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3G Memory

As the IMT2000 auction and allocation process gets under way in Europe, it becomes increasingly obvious that we are moving into an era of spectral surplus – 70 MHz of GSM 900 bandwidth, 150 MHz of GSM 1800 bandwidth, 120 MHz of IMT2000 paired bandwidth, 35 MHz of IMT2000 non-paired bandwidth – nearly 400 MHz of spectrum.

As with any commodity, if supply exceeds demand, the 'real' value of the commodity goes down.

A parallel process is occurring in wireline backhaul bandwidth – ISP's can buy 'minutes of use' on the spot market, the price goes down and so does the margin – wireline and wireless delivery is fast becoming a commodity business in which delivery per se retains only marginal residual added value.

The ISP business model however is not built on delivery bandwidth but on memory bandwidth – your choice of ISP is determined by how much web space will be made available to you – 20 Mbytes, 40 Mbytes, 100 Mbytes, billing by the megabyte, not megabit.

Applying this business model to wireless yields some curious results.

Vodafone in the UK recently invested in a 10 terabyte data warehouse – 10 million million bytes of memory bandwidth. The purpose of the data warehouse is to collect network user information, integrating network engineering, customer satisfaction (MIS) information, churn management and revenue enhancement products. As a result, Vodafone are in the business of bulk buying memory -–ie buying memory at advantageous prices. As a result, Vodafone could be in the business of reselling memory bandwidth to corporate and personal subscribers. You could argue of course that this already happens with voice mail and SMS – yes it does, so it should. It is just a question of realising that this implies a shift from delivery to memory bandwidth added value.

But now consider the distribution of memory in a network. A traditional telco would assume that memory bandwidth would be most efficient if centralized – the data warehouse. Well yes, up to a point. But consider, if you were to take 10 million subscribers and each subscriber had 10 Mbyte of memory in his or her handset, you would have a 100 terabyte data warehouse. If each subscriber had 10 gigabytes of local memory, you would have a 100 exabyte** data warehouse, better still, the warehouse would be distributed right out at the edge of the network. Add in 500 MIPS per terminal to give 500,000 MIPS and you wake up one morning to find that you own the world's largest distributed storage and processing machine.

Why does this make sense for wireless? Well, although we argue that we have a surplus of RF access bandwidth, it is difficult to get immediate and instantaneous access to that bandwidth, predominantly because we are power limited (by practice and decree) on both uplink and downlink.

Localized memory in a handset helps solve this problem. Let's take an example.

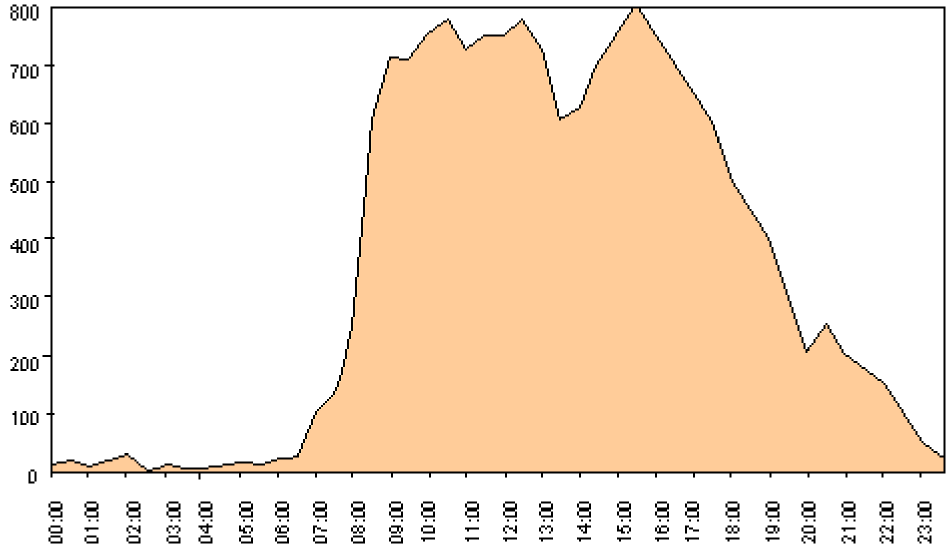

FIGURE 1: TYPICAL 24 HOUR RADIO SITE LOADING

Figure 1 shows the loading in Erlangs on a typical semi-urban cell site across 24 hours. The loading at night is abysmal. Provided a user can be persuaded to leave his handset on when recharging over night, this is the time to difference down web sites and applications to the user's terminal (using USSD or a GPRS 'always on' packet delivery channel).

In the morning, the user has the 'illusion of instantaneous access', a fully charged handset and very little need to use access bandwidth for the remainder of the day.

So we now have two choices – to invest in network memory bandwidth and/or terminal/handset memory bandwidth.

Terminals today are substantially light on memory – a few hundred kilobytes of ROM, a few hundred kilobytes of RAM. However, keep an eye on memory technology in two areas, FRAM and hard disk developments. In FRAM (a ferroelectric random access memory device), the storage cell consists of a transistor to switch the power on and off and a capacitor to store a charge representing one binary digit (bit) of information. As with all memory devices, a FRAM capacitor can change between 2 different but relatively stable steps to represent a 0 or a 1. The bit storing capacitors are coated with a thin film of material that changes from positive to negative when a voltage is applied to it. The clever thing about FRAM is that it maintains this polarization even when voltage is removed – ie potentially it has the capacity and cost benefits of DRAM but with the added benefit of non-volatility (memory without power consumption).

Alternatively, it is really quite plausible to consider hard disk drives even in small form factor appliances.

Miniature hard disk drives compatible with a 10.5 mm deep Type III PC card started becoming available in the early 1990's, typically 40 Mbyte devices. By 1998, 1 Gbyte had arrived, compressed into a 5 mm type II PC card. By 2002, 15 gigabyte Type III cards will be practical and cost effective (typically a hard disk solution will be an order of magnitude cheaper than solid state, per megabyte of storage supplied).

To put this into a consumer electronics perspective, a standard CD ROM holds 680 Mbytes of memory, a DVD (digital versatile disk) holds 17 Gbyte of memory – either way, it gives you the equivalent of nine hours of studio quality video and multi channel surround sound stereo in the palm of your hand!

Why would you need this? Simple, for sending and receiving MP3 and MP4 files. MP4 takes MP3 (high quality audio streaming) and moves it to a standard for handling complex content divided into still images, video and audio objects. MP4 is effectively a building block for future 3G revenues – it is **very** dependent on having substantial localised memory bandwidth available.

Ericsson's demonstration at Cebit of an MP3 player embedded into a cell phone (using a 340 Mbyte Microdrive miniature hard disk) provides a topical practical example.

Memory technologies will be a key facilitator in the implementation of 3G networks. Apart from all of the above, packet networks need memory bandwidth to avoid packet loss – look at what happens when a router runs out of buffer bandwidth.

Investing in memory bandwidth therefore includes investing in transport bandwidth, network bandwidth (data warehousing for re-sale to subscribers) and terminal resident bandwidth – the returns from investing in memory bandwidth will be higher than an equivalent investment in delivery bandwidth (whether wireless or wireline). Optimising the distribution of memory bandwidth will be a key design parameter in 3G network implementation. For wireless, where power constraints limit the amount of instantaneous accessibility available, it makes particular sense to invest in memory bandwidth in the user appliance (ie subsidize memory bandwidth).

What is an Exabyte?

An Exabyte is 1000 timesbigger than a petabyte, which is 1000 times bigger than a terabyte, which is 1000 times bigger than a gigabyte, which is 1000 times bigger than a megabyte, which is 1000 times bigger than a kilobyte.

Exa	E	10^{18}
Peta	P	10^{15}
Tera	T	10^{12}
Giga	G	10^{9}
Mega	M	10^{6}

Kilo	K	10^3

MP4 Note: MP4 will be profiled in detail in our next hot topic (February) '3G Compression'.	www.mpeg.org www.mpegtv.com
DVD	www.c-cube.com
Miniature hard disk drives	www.calluna.com www.micronas.com
FRAM	www.ramtron.com

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