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Cost benefits of WCDMA- facts and fiction

In our last Hot Topic we referred to the possibility that W-CDMA might be more cost efficient than GSM based technologies (GSM, GPRS, EDGE). In this month's Hot Topic we set out to identify where and how these cost savings might be realised and when.

To start, it is important to differentiate between the impact of the radio layer on costs and the impact of network topology on costs. We are talking specifically about a W-CDMA 5 MHz radio layer and a UMTS network topology consisting of an IP RAN (radio access network) and IP core.

Impact of the W-CDMA radio layer on long-term costs

When GSM was introduced, it seemed to be an expensive way of solving a problem that didn't exist. The technology was marketed as being more spectrally efficient than existing analogue technologies (E-TACS in the UK, NMT in Scandinavia and AMPS in the USA). In practice and despite what most operators were saying and continued to say through the 1990's there was absolutely no shortage of radio spectrum. Given that cellular radio spectrum was, and still is in over supply (spectrum as a liability not an asset) there is no way that spectral efficiency could be or can be translated into bankable cost advantage.

The real cost benefits of GSM were twofold - a reduction in component count and component cost in handsets and a reduction in RF network capital and maintenance cost.

		Spectrum	Channel Spacing	No of RF Channels
1G	E-TACS	33 MHz	25 kHz	1321
	AMPS	25 MHz	30 kHz	833
2G	GSM 900 (E-GSM/GSM-R)	39 MHz	200 kHz	195
	GSM 1800	75 MHz	200 kHz	375
3G	IMT2000FDD	60 MHz	5 MHz	12
	IMT2000TDD	35 MHz	5 MHz	7

Selectivity increasingly achieved at baseband.
Reduced requirement for RF filtering.
Reduced requirement for reference stability

E-TACS	1 PPM
GSM	2.5 PPM
IMT	3 PPM

Table 1: Simplified RF Architecture

Table 1 illustrates how and why this happened. Taking the UK as an example, the legacy E?TACS networks ended up with a shared 33 MHz of spectrum divided into 1321 x 25 kHz channels. 1321 RF channels were quite hard to manage both in the handset and the network. In the handset, it meant a relatively tight (1ppm) frequency reference, quite a lot of analogue filtering and a reasonably complex synthesiser design. In the network, 1321 RF channels implied quite complex RF planning and plumbing **-** a change in network topology involved considerable expense and effort retuning or replacing cavity resonators, combiners and all those frequency conscious bits needed to make RF work.

GSM represented a step change in reducing these costs, both in the handset and the RF part of the network. Even with E-GSM's 39 MHz band allocation, there were only 195 x 200 kHz channels to worry about. The frequency stability in the handset could be relaxed (to 2.5ppm) together with the associated tolerances for frequency conscious components. On the radio access side of the network, RF planning and plumbing became significantly simpler.

Savings in the core network were more elusive. Essentially GSM-MAP was and still is an ISDN network with added mobility functionality (the **M**obile **A**pplication **P**art) - HLRs VLRs etc. At least the network components and circuit switched topology fitted reasonably well with existing network investments.

Ten years later, the story for the radio layer repeats itself (Back to Figure 1!). GSM900 and GSM1800 now totalled 570 x 200 kHz channels. W-CDMA FDD (still sometimes described as IMT2000 FDD) has in comparison a total of 12 x 5 MHz channels or 19 if the additional time division duplexed (TDD) channels are added in. The reference stability in the handset can be relaxed (to 3ppm) and some, well actually most of the tasks involved in delivering stability, sensitivity and selectivity are moved to the baseband processor both in the handset and node B. The result should be lower components costs, and simpler RF planning and plumbing (though the jury is still out as to how expensive code planning might be in the short to medium term).

As with GSM, it is also reasonable to expect some performance gain from the new air interface. Better power efficiency should deliver a longer duty cycle (more revenue), some bandwidth gain should deliver some coverage benefit and last but not least the additional layer one flexibility should produce some significant user benefits in terms of application quality (A consistent user experience).

It might be that W-CDMA may also prove to be more spectrally efficient than GSM (or GSM EDGE). However in practice it is possible that code orthogonality issues will make it difficult to realise spectral efficiency gain and anyway (returning to our start point) as there is even more of a spectral glut now than there was in 1992, it would be fiscally improvident to translate spectral efficiency gain into bankable cost advantage. The cost benefits come not from spectral efficiency but from component cost reduction and simpler RF network planning and plumbing.

So how about all these savings from implementing the IP RAN and IP network

core?

The assumption has been that aggressive implementation of an IP network will result in a decrease in network and transport costs.

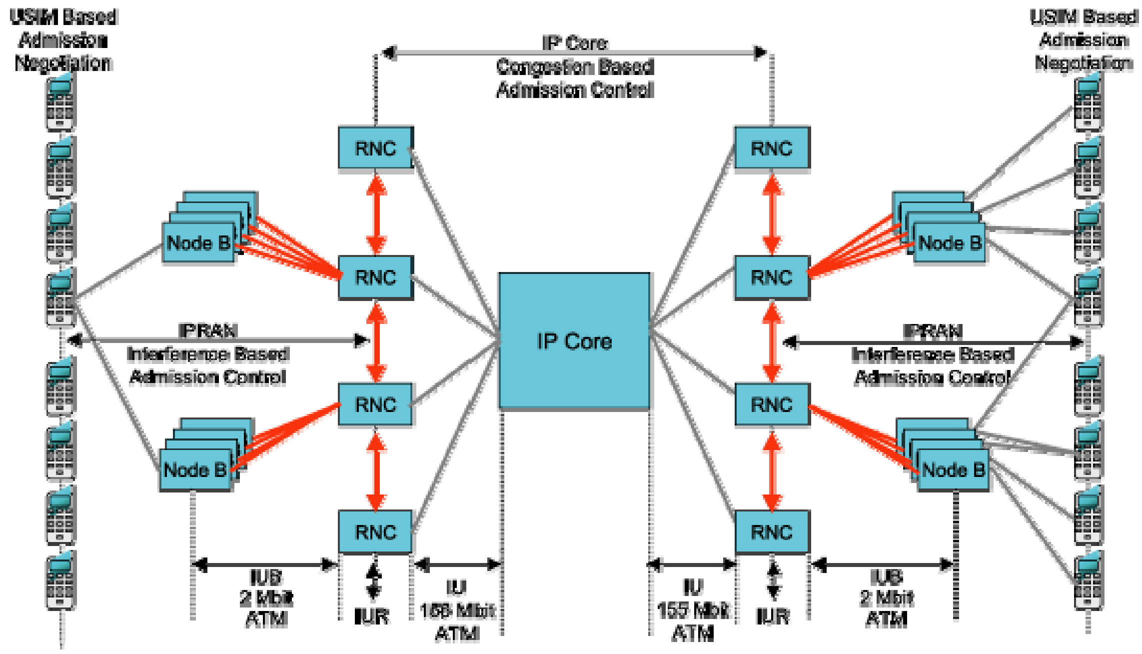

Figure 1: Network Hardware IP QoS Networks

Figure 1 shows the topology of the IP RAN and IP core and some of the access and network components. Consider that the traffic coming from the handsets will be highly asynchronous and that this asynchronicity is increasing over time (The February Hot Topic provides an account of this process). IP networks are not very good at handling aggregated asynchronous **time sensitive** traffic.

It is our contention that a significant percentage of the **margin** contribution (as opposed to the revenue contribution) in 3 to 5 years time will be from real time multi media exchange - a highly asynchronous and **time sensitive** offered traffic mix. The properties of this offered traffic can really only be preserved either by using ATM transport or by emulating ATM using IP. Delay and delay variability will need to be at least as good as existing circuit switched networks. If this is the case, it will be hard to realise network efficiency gains from an IP network.

The Good News and the Bad News

So the good news is that the W-CDMA radio layer should deliver cost savings and performance gains including lower handset costs, lower node B costs and lower cost RF plumbing and planning. The less good news is that it may be harder to realise network and transport efficiencies and hence achieve lower network and transport costs. Either way, as with GSM, cost savings and performance gains will only be realised some 3 to 5 years after initial implementation (1995/1996 for GSM, 2006/2007 for W-CDMA) at which point the savings and margin gain opportunities may prove to be significant.

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