RTT TECHNOLOGY TOPIC
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Mobile Broadband

Quality and experience expectations - the disappointed consumer

A number of **class action litigation suits** have been initiated recently against Apple Inc and AT&T Mobility

The claims allege that I Phones are not well made - **a disappointed quality expectation**, and fail to work as advertised on the AT&T network - **a disappointed experience expectation**.

Manufacturing defects it they exist, are relatively easily addressed though may have a cost implication.

Network performance is more complex and highlights the growing gap between consumer expectations and real life wireless network economics. The issue is that data rates at the cell edge can be disappointing as can data rates within a building.

This is not a challenge specific to AT&T but is generic within the wireless industry.

In this month's technology topic we revisit some of the technical challenges of delivering mobile broadband.

There are a combination of actions that can be taken to improve within building and edge of cell data rates but all involve ongoing R & D expenditure and additional network and or handset cost and complexity.

This implies technical and commercial risk which can be hard to justify in an economic environment where risk is highly priced.

The problem of cell geometry - the frustrated operator

The root of the wireless problem is that users are never quite where you want them when you want them.

In an ideal world, high data rate users would be close to a base station. In practice, users will be distributed across a cell and a significant percentage will be indoors where penetration loss can be of the order of 20 or 30 dB particularly at higher frequencies.

Users at the cell edge will be transmitting at maximum power and will therefore be casing interference into the adjacent cell - a problematic mix of capacity and coverage constraints.

Increasing cell density as one solution

One solution is to increase the number of cells and or to add operator owned pico cells or WiFi Hot Spots but these add cost to the network that may or may not be recovered from higher data throughput revenues.

Another solution is to encourage the uptake of user owned femto cells. However this only makes sense if or when femtocells work as well and cost the same or less as existing consumer and SME WiFi router hardware.

Better handset sensitivity and selectivity as another solution
An alternative is to improve the sensitivity and selectivity of cellular handsets and user devices. Better sensitivity translates into more data throughput in a noise limited environment. Better selectivity translates into more data throughput in an interference limited environment.

Sensitivity can be improved by using more expensively specified RF components in the front end of the phone and through optimised RF design.

However mechanical design constraints can easily 'throw away' these performance gains. Antennas are one example. User devices have become smaller while also needing to support a wider range of functions. This results in fierce competition for internal real estate. Adding quality audio to a handset for example may require cavity backed speakers at the top of the phone, exactly where antennas should be placed.

A need to support increasing numbers of bands has further compromised antenna performance. Adding additional switch paths and or multiplexers have introduced extra insertion loss. Alternative wide band transceiver architectures have to date proved hard to realise.

Selectivity can be improved by implementing interference cancellation techniques in the handset either based on diversity reception (See the Arraycomm and Icera web sites for background on this) or single antenna interference cancellation. (See the Advanced Receiver Technologies web site for background on this).

These techniques can significantly increase downlink data rates at the edge of a cell by cancelling out unwanted signal energy but there is a cost in terms of baseband processing overhead which translates into additional DC power drain.

Improvements in transmission efficiency may help. (See the Nujira web site for some background on this) Reducing the uplink power budget releases additional power for additional receive signal processing but overall the competition for power in a handset is increasing rather than decreasing over time.

Larger form factor products for example notebook computers have less severe form factor constraints but introduce other challenges including processor and display driver noise. Always on broadband connectivity may also result in unacceptably short recharge duty cycles so although the overall power envelope of the device is greater, of the order of 20 watts or more, the RF power budget and radio modem baseband overheads remain constrained.

RAN sharing as another solution

All of the above are symptoms of a link budget which is acceptable for voice but inadequate for mobile broadband data.

An alternative is for operators to share radio access networks - making multi network coverage available to users in their local market.

Technically this is attractive in that the chances of one of five operators having a base station that is near to you at any given time is higher than if only one operator's network is available. The cell geometry when averaged over all operators improves. This increases cell and per user data throughput. User TX power will be lower. This reduces the overall noise floor and improves user data duty cycles.

To an extent this happens when roaming when more than one network is available and connection can be made on a best connect basis. The practical benefits of national roaming are already being realised in machine to machine network solutions and it would be technically beneficial to see this more broadly applied.

Commercial issues - regulatory encouragement of RAN sharing - short term loss, long term gain
However operators are reluctant to share resources that are the product of thousands of man hours of site acquisition and millions of dollars of infrastructure investment.

Infrastructure vendors similarly are wary of the effect that shared networks may have on future business volume.

The recent Digital Britain Report (Page 13) promotes RAN sharing as a mechanism for reducing the cost and improving the efficiency of mobile broadband access. Importantly it would improve the consistency of the user experience.

However there is an implied need for a level of trust and cooperation between operators which is hard to foster in a business environment where operator specific short term market advantage has to be given a higher priority than the longer term efficiency and profitability of the industry in general.

The I phone - short term gain, long term cost
This brings us back to the I Phone

The I Phone has delivered short term business advantage to the operators who secured initial distribution rights.

Short term gains however have a habit of incurring longer term costs that are not always fully factored in to the initial decision making and commercial negotiation process.

Short term costs with long term gains - a better model?
Intuitively it is better to focus on investment that realises a long term gain from a short term loss but this is dependent on investors and financial institutions recognising that long term gains may be realised over decades rather than days.

This is not just a network operator issue but applies to all parts of the industry value

chain including component vendors and the user device design and test community.

RF MEMS are a present example. RF MEMS and other micro scale devices are beginning to be incorporated into cellular handset designs to realise adaptive matching, filter, oscillator and switch functions. Fbar filters, a form of micro scale device, have delivered significant RF performance gains though relatively small cost premiums have been frustratingly hard to justify, particularly in lower cost handsets.

The cost premiums are unsurprising given that these innovations are the product of research started the best part of thirty years ago including fundamental work on material properties, device packaging and mechanical aging effects.

Advanced baseband processing techniques are also based on years of academic and industrial research which represent a cost that some one has to finance in order for the work to be sustainable.

Arguably it would be sensible today to be increasing rather than decreasing R & D spending. However if market volumes decrease, R & D spend as a percentage of turnover will escalate to a point which will be incompatible with present investment sentiment.

This suggests that companies undertaking fundamental research and associated manufacturing investment may need to be insulated from short term market forces.

The proposed move to indefinite licenses (Page 32 of The Digital Britain report) is recognition that investment returns for operators cannot be achieved within traditional twenty year license periods.

This is unsurprising. Building a wireless network is directly analogous to building roads, railways, water, or investing in utility infrastructure - returns can be amortised over the physical lifetime of the investment and as such are intrinsically long term.

However similar time scales apply to component and handset and test equipment vendors with the additional complication that research and or manufacturing assets are less tangible than tarmac and steel or a network operator's mix of copper and concrete.

Financial expectations - the disappointed banker
The result is a disconnect between financial expectation and present market reality.

Merger and acquisition is a possible answer but the component and handset and test equipment industry is arguably now over consolidated and any possible scale efficiency gains have already been made.

The recognition by governments and regulatory authorities that operators require security of tenure in order to sustain investment is welcome but only solves half the problem.

Other parts of the industry need similar levels of investment security and or incentive.

The alternative is to carry on as we are. There are two problems with this.

The gap between consumer expectations and what we can actually deliver technically and commercially will increase rather than decrease over time.

The gap between the expectations of the financial community and what we can actually deliver in terms of short term returns will increase rather than decrease over time.

This is not a problem that can necessarily be efficiently resolved by market forces.

Infineon's request to the German government for financial support prompted by the expiration of present loans and bonds is just one example of this present tension.

Government intervention may be a necessary short term option but is unlikely to provide an effective long term solution. The management time involved in meeting government obligations may exceed the benefits accrued.

This implies a need for a more comprehensive review of present financial investment process and a more fundamental rethinking of investment policy for industries that deliver strategically important but intrinsically long term returns.

Standards and spectral allocation policy- adding to the cost and risk of mobile broadband provision

In parallel we have to re examine some of the complexities that have been introduced in to our industry which in present circumstances may prove to be unaffordable.

For example it may be that some of the standards that we are working to realise may be over complex and may introduce additional, unnecessary and insupportable industrial cost.

Over complex standards are not only difficult to design to they are also difficult to test. You might expect test vendors to welcome this complexity but in practice the time and cost needed to produce test scripts is in itself becoming unsustainable.

Present spectral allocation policy adds to these costs. All together they make mobile broadband provision less fiscally viable.

Specifically, the combination of over complex incompatible radio standards and twenty five cellular radio bands suggest an untenable dilution of available R&D resource.

R&D opportunity cost and future industry value

This is especially true if we take into account that R & D is an area where opportunity cost substantially exceeds actual expenditure.

Poorly directed poorly targeted engineering effort may well translate into millions of dollars of lost revenue and lost profit opportunity.

A few hundred hours of well directed well targeted engineering effort may well

translate into millions of dollars of future industry value - a positive note to end on.

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RTT, the Shosteck 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.

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