RTT TECHNOLOGY TOPIC
June 2000

2 G Connectivity constraints

In our last Hot Topic (The 3G PC) we showed how MP4 encoders generate single or multiple user specific traffic streams each requiring particular quality of service parameters --maximum and minimum bit rate, maximum and minimum bit error rate, end to end latency and end to end jitter guarantees, for example voice/audio streaming on a low latency, low bit rate channel, image/video streaming on a low latency high bit rate channel, application streaming on a best effort IP channel.

The variable rate encoder outputs for voice, image and video streaming require a variable rate physical channel.

In GPRS, this is achieved by using between 1 and 8 time slots on the uplink and downlink to provide a limited amount of bandwidth on demand negotiation capability. In IS95 A, B, C, the GPRS equivalent known now as 1xMC MDR (medium data rate) uses up to 8 multiple Walsh codes on the downlink and up to 8 multiple PN off-sets on the uplink. In either case, bandwidth on demand is delivered in increments of either 1 x 9.6 kbps or 1 x 14.4 kbps, i.e. a minimum rate of 9.6 kbps, a maximum rate of 76.8 kbps in a fully coded channel, a minimum 14.4 kbps or a maximum rate of 115.2 kbps in a partially coded channel.

In practice, however, the output from an MP4 coder will vary by a ratio of up to 64 to 1 from one 10 millisecond frame to the next.

In 3G air interfaces (IMT2000 MC or IMT2000DS) this is achieved by using orthogonal variable spreading factor codes which give a chip cover of between 4 chips and 256 chips per symbol - a ratio of 64 to 1.

2.5G air interfaces (GPRS and/or MDR) will by comparison be significantly limited in their ability to handle MP4 encoded output in terms of data rate dynamic range - the result will be a disappointing user experience.

The second requirement is to increase the maximum data rate available to support higher bandwidth image and video streaming.

2.5G solutions for this include 'EDGE' for IS136 and GSM air interfaces and HDR (High Data Rate) for IS95.

Both EDGE and HDR rely on higher level modulation to increase the number of bits per symbol modulated on to the existing RF channel. For EDGE, rotating 8 PSK is used, for HDR, either 8PSK or 16 level QAM.

Although superficially this addresses the need for higher throughput, either option fails to address the real issue of uplink and downlink power limitation. Every doubling of modulation still requires us to increase the link budget by at least 3 dB, ie double the power, to maintain an equivalent bit error rate.

In 3G air interfaces - IMT2000MC and IMT2000DS, link budget gain is achieved through bandwidth gain - wide band to narrow band processing gain. An improved link budget will be critical to delivering acceptably low error rates for image and video streaming.

An essential pre-condition for 3G access connectivity will be the need to deliver wireline/wireless access quality equivalence. Wireline access, for example ADSL, delivers a bit error rate of 1 in 106 - 1 bit error per 10 billion bits - this bit error rate is constant and consistent over time. Wireless access today is typically delivery 1 in 103 bit error rate. To move from 1 in 103 to 1 in 106 requires 3 dB of additional link budget (double the power), to move from 1 in 106 needs another 3 dB, from 1 in 109 to 1 in 1012 another 3 dB.

This is unlikely to be achievable in 2G access networks without implementing complex smart antenna deployment or significantly increasing existing network densities - note also the variability in channel quality caused by slow and fast fading in the 2.5G physical channel. In IMT2000DS, the adoption of 5 MHz channel spacing delivers significant performance benefits in terms of access quality consistency - for example it is far easier to track and control slow and fast fading effects in a 5 MHz wide RF channel - the fading envelope reduces as channel bandwidth increases.

The fundamental differences between 2.5G (GPRS/EDGE and IS95 MDR) and 3G (IMT2000 MC and IMT2000DS) air interface implementation will mean that user quality benchmarks in IMT2000MC/DS will be substantially higher.

This should be unsurprising - there would be no point in moving from one technology to the next if the new technology did not at least promise to deliver a significant performance improvement.

To say that 2.5G air interfaces will deliver an equivalent user experience in terms of image and video streaming quality is disingenuous at best - vendor claims to this effect should be treated with substantial circumspection.

A NOTE ON 'EDGE' IMPLEMENTATION

In IS136, 200 kHz EDGE channels will need to be defined within the existing 30 kHz IS136 channel raster. Present proposals involve 2 options:-

(1) 'Compact' EDGE

In 'compact' EDGE, 3 x 200 kHz channels are built up using 7 x 30 kHz channels - a 50 kHz guard band will be needed either side of the allocated EDGE channels.

50 kHz Guard Band	200 kHz EDGE	200 kHz EDGE	200 kHz EDGE	5-kHz Guard Band

(2) EDGE 'Classic'

In EDGE 'Classic', 12 x 200 kHz channels are concatenated together to give 2.4 MHz, with 50 kHz guard band on either side.

50 kHz Guard Band	200 kHz x 12 EDGE channels	50 kHz Guard Band

The guard band overhead for EDGE Compact is therefore higher. Vendors also differ presently on how much guard band is needed for both 'Classic' and 'Compact' EDGE deployment and the impact of EDGE spectral occupancy on adjacent channel performance.

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