relays are presently being standardised as part of 3GPP Release 10 through 12.

http://www.etsi.org/deliver/etsi_ts/125100_125199/125106/10.02.00_60/ts_125106v100200p.pdf

Repeaters receive, amplify and retransmit and do not demodulate /remodulate the channel.

Low cost HSPA repeaters are already available.

They include devices that use an SD card loaded with an operator specific Absolute Radio Frequency Channel Number (UARFCN).

This is used to programme the synthesiser and phase lock loop in the transceiver to mix down the 'wanted' 5 MHz channel from the designated pass band for example a 5 MHz channel within the 35 by 35 MHz duplex pass band of Band 8.

Relays, specifically Advanced Relays, decode before retransmitting. HSPA and LTE relays use an in band HSPA or LTE in band link to a host e NB (macro base station).

Repeaters apply front end filtering to the pass band and in a direct conversion transceiver translate the wanted modulated channel down to baseband.

The signal to noise of the wanted channel will be directly related to the carrier to noise ratio but will also be affected by the quality of the down conversion process so additional noise will be introduced by the mixing process and LO injection.

Some window mounted domestic repeaters then remix the signal on to a 5 GHz link to communicate with a second indoor unit which then remixes back to baseband.

Repeaters lift the power of the carrier but do not improve the signal to noise ratio. They therefore depend on the noise floor in the pass band being low (as a ratio to the low power carrier). This is often the case in deep rural areas so repeaters can be effective in providing reception a long way from a mast. They are popular and effective in Australia for example.

However when the signal to noise is marginal a repeater will often not help and may make things worse.

A relay does everything that a repeater does but demodulates and re modulates before retransmitting. The demodulator should therefore have a clean-up effect on the signal.

Existing HSPA Repeaters for the domestic market typically support four bands, for example Band 5 (850) and Band 2 (PCS 1900) for the US and Band 8 (900 MHz) and Band 1 (1.9/2.1 GHz) for Europe.

They are however single channel devices so for example will support a single 5 by 5 MHz channel within the Band 1 or Band 8 pass band.

This of course does not matter given that the devices are operator specific but does matter if multiple users want to access multiple operators over the same device.

The commercial reason for this is that the operator will usually have subsidised the device so will not want it used to support other operators.

The technical reason is that single channel support means that the uplink and downlink will be separated by the duplex spacing, for example 45 MHz at 900 MHz whereas multi-channel support means that one user might end up being at the top end of the lower duplex and another user at the bottom end of the upper duplex which means that they will be separated by the duplex gap, for example 10 MHz at 900 MHz

Filtering therefore becomes more difficult.

Similar constraints apply to femtocells.

This is a problem distinct to networks deployed into multichannel pass bands, for example Band 5 or 8 where the channels could be a mix of GSM (200 KHz) and 5 MHz HSPA/LTE.

The duplex filtering and channel filtering must take into account worse case conditions including the channel filtering needed at the edge (or rather four edges) of the duplex pass band.

Repeater and relay front end design is therefore a non-trivial task and operators are understandably keen to ensure that devices comfortably meet conformance standards in order to avoid or at least minimize potential interference problems.

Managing a device through an SD card allows an operator to remotely disenable the repeater which partially helps to resolve this concern.

The problem is easier when the channel bandwidth and pass band are the same. For example Band 17 (AT and T LTE 700 MHz band) and Band 13 (Verizon LTE 700 MHz) are both deployed as single channel 10 by 10 MHz LTE within a 10 by 10 MHz LTE pass band.

These deployments are however relatively unusual and most new LTE bandwidth will be multi-channel, for example the 45 by 45 MHz pass band of APT (a) and (b) for Asia, Latin America and Africa.

This band will be realised using two overlapping 30 MHz bandwidth acoustic filters in order to realise sufficient roll off at the band edges.

This highlights the present reality that FDD band planning remains constrained by acoustic filter bandwidth limitations and the limited Q available from LC filters (for channel to channel selectivity). High Q tuneable front ends would make repeaters and relays more effective and open up opportunities to realise integrated DVB T2/LTE devices.

Even if this proved technically and commercially impractical, the coupling of LTE repeaters and relays to dominant macro sites on taller towers could transform mobile broadband delivery economics. Sparse networks are inherently more efficient than dense networks – lower capital costs, lower running costs, less signalling overhead, less backhaul – they just need to be designed in a different way.

This includes locating dominant sites on new high rise buildings. An LTE macro site on the top of **the Shard** in London with beam forming antennas would provide enhanced coverage to inner London, outer London and line of sight visibility to most of rural Cambridge.

Sometimes, big is better.

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http://www.rttonline.com/tt/TT1998_008.pdf

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00 44 208 744 3163