RTT TECHNOLOGY TOPIC
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Making Smart Phones Work (1)

With the August announcement of a $12.5 billion bid from Google to buy Motorola Mobility, with the launch of the iPhone4s (coinciding with the sad news about Steve Jobs) and with new smart phone product announcements either made or pending from Samsung, LG, HTC, ZTE, Huawei and of course Nokia it would be hard to address any subject other than smart phones in this month's technology topic.

This is the first of a series of Technology Topics in which we review smart phone performance issues and the impact of smart phones on network performance and network economics.

Ten years of smart phones.
We would argue that the smart phone revolution can be dated from 2002 with the launch of the Nokia 9210 Communicator. This was a dual band EGSM900/1800 device supporting 'high speed circuit switched data' (remember that?) up to 42 kbps, a 4096 colour display and a 'video function which allowed you to see' video. It had a lithium ion 1200 mAh battery, 40 MB of memory and a 32 bit ARM 9 processor running at 80 MHz. Talk time was quoted as between four and ten hours and standby between 80 and 230 hours.

Ten years on a Nokia N8 supports quad band GSM/EDGE 850/900, 1800 and 1900, Band 1 WCDMA and WCDMA for the re farmed 850, 900, 1700 and 1900 MHz bands. The peak downlink data rate is 10.2 Mbps albeit under ideal conditions and a 2 Mbps uplink. A 1200 mAh battery gives 12 hours of talk time on GSM, six hours on WCDMA, 390 hours of stand by time on GSM and 400 hours of standby on WCDMA.

The device has 16 GB storage including 256MB of RAM and 512 MB of ROM and up to 32 GB of plug in memory using a Micro SD card. There is a 12 mega pixel camera. The ARM 11 processor clocks at 680MHz.

Over ten years that represents an order of magnitude increase in processor clock speed, an 800 times increase in solid state memory bandwidth and a 250 times increase in downlink speed.

Five years of smart phones
The first iPhone was announced in January 2007 so that makes five generations in five years. Just like the iPod introduced five years before, the success of the product was based on a combination of transformational technologies.

For the **iPod** this was initially the miniaturised hard disk transitioning to Flash memory from 2005 onwards combined with various input methods including the scroll wheel and associated store, sort and search algorithmic innovation.

For the iPhone it was the capacitive touch screen display coupled with the mathematics behind the screen coupled with micro positioning (gyroscope and accelerometer) that enabled the user interface to do all those clever things on which the product's functional success has been largely based. The addition of GPS a year later and 3G connectivity from 2009 helped as well. The table below also shows how imaging and connectivity bandwidth has increased over the first four generations.

Five years of iPhone evolution

January 2007	**July 2008**	**June 2009**	**June 2010**
iPhone	iPhone 3G	iPhone 3Gs	iPhone 4
2 mega pixel camera	2 mega pixel camera	3.2 mega pixel	5 mega pixel camera

	Assisted GPS	camera Compass Voice control	plus video camera Ambient light sensor
Wi Fi and GSM and Bluetooth	Wi FI and EDGE and Bluetooth	HSPA Band 1 plus quad band plus EVDO 850 and 1900 3G plus Wi Fi and Bluetooth	

The iPhone 4S announced as this technology topic was being written added an 8 megapixel camera and HD video capability up to 30 frames per second.

LTE smart phones are also now becoming available though not as yet the iPhone. At August 2011 Verizon were selling HTC Thunderbolt, LG Revolution and Samsung Droid Smart Phones with 1X EVDO Rev A support for the 850/1900 band and LTE 700 Band 13. Connectivity is therefore improving over time though not as fast as some operators would like. A topic to which we will return.

The increase in code bandwidth over time.
The parallel trend to this has of course been the relentless increase in code bandwidth. Between 1985 and 2002 code bandwidth increased from 10,000 lines of code to one million lines of code. Today (nine years later) an **Android operating system** in a smart phone consists of 12 million lines of code including 3 million lines of XML, 2.8 million lines of C, 2.1 million lines of Java, and 1.75 million lines of C++ . http://source.android.com/tech/index.html

Code bandwidth as an example of an engineering transform
In the **August Technology Topic** we talked about mathematical transforms, comparing Fourier and Hadamard. It can also be argued that the expansion of code bandwidth is an engineering transform. Engineering has three functions, to make individual technologies work, **(Bran Ferren's description of technology as 'stuff that doesn't work yet'),**
to make separate technologies work together and to add value either to the individual or composite technology offer. Often now this value is achieved by adding software on to the composite hardware platform. In Apple's case significant credit is also due to the **(British led)** industrial design team.

The success of Apple and the legacy of Steve Jobs are both usually attributed to an ability to anticipate market needs before the market is aware of those needs. This may be partly true but there is also a case to be made that there is no point in anticipating a market need if that market need cannot be served efficiently hence our argument that technology innovation is the essential start point. A technology transform translates into an engineering transform which translates in to a market transform which translates into a business transform.

For example Apple apparently now have more than 50% of the global smart phone market by value(a market transform) and $47 billion in the bank (a business transform), rather more than the available cash retained by the US Treasury.

Some of that value has been generated at the expense of competitors; some is additional market value (consumers spending more than they did previously). Either way the five dominant vendors supplying high end phones in 2007 have now expanded to twenty five vendors attempting to service the global smart phone market with iClone products.

This is pretty much unsustainable for several reasons. Although Apple has established a premium realised price point for the iPhone, other brands find it harder to compete and differentiate and therefore cut prices in an attempt to achieve volume.

The twenty five vendors are competing for mind share in operator range planning departments and with end users and are competing for the limited supply of device, design and implementation expertise available to put these devices together into a working phone. The implementation expertise includes things like making the RF sections of the phone perform which can be problematic. It has to be remembered that these devices as and when they are LTE capable will also have to work in re farmed spectrum where 5 or 10 or 20 MHz LTE channels can potentially be adjacent to 5 MHz LTE channels or 200 KHz GSM channels. This presents some particularly interesting system level issues.

A heavy reliance on reference design platforms may mitigate some of the design risk and a large number of the vendors also source from the same ODM suppliers but the need to achieve market differentiation or service sub scale markets makes it necessary to have some market or regionally specific customisation which is implicitly costly particularly if a handset linked network performance risk is also implied (see above!).

Some of these vendors have a PC and lap top heritage and have not had the benefit of a technical and commercial presence in the cellular phone design, supply and distribution chain. The assumption that smart phones would provide a new profitable income stream has therefore proved to be over sanguine even for major players such as **Acer**, the world's number two PC and lap top vendor.

The emerging challenge of course is to move smart phone functionality to the parts of the market that smart phones have not presently addressed. One option is to reduce the memory footprint and hence memory cost of devices; Recent announcements of an 8 GB iPhone4 for Asian markets suggest that this is an Apple strategy. Given that memory cost can be 25% or more of the total BOM that makes sense but suggests an increased dependency on connectivity to sustain an acceptable user experience which in Apple language must imply more emphasis on the **iCloud.**

This in turn leads to a discussion as to the relative importance of the RF BOM in smart phone devices. In the RTT **2007 study** for the GSMA, **RF Cost Economics for Handsets** we said that the RF BOM had remained remarkably constant over time at 7% of the total bill of materials both of low, mid and high end phones.

In a current update of this work it appears that this is probably still a working average but with a greater variation across different phone platforms. For example the recent trend toward two or three band rather than (five band or above) multi band phones produces phones where the RF BOM is 4% of the BOM, extended multi band phones (eight bands or more) may have an RF BOM of well over 10%. The RF performance of two or three band phones should also be significantly better.

The RF BOM will also or should also have to increase to accommodate new functions such as dual or aggregated carrier options and simultaneous voice and data. Some but not all of this additional complexity can be realised at base band or integrated in the RFIC but ultimately these functions have to be matched to a noise efficient and power efficient front end.

Apple of course discovered that poor RF performance could cause reputational damage though this apparently had a minimal impact on product sales. In the longer term however it can be persuasively argued that RF component innovation and RF design and implementation capability are becoming more rather than less important over time.

Out sourcing this expertise to third parties or an over dependency on third party support for these skills may therefore prove to be have been short sighted.

ENDS

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It is an absolute truth that ambitious commercial plans can be invalidated by apparently trivial technical details.

In an ideal world operators and vendors would deliver solutions to market that are technically and commercially efficient.

Competition policy, regulatory and standards policy and competitive market dynamics sometimes facilitate and sometimes frustrate this process.

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If you are working in the Asia market as a vendor or operator or have an interest as a major end user then these workshops will be directly relevant and useful to you.

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