RTT TECHNOLOGY TOPIC
January 2001

3 G Costs

Our last two **HOT TOPICS** have addressed general design issues relevant to wireless performance optimisation (including 3G design optimisation).

This month's **HOT TOPIC** explains some of the variable costs implicit in delivering 'complex content'.

Complex content can be defined as a mix of voice/audio streaming, image, video and application streaming. The delivery of complex content in a conversational or interactive session requires careful control of end to end latency and delay variability (often described as jitter). The degree of control needed is defined in terms of 'quality of service'.

The quality of service needed will be defined by the content itself (**not** the subscriber).

The content is 'declarative', i.e. it 'declares' its bandwidth quantity **and** quality requirements.

In our October HOT TOPIC (Wireless Web), we pointed out that user performance expectations increase over time - frame rate, resolution, colour depth, contrast ratio, pixel density, (or for application streaming, application performance).

Complex content becomes more complex over time.

As content becomes more complex, we need ever closer control of end to end connectivity, (latency and jitter control).

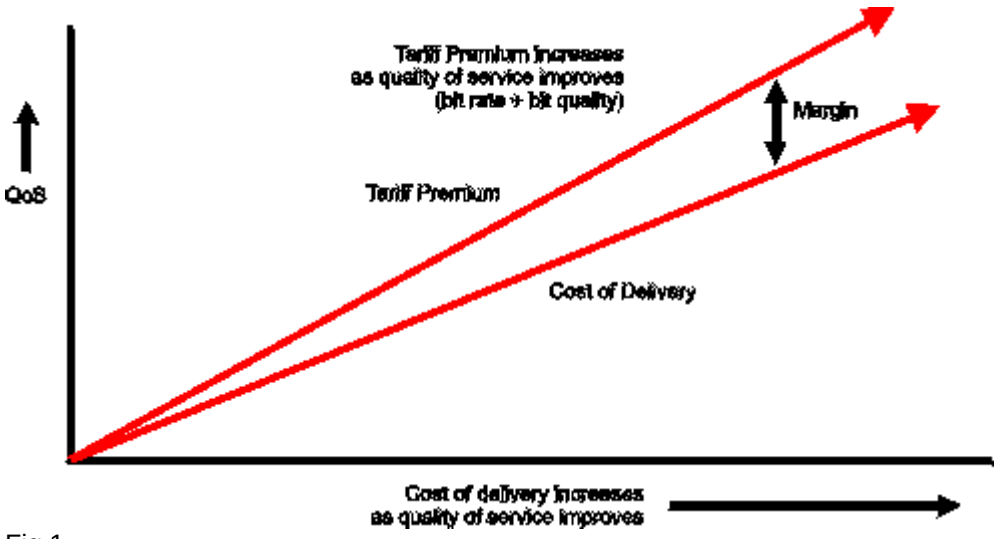

Fig 1

Part of the assumption behind the 2G to 3G transition is that the cost of delivery (per megabyte delivered) will reduce as a consequence of moving from circuit to packet switched networks - packetised traffic, packet switched through the core network, access network and across the radio air interface. Vendors have suggested that savings in the order of a magnitude or more may be achievable. However, as our graph illustrates (Fig 1), the cost of delivery increases as quality of service increases. For example, in an IP network, end to end connectivity control is delivered by superimposing a number of traffic management and traffic shaping protocols. These protocols reduce the bandwidth efficiency of the packetised traffic. For networks requiring a high degree of latency control, **packet switching is no more efficient than cell or circuit switching**.

This is particularly true when applied to wireless networks. Circuit switching is generally cited as being inefficient in that a 'circuit' is dedicated to a conversation for the duration of a call. People do not talk at the same time, so at least 50% of the bandwidth is wasted. Well, not so true in wireless. Even in 1G (analogue) and 2G (GSM) cellular networks, discontinuous transmission in the uplink (and sometimes the downlink as well) effectively means RF power is only put into the channel when there is activity (someone is speaking). Thus although the logical channels are allocated for the duration of the call, the physical channels are only used when needed.

In 3G air interfaces, the matching of the (complex) encoder output to the physical channel is achieved by using orthogonal variable spreading factor codes - low bit rate, high spreading gain less power; high bit rate, low spreading gain, more power - you are only using the RF channel when it's needed. In other words, packet switching from the phone across the radio and interface will deliver little, if any, gain in bandwidth efficiency.

In addition, given that users will have multiple simultaneous traffic streams multiplexed on to code channels, each with differing quality of service requirements, a robust traffic management fabric has to be put in place from the network edge to the network core.

In many respects, it makes sense to use cell switching (asynchronous transfer node) to manage this multiplexed traffic, particularly as it may well be that the bulk backhaul for much of the 3G network traffic will be shared with digital TV (which already uses ATM).

In practice, 3G networks will be a mix of legacy circuit switching and ATM cell switching over which packetised traffic will pass. The 'all IP' switched network remains a distant option.

So if packet switching is not going to deliver a reduction in cost of delivery, how will the 3G business model survive.

Well, in a rational world, it would make sense for network operators to share base station sites, access and core network resources and backhaul resources - the technology/business plan proposed by Crown Castle Transmission, NTL, Spectrasite, American Tower and similar 'third party' infrastructure providers. Note that Crown

Castle and NTL not only manage digital TV and cellular sites, but also manage digital TV/ATM backhaul transport.

In practice, there remains some reluctance amongst network operators to pass over control of such fundamental 'delivery asset hardware'.

There is an alternative route to cost reduction - reducing the RF complexity of the network and reducing the RF component cost of handsets.

First generation analogue cellular in the 1980's was relatively complex in terms of number of RF channels deployed, for example, 833 x 30 kHz channels in a 25 MHz AMPS band and 1321 x 25 kHz channels in a 33 MHz ETACS band. This meant that networks were hard to plan in RF terms, and involved substantial RF plumbing (resonators, combiners, diplexers) in the base stations and high RF costs in the handsets.

GSM (2G) simplified this. Instead of 1321 E-TACS channels, you had 125 x 200 kHz RF channels in a 25 MHz GSM 900 allocation (which is now 195 RF channels for E-GSM) and 375 x 200 kHz channels for GSM1800 (75 MHz), ie 375 x 195 = 590 RF channels. The air interface in addition supported time division duplexing which helped to reduce RF component costs (duplex filters) in GSM phones.

Third Generation reduces RF complexity to the point where you have only 12 x 5 MHz RF channels in a 60 MHz bandwidth (with an additional 3 x 5 MHz non-paired band allocation).

Although a superficial look at a 3G base station and handset would seem to suggest a large cost increase over the short term, in the longer term, costs should fall below existing GSM cost floors.

There should be no surprise in this. There is no point in adopting a new technology unless it promises substantial hardware cost reduction - the cost reduction will however be RF based, **not** the result of a circuit to packet switched transition.

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We aim to introduce new terminology and new ideas to clarify present and future technology and business issues.

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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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