RTT TECHNOLOGY TOPIC
December 2014

Ultra Sparse Networks

Our October technology topic **Taller Towers** highlighted the role of dominant sites in broadcasting and the presently under developed role of dominant sites in LTE delivery.

The generally held assumption is that it is technically and commercially efficient to deliver LTE capacity through a process of network densification, ever smaller cells. Small cell topologies however have a number of drawbacks including site acquisition costs, management costs, backhaul costs, handover and signalling overhead and variable routing latency.

Small cell networks can be described as **a distributed cost model** delivering capacity at a cost which **makes capacity gain increasingly expensive over time.**

In 3 G networks there are technical reasons why small cell topologies have been a preferable option.

The decorrelation techniques used in CDMA and HSPA required received symbol energy to be relatively equal, a power dependent time domain process. This is easier to achieve in smaller cells.

In LTE, this discrimination process is achieved by having orthogonal (OFDM and/or SCFDMA) signals which are decorrelated in the frequency and time domain. The process can tolerate relatively large differences in received symbol energy.

The air interface can therefore inherently support a larger dynamic range without incurring excessive power control overheads. As dynamic range is a proxy for capacity this means that LTE can deliver a capacity gain over and above CDMA based systems.

However it also means that there are more opportunities to deliver capacity gain from larger cell topologies.

This is **a concentrated cost model** which delivers capacity at a cost which **makes capacity gain less expensive over time.**

Concentrated cost models are therefore of particular interest for operators who are finding that EBITDA is negatively coupled to data throughput growth. The more you deliver the less money you make.

Reversing this trend is a precondition for realising economically sustainable 4G and 5G deployment.

In this month's technology topic we study Super Macro Site Ultra Sparse Networks as a concentrated cost solution for the mobile broadband community.

Read on

Terrestrial Examples of Ultra Sparse Networks

We have already referenced terrestrial TV in the UHF band as one of the most globally successful (concentrated cost) economic delivery models.
http://www.rttonline.com/tt/TT2014_009.pdf

However in practice the delivery efficiency of terrestrial TV is eclipsed by long wave and medium wave and short wave radio.

It remains incontrovertible that a single radio site albeit a site covering several hundred acres and transmitting at hundreds or sometimes thousands of kilowatts can cover the world.

http://www.mediumwaveradio.com/longwave.php

http://www.mediumwaveradio.com/longwave.phphttp://www.mediumwaveradio.com/bbc_national.php

Our interest is to see whether there is an evolving middle model in which Ultra Sparse Networks supported by Super Macro Sites (hundreds of watts rather than thousands of Watts) could be a technically and commercially efficient option for mobile broadband networks.

Extra-terrestrial examples of Ultra Sparse Networks

There are plenty of examples of Ultra Sparse Networks other than TV and radio broadcasting.

GPS for example provides global coverage from 24 Medium Earth Orbit satellites
http://www8.garmin.com/aboutGPS/

Iridium provides global coverage from 66 Low Earth orbit satellites

https://www.iridium.com/About/IridiumNEXT.aspx

Europa SAT provides very adequate 'middle earth' 48th to 48th parallel coverage and high data rate delivery from three geostationary KA band satellites.

http://www.europasat.com/why-choose-europasat/satellite-broadband-versus-mobile-cellular-data-services-3g-4g/

And Inmarsat has its first Inmarsat 5 KA band satellite on orbit with two more to follow next year providing 50 kbps connectivity to Europe, The Middle East, Africa and Asia. The integration with existing Inmarsat L band and S band platforms should be a compulsory case study for the 5G research community.
http://www.inmarsat.com/about-us/our-satellites/

Two way radio examples of Ultra Sparse Networks

Tetrapol continues to deliver specialist radio provision to millions of public safety users in Europe, Latin America, the US, Middle East and Asia (Malaysia and Singapore) using high power (three watt) mobiles and hill mounted high power radio sites, typically three hundred or 500 watts.

http://www.tetrapol.com/community/references/

http://www.tetrawatch.net/national/tetrapolprofiles.php

Application of space sector technology to Ultra Sparse Networks using terrestrial super macro sites

Tetrapol is however a narrow band radio system providing coverage but limited data throughput.

Mobile broadband requires coverage **and** capacity (data reach **and** data throughput).

A number of technology developments make it possible to realising capacity gain from terrestrial super macro sites.

This includes space sector technologies such as low noise receiver front ends and smart antenna arrays which deliver a combination of link budget gain and channel selectivity coupled to super stable high accuracy references to provide time domain performance gain.

These gains can be augmented by applying interference cancellation techniques. Last month's technology topic (Interference Cancellation in the RF and Optical Domain) discussed present developments in analogue and digital cancellation within the handset. These techniques are easier to apply in a base station with an energy budget of several hundred watts.

http://www.rttonline.com/tt/TT2014_011.pdf

Other techniques such as high Q low loss filtering using superconductor filters also become more applicable.

http://www.suptech.com/lte_at_700.php

These techniques together could deliver a link budget gain of the order of 50 dB which could be over and above the dynamic range of present LTE networks and could therefore be translated into coverage and capacity gain.

Additional EIRP is achieved from height gain with additional capacity and coverage realised from reduced signalling overhead, using beam forming rather than handover to manage uplink and downlink power allocation and interference.

Reduced backhaul reduces operational costs and provides tighter control of end to end latency overheads eliminating the latency uncertainty implied by routing path delay in IP backhaul.

What is stopping the adoption of Super Macro Site Ultra Sparse Networks?

You might wonder why given the present pressure on EBITDA there has been so little attention paid to the Super Macro Site Ultra Sparse network option.

One answer is that vendors are happy with the volume gains achievable from network densification and the associated service revenues linked to managing and optimising these increasingly complex dense network topologies.

However if low and reducing EBITDA is the outcome then no one wins.

This may be a particularly appropriate time to revisit the basic assumptions on which present mobile broadband investment plans are based.

As we said at the end of our piece on Taller Towers, Big is often better. Biggest is sometimes best.

CW TEC Technology Conference in London March 24 2015
The potential translation of space sector technologies to terrestrial super macro sites is one of the subjects discussed in the CW Technology Conference in London next March with presentations from Avanti highlighting the remarkable innovations being implemented in the satellite domain and parallel presentations from EE, Qualcomm, the BBC, BskyB, Radio Design, u-blox, CSR and Samsung.

Spaces on this event are very limited so it's useful to book now rather than later

http://www.cambridgewireless.co.uk/cwtec/
http://www.cambridgewireless.co.uk/cwtec/programme/

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

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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 **geoff@rttonline.com**

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