RTT TECHNOLOGY TOPIC
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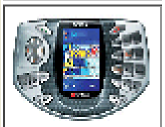
Handset and network value

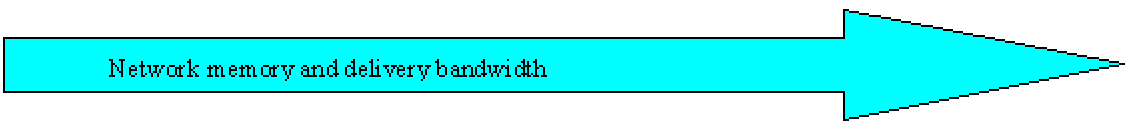
Last Month's Hot Topic studied the impact of handset hardware and handset software on the user experience and the related properties needed from the radio layer and the network.

This month's Hot Topic analyses the interrelationship between handset and network value using Symbian based Nokia devices to illustrate the impact of handset form factor on network functionality.

Handset Form Factor
Consider first the range and mix of user devices.

Figure 1: Device and Network Form Factor

	**Series 40** 6230 Memory	Voice	Text	Image					
	**Series 60** 7610 Memory +	Voice	Text	Image	Video				
	**Series 60** N-Gage Memory ++	Voice	Text	Image	Video	Gaming		Audio Stereo FM or DAB/ DMB	
	**Series 80** 9500 Memory +++	Voice	Text	Image	Video	Gaming	Enterprise (Wireless LAN)		
	**Series 90** 7700 Memory ++++	Voice	Text	Image	Video	Gaming			TV HSDPA DVB-H DVB-T
		Conversa-tional	Best Effort	Best Effort	Streamed or convers-ational	Interactive	Best effort	Streamed	Streamed
		Symmetric	Symmetric	Symmetric Asymmetric	Symmetric Asymmetric	Symmetric	Asymmetric	Asymmetric	Asymmetric
Storage		Voice Messaging	SMS gateway	Image store	Video store	Game store	Corporate servers	Audio store	Free to air content



A Series 40 handset such as the 6230 is an entry level camera phone with an application form factor that is a mix of voice, text and imaging.

A Series 60 handset, for example the 7610, adds video to the traffic mix, an N-Gage adds gaming and a stereo FM receiver. Note the potential benefit in the longer term of having a high quality high bandwidth audio and data downlink multiplex for these devices- for example a DVB-H or DMB multiplex.

A Series 80 device such as the 9500 adds enterprise functionality. The inclusion of PowerPoint, Word, and Excel determine uplink and downlink delivery and memory requirements. Wireless LAN connectivity helps support the 'enterprise network' proposition.

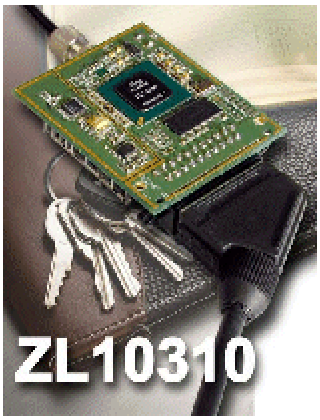
A Series 90 device, for example the 7700, turns the 'enterprise network' proposition into a 'media network' proposition. This places particular demands on the downlink. The choice here is either to use existing EDGE time slot or WCDMA code channels or HSDPA or DVB-T/ DVB-H.

Neither EDGE nor the Release99 WCDMA radio layers were ever designed to be suitable or optimised for the delivery of digital TV. The radio layer and MAC layers are not sufficiently asymmetric and although low bit rate TV is possible (Vodafone's 128kbps TV streaming demonstration is a recent example), it is difficult to see how these services could ever be widely deployed without compromising existing voice performance metrics.

With HSDPA, a headline data rate of 10.8 Mbps implies a ten to 1 asymmetry (assuming an eventual max uplink from the handset of 960kbps in more or less perfect channel conditions). HSDPA also drops power control, helping the power budget (in both directions). The 5 code, 10 code or 15 code (SF16) multiplex could work for re-purposed digital TV but the cost is substantial processor load in the receiver (over 200 MIPS to support the turbo decoder.)

The alternative is to put a DVBT or DVBH receiver into the phone. Previously this would have seemed imprudent from the point of view of the overall power budget of the device but this is changing (see www.ti.com, www.radioscape.com , www.frontier-silicon.com and www.zarlink.com for examples).

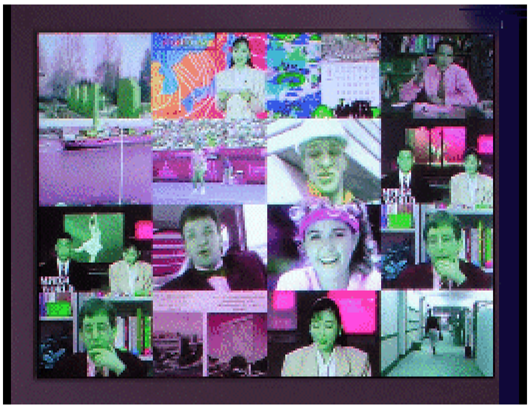
Figure 2: A DVB-T receiver from Zarlink.
Similar form factor devices are being sampled by Sony SES/Freescale, Panasonic and Pro Television Technologies in Denmark but including DVB-H compatibility.



DAB and DMB receivers capable of simultaneously demodulating 3 audio channels (TMS320DRE310DSP) typically draw less than 200 milliWatts. DVBT or DVBH receivers have a tougher job to do (adding video to the multiplex) and current production versions, which are designed for use in set top boxes typically draw 2 to 3 watts from a power supply. In principle though, DVBT or DVBH should both be able to offer a more power efficient receiver implementation per bit processed than HSDPA. (More work is done in the broadcast transmitter (encoder) leaving less work to do in the receiver). In DVB-H, IP audio/video data streams are time sliced. Time slicing helps the decoder power budget and allows single receiver devices to use spare time slots to measure serving and adjacent transmitter signal strength and signal quality (receiver driven handover). An optional 4K OFDM carrier multiplex and additional forward error protection with extended interleaving helps improve Doppler tolerance. Note that a DVB-H multiplex can be added to an existing DVB-T transmission. Intriguingly, there is also support in the present DVB standard for 5 MHz channel spacing so in principle either DVB-T and or DVB-H and/or DAB could be implemented in existing cellular spectrum - the time division duplexed bands in UMTS being one possibility.

So, back to receivers. The point of the 7700 device is to have a 16:9 form factor display (wide screen TV) with a touch screen to allow users to preview multiple channels. Figure 3 shows an example from ST Microelectronics (www.st.com) of a VGA display capable of showing 16 QCIF streams. The mosaic screen may be compiled at source or be required to select frames from available services. Either way, the implication is that both HSDPA and DVB therefore have to be capable of supporting multiple data streams.

Figure 3: 16 QCIF streams on a VGA display



Network Form Factor

Which brings the topic round to network form factor. From Figure 1, it can be seen that the mix of handsets supported by the network will determine the hardware and software needed in the network.

Consider first the qualities needed from the end to end bearers.

All the products featured have voice as a common denominator. Voice is 'conversational' and 'symmetric'. It has a multiplier effect in that it also generates a need for voice messaging in the network (network added value).

All the products featured have SMS text as a common denominator. SMS is intrinsically 'best effort' though 'best effort' works best (and has most value) when the end to end delay and delay variability metrics are closely controlled. It has a multiplier effect in that it also generates a need for SMS gateways and SMS storage in the network (network added value).

All the products have imaging capabilities. Bi-directional imaging bandwidth is determined on the uplink by the imaging bandwidth of the CMOS camera and on the downlink by the display and display driver bandwidth.

Figure 4: Display and CMOS camera bandwidth

Display	Resolution	Number of Pixels	CMOS camera
CIF	352x288	101,376	100,000 pixel
QVGA	320X240	76,800	100,000 pixel
VGA	640x480	307,200	300,000 pixel
SXGA	1280X1024	1,310,720	1.3 M/Pixel
HDTV	1920x1080	2,073,600	2 M/Pixel
QXGA	2048X1536	3,145,728	3 M/Pixel

Note that 18 months ago, 100.000 pixel CMOS cameras were considered pretty good. Today's devices (for high-end camera phones) are typically 1.3 Megapixel. An example would be Micron's 1/3rd inch format MT9M011device. www.micron.com

A 1.3 Megapixel camera is equivalent to an SXGA resolution display. A 2 Megapixel camera is equivalent to HDTV. The Micron device uses 85 milliwatts 15fps full resolution or 50 milliwatts at VGA resolution, i.e. compatible with the overall power budget of a high-end phone.

The impact of this imaging bandwidth is significant both in terms of local memory requirements in the handset and network delivery and storage bandwidth. A 65000-colour display is equivalent to 16-bit colour depth. A 1.3 Megapixel camera at 16 bits per pixel therefore generates an image size of 20.8 M/bits which at 15 frames per second implies a data rate of 312M/bits/s. Given that the 7610 can capture 10 minutes of video, even a compressed file can be several hundred megabytes. These images then need to be stored or sent somewhere.

Some of this video traffic will be streamed. However simultaneous voice and video may be (and most likely will be) conversational and symmetric rather than asymmetric, implying particular demands on uplink performance. Gaming needs an interactive bearer, Series 80 devices are best effort and audio and video services will be streamed. The ratio in which these bearers will be needed will be determined by the handset product mix- the product mix defines the traffic mix and required traffic properties.

Note also how network storage value increases as the product mix shifts towards higher end phones. A Series 40 device needs basic voice messaging, an SMS gateway and an image store. A Series 60 device creates the need for a video store and (for N-Gage) a game store/game server platform (and related 3D rendering capabilities). The Series 80 devices generate a demand for corporate enterprise servers; Series 90 devices create a demand for audio and video storage and broadcast content servers.

Summary- Symbian and the Series 40/60/80/90 Network

The mix of handsets used on the network determines the form factor of the network.
Handset hardware and software form factor determines network hardware and software form factor.
Handset hardware and software value determines network hardware and software value. More MIPS and memory in the handset generate a need for more MIPS and memory in the network. MIPS and memory in the network translate into increased network added value. A Series 60 network has more value than a

Series 40 network a Series 80 network has more value than a Series 60 network, a Series 90 network has more value than a Series 80 network.

This highlights the importance of Symbian and the Series 40/60/80/90 GUI's as a multiplier mechanism for network value and helps to explain why Ericsson have been keen to consolidate their interest in Symbian over the past few weeks.

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