RTT TECHNOLOGY TOPIC
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LTE user equipment, network efficiency and value

On the 26th and 27th July the CEO of Ofcom, the UK regulator, briefed journalists on the disparity between headline peak data rates and actual peak data rates in copper and cable fixed access networks.

The example given was an ‘up to 20 Mbps service’ where 65% of users had less than 8 Mbps, 32% between 8 and 14 Mbps and ‘only’ 2% had 14 to 20 Mbps.

The suggestion was that there should be an agreement within the industry on a Typical Speed Rating similar to the APR used in banking or MPG (miles per gallon) or grammes of CO2 per 100 km used in the automotive industry.

The widening gap between rural and urban connectivity was also discussed.

If nothing else this stirred up spirited on line comment about broadband connectivity being a ‘scandalous rip off’ or ‘extraordinarily good value’ and all points in between.

The reality as we know is that this is a contended service which more often than not in developed countries has to be delivered over a legacy network that includes copper and occasionally aluminium which has been there an admirably long time. Why replace a physical asset when it works for most people most of the time.

We could of course have fibre piped in directly to our homes and offices and some of us do but some of us also have ‘old fashioned’ telephones that pull DC power from the copper twisted pair. In our most recent power cut, timed to coincide with England’s exit from the world cup, this was the only fixed communications device to stay alive.

And the reality of the urban/rural divide is, well just that, a reality. The economics of rural broadband connectivity are puzzling at best when possibly the only beneficiary of a network upgrade is your maiden aunt Jean in Rosyth.

Mobile broadband is promoted as the magic solution to this particular conundrum. This is of course misleading. Fixed wireless broadband with a roof mounted high gain antenna might be the answer to your maiden aunt’s prayer but mobile broadband is something rather different.

The mobile bit of mobile broadband implicitly assumes that the user is not continuously tethered to a mains power socket. If this is a necessary pre condition of broadband connectivity then this might at a pinch be described as portable broadband but is definitely not mobile broadband in any sense that users would be likely to understand.

Our expectations of connected mobility are very much determined by past experience. The reason that we bought GSM phones in 1993, 1994, 1995, 1996 and 1997 was that every year the phone we bought or were given by our service provider worked better than the phone it replaced.

Voice quality improved, coverage improved, blocked calls and dropped calls reduced and the phones delivered an apparently miraculous talk time and stand by time from a remarkably small battery. The devices were also smaller, lighter and cheaper. A year on year cost reduction of at least 15% became both an expectation and realisable objective.

The performance gain was due to a combination of factors. Network density increased and network build outs started to be dimensioned for capacity rather than coverage which meant that phones generally were operating at a fraction of their maximum transmit power. Base station sensitivity and selectivity also improved. Touch screen high resolution colour displays had not been invented so that helped as well.

The other factor that helped deliver a year on year improvement in the user experience was an improvement in handset RF performance, of the order of 1dB or so per year. This was a function of market volume and engineering effort that was focussed **equally** on cost and performance engineering. As market volume increased it was possible to tighten RF component production tolerances and still achieve good manufacturing yield. Voice codecs improved as well.

Ten years on and tracking 3G user equipment performance between 2002 and 2007 it is reasonable to argue that although headline peak data rates have improved, other metrics such as user data duty cycle have either stayed the same or worsened on a year to year basis.

Partly this is due to a shift to user equipment with high resolution colour displays, partly this is due to the update and signalling load that smart phones impose on the network but partly it is also due to a lack of significant improvement in user equipment RF and baseband efficiency. A need to support additional bands has further compromised RF performance.

This can be relatively easily explained but not necessarily excused. An opportunistic spectral auction system designed to exploit short term investment sentiment resulted in over priced unharmonised spectrum which in turn imposed severe cost pressures on all of the industry supply chain.

One result of this has been an inevitable and understandable concentration on user equipment cost engineering that has included aggressive cost engineering of the RF front end and a reluctance to implement advanced receiver base band algorithmic innovation on the basis that additional clock cycles and memory add cost.

Note that an improved front end delivers better sensitivity and selectivity, an improved back end delivers performance gains in other areas, for example on channel interference cancellation. Both are needed and are complementary to one another.

The assumption has been that as long as user equipment just about meets the conformance standard then that's good enough. Very few operators do comparative testing now as the number of products that would need to be tested and their short life span would make this uneconomic. Vendors self certify so there is little competitive advantage to be realised in adding cost to improve performance.

Mediocre user equipment performance tends not to be noticed in new network roll outs where the noise floors are initially relatively low. Additionally established networks dimensioned to deliver capacity generally have plenty of link budget to accommodate relatively deaf user devices though this will not be generally true in future efficiently loaded mobile broadband networks.

You could argue that mediocre is too harsh a term for a device that meets a conformance specification.

However conformance specifications are set so that user devices can be manufactured and shipped from day one of a network going live. (This November for LTE in the US market).

Operators have a legitimate right to expect that user equipment performance should improve with volume and technology maturation on a year by year basis at least up to the point where processing gain and noise performance are close to theoretical limits but this will only happen if there is sufficient incentive to make it happen.

This can be either negative or positive. A negative though effective incentive would be to reintroduce more comprehensive comparative testing as part of the operator range and vendor selection process. In theory the vendor with the largest market volume should be in the best position to cost and performance optimize user equipment so the largest vendor by volume should theoretically have a competitive advantage. If this is not the case it would suggest that that vendor is not efficiently leveraging volume advantage into performance gain.

The positive incentive from a user equipment vendor perspective would be for operators to accept a small increase in the RF and base band BOM.

This would only make financial sense if it could be shown that a small increase in the RF and baseband BOM could be shown to achieve a relatively large gain in user equipment efficiency which in turn could be translated into a net gain in terms of network efficiency and value. Such a shift would also need to make sense to all parts of the industry value chain.

Superficially this seems unlikely. If a dollar was added to the cost of every phone manufactured then the added cost would amount to one billion dollars per year which amounts to a substantial amount of network hardware and software investment.

The decoupling of user equipment and infrastructure development, manufacturing and sales at vendor level means that additional margin in user equipment would not balance decreased revenues in infrastructure hardware and software shipments.

However at this point it is worth considering the equation from the self interest perspective of each part of the industry supply chain

Stating with the end user it is fair to say that any or all of us buy new devices for a combination of emotional and practical reasons but justify the purchase on the basis that the product works better on every metric that matters when compared with the product being replaced.

In mobile broadband it could be argued that the user experience is dominated by how fast applications run and how long the device survives between recharge cycles.

A counter argument is that users seem willing to buy devices that have at best variable connectivity but this cannot be a sustainable basis for building customer loyalty and satisfaction.

A user device with poor and or inconsistent connectivity that is the consequence of poor sensitivity and selectivity in the user device will load a network with unnecessary coding and signal overhead. This means that the user is more expensive to support both directly in terms of radio and power bandwidth consumed and indirectly by degrading the service of all other users in the cell – an opportunity cost. These devices will be particularly problematic at the edge of cell but a nuisance wherever they are. The user's battery will also go flat faster.

If cell capacity is constrained by these devices then session set up failure rates will increase and session completion rates will decrease to the point where product return costs and churn costs become significant. A user will naturally blame a network for poor performance rather than the device which he/she has been responsible for choosing on the basis of aesthetic appeal and assumed functional efficiency.

Turning this in to a positive narrative, a small increase in RF and baseband performance can be shown to realise a large increase in network scheduling efficiency.

Scheduling algorithms are network vendor specific and are an important competitive differentiator. Their job is to improve radio bandwidth utilisation on a bit per hertz basis.

However a well executed scheduling algorithm should and can also deliver a power budget gain at user level measured in terms of watt hours per megabyte or joules per bit. It therefore adds user value. It also saves energy cost at the node B which is an added benefit.

For the sake of simplicity scheduling gain can be divided in to micro scheduling gain and macro scheduling gain.

Micro scheduling gain is achieved by scheduling resource blocks on the basis of the quality of available bandwidth at any time across a group of users set against the quality of service required by each served user.

Improving user equipment RF and baseband performance can be shown to be directly linked to the amount of scheduling gain that can be achieved. Intriguingly it is probably a non linear relationship

Macro scheduling gain is our old friend the handover algorithm suitably updated and given a fresh new name

Macro scheduling gain takes over at the point where micro scheduling stops working. This is classically in an edge of cell situation where there is a direct conflict between what the applications in the user device are asking for and what the network can afford to deliver.

A handover within the network is a partial solution but consider that in most markets even with operator consolidation there are many geographic areas where operator base stations are not co sited.

In a mobile broadband network there will be many instances where the direct and indirect (opportunity) cost of serving an edge of cell user is greater than the session value realised from that user.

If the user is close to another operator’s cell site the cost of delivery will be lower if the session is supported from that cell and the saving in opportunity cost will be greater than any reduction in session margin (the cost of sharing the session value with the competitive network.) Operator EBITDA for both operators will be improved, the user’s power drain will be lower and his/her applications will run faster. User value as a consequence will be greater.

However this implies a need for band flexibility. The problem is that every new band added in to user equipment degrades the RF performance of the device.

There is therefore a need to both improve RF and baseband performance on a year on year basis and support extended band flexibility.

This is challenging but not impossible and can be shown to be fiscally worthwhile for all parts of the industry supply chain. The cost of supporting extended multi band capability for example can be at least partially off set by inventory management savings.

Network loading in cellular and mobile broadband networks is presently increasing at a faster rate than network income. The effect of this can be off set by improving network efficiency and or increasing income on a subscriber per bit delivered basis.

The efficiency of the user's equipment is a key part of this gain equation.

A new study from RTT
LTE User Equipment RF and Baseband performance, network efficiency and value
A collaborative mobile broadband industry technical and commercial study
Not entirely coincidentally this topic is covered in substantial detail in a new study authored by RTT and sponsored by **Peregrine Semi Conductor** and **Ethertronics**. Research study partners include **IWPC** and the **National MicroElectronics Institute**.

The market, business and economic modelling in the study has been done in association with **The Mobile World** with technical inputs from over thirty vendors including RF component suppliers, baseband vendors, infrastructure vendors and the operator and user community.

The study analyses the impact of LTE user equipment performance on user value and operator EBITDA and the related fiscal benefits that accrue to LTE infrastructure hardware and software vendors, LTE user equipment developers and manufacturers and their supply chain including component vendors and algorithmic design teams.

As far as we know it is the first time these relationships have been modelled in this level of detail at least in the public domain.

The study will be available to download in early September but if you would like to contribute or discuss the study outputs prior to publication please contact **geoff@rttonline.com**

Additional sponsorship would also be welcome and would support additional modelling and a broader distribution of the study to interested parties.

The study validates that a move to LTE if coupled with investment in band flexibility and year on year user equipment efficiency improvement yields sufficient radio access network efficiency gain and incremental user value to provide an acceptable return on present and future spectral and network investment.

Makingtelecomswork.com
An additional level of detail on the study and related topics can be accessed via the **Resources section** of our linked web site **www.makingtelecomswork.com**

www.makingtelecomswork.com provides a cost and time efficient way in which telecommunication engineers, product managers and policy makers can access **technical information and advice not readily available elsewhere in the public domain.**

The web site also provides information on RTT workshops, **Making Telecoms Work Europe**, **Making Telecoms Work Asia** and **Making Telecoms Work in the US.**

The workshops demonstrate how engineering issues can be practically resolved and how performance gains and cost savings can be achieved.

European work shops are held at the Science Museum in Kensington West London.
Information on the next workshop is available here.

There are a number of sponsorship opportunities available linked to the new web site and related Science Museum telecom industry educational initiatives.

If you would like more information on these opportunities please e-mail **geoff@rttonline.com** or phone **00 44 208 744 3163**

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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 cellular, two way radio, satellite and broadcasting industry.

If you would like more information on this work then please contact
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