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Ultra Low Cost Handsets

Introducing this months Hot Topic

There has been an industry focus recently on **U**ltra **L**ow **C**ost **H**andsets, handsets with an ex factory cost of 30 dollars or less targeted at emerging markets.

From a regulatory perspective, ultra low cost handsets are politically, socially and economically expedient, meeting the perceived and practical need to bridge the 'digital divide' between developed and developing nations.

From an industry perspective, lower entry costs increase the size of the addressable market, creating new volume based value opportunities.

Ultra Low Cost Handsets remove or reduce the need for subsidy and therefore allow for lower cost service. As such, they would seem to be a pre requisite for the future development of cost and tariff sensitive markets.

The lowest cost silicon approach would seem to favour GSM only handsets with limited functionality.

However, there is a parallel need to reduce infrastructure cost which implies an aggressive transition to UMTS or alternative wide band technologies in presently deployed spectrum.

This implies a business model in which there is a justification for subsidizing relatively fully specified GSM/UMTS dual mode phones to be made available to the market at ULCH prices. The additional justification for such a strategy would be to bring forward the availability of single mode (even lower cost) UMTS into both developed and developing markets.

This suggests that the market for GSM specific ULCH silicon may be smaller than expected which in turn will make the GSM specific ULCH price point harder to achieve.

This month's Hot Topic tries to uncover the cost and value metrics that need to be taken into account when sizing these discrete market sectors.

Given that device costs are a function of technology specific volume we also look at the likely impact of WiMax on the ULCH market and the reciprocal impact of ULCH on WiMax.

Technology value

New technologies are adopted on the assumption that they will deliver a decrease in

cost, an increase in functionality and higher margins for vendors.

In the 1970's and 80's the prevailing consensus was that it was going to be easier to filter in the time domain rather than the frequency domain. This assumption provided the basis for the transition from frequency multiplexing to time division multiplexing in both fixed and mobile communications.

First Generation Cellular
In mobile communications, first generation cellular systems used 12.5 KHz, 25 KHz or 30 KHz channel spacing. This implied a substantial need to filter in the frequency domain across a large number of radio channels.

For example an ETACS phone in the UK needed to access 1321 channels within the 33 MHz of allocated ETACS spectrum, an AMPS phone in the US needed to access 833 channels in the 25 MHz of allocated AMPS spectrum.

This implied a relatively high degree of reference stability in cellular handsets, a need for substantial frequency selectivity and a need to be frequency agile across a large number of radio channels.

Similarly an ETACS or AMPS network was relatively complex with frequency planning realised across several hundred RF channels - a costly and complex RF plumbing problem.

Second Generation Cellular - GSM
The motivation for the transition to GSM was to simplify the RF filtering both in the handset and the network by relaxing the channel spacing to 200 KHz. User to user selectivity was moved into the time domain.

GSM phones started to be available in 1991. By 1996, 5 years after market introduction, GSM phones had a lower ex factory cost than ETACS phones, a longer talk time (improved power efficiency) and better more consistent voice quality.

In parallel, GSM networks were becoming simpler to deploy and manage than ETACS networks. GSM networks also had better mobility management, a function of the increased signalling bandwidth available.

The combination of lower cost higher functionality handsets and a lower cost higher functionality access network provided the basis for a step function increase in mobile cellular business volume and value.

The industry also claimed substantial improvements in spectral efficiency partly as a consequence of moving from analogue to digital voice codecs. In practice these gains were less significant than might have been expected.

Third Generation - UMTS
So it seemed sensible to take the process another step further and relax the channel spacing from 200 KHz to 5 MHz, simplifying RF filtering in the handset and the network and moving user to user selectivity into the code domain, the basis for third

generation UMTS cellular standards.

Given that it is now five years after market introduction, logic would suggest that UMTS phones should have a lower ex factory cost than GSM phones, a longer talk time (improved power efficiency) and better (more consistent) voice quality, in addition to other desirable non voice features.

In parallel, UMTS networks should be becoming simpler to deploy and manage than GSM networks with better mobility management (a function of the increased signalling bandwidth provided by UMTS).

This combination of lower cost higher functionality handsets and a lower cost higher functionality access network should be providing the basis for a step function increase in mobile cellular business volume and value.

The industry is also claiming improvements in spectral efficiency though in practice these gains may be less significant than expected. There is also additional spectral flexibility in terms of non paired band allocations for TDD (time division duplexed) UMTS.

Table 1 Simplified RF channel spacing by generation

		Spectrum	**Channel spacing**	**Number of RF channels**
1G	ETACS	33 MHz	25 KHz	1321
	AMPS	25 MHz	30 KHz	833
2G	GSM 900	39 MHz	200 KHz	195
	GSM 1800	75 MHz	200 KHz	375
3G	UMTS FDD	60 MHz	5 MHz	12
	UMTS TDD	35 MHz	5 MHz	7

So why has UMTS failed to date to deliver cost and performance gain?
For various reasons, UMTS has to date failed to deliver cost or performance gains.

Partly this is due to the industry going into a severe recession, a function of the Dot Com collapse compounded by over zealous bidding for UMTS spectrum. This prompted a necessary but nasty downsizing of technology and engineering resources in the industry.

The consequence is that it has been hard to deploy sufficient resource to adequately optimise UMTS handset and network design. The problem is compounded by network operators' reluctance to invest in a new technology that has to date failed to deliver substantial cost reduction or user experience advantage.

This in turn has meant that UMTS volume both in terms of handset and base station shipments is still small in comparison to GSM shipment volume. This has meant that it is easier to achieve low cost and price points for GSM only handsets and hard to achieve aggressive cost reduction on UMTS.

The additional linearity requirements of UMTS have also added some incremental component costs.

There are other factors. GSM intellectual property rights are well understood, relatively well managed and mature (including patents which are close to their expiration date).

UMTS intellectual property rights are more vigorously contested and presently add cost to the handset.

Except in Japan, most markets require dual mode UMTS/GSM handsets in order to deliver an acceptable user experience in terms of coverage and roaming functionality. A single mode UMTS handset only becomes practical as and when UMTS is more broadly deployed into existing GSM spectrum.

This would suggest that an ultra low cost GSM only handset has a sufficiently wide window of opportunity to achieve mass market adoption and that it will be some years, let's say at least three to five years, before a UMTS only handset can be shipped at a cost that is lower than a GSM only device.

However there are a number of balancing factors.

The impact of WiMax on the ULCH market
The promotion of WiFi and WiMax products into developed and emerging markets will have a number of effects on the GSM to UMTS transition. Wi Fi access point prices are presently substantially lower than either GSM or UMTS.

Similarly Wi Max base stations are likely to be competitively priced. Wi Max handset pricing is still speculative but in theory the combination of wider channel spacing (20 MHz) and time division rather than frequency division duplexing will support low cost devices.

There are differences of opinion on this. It can be argued that wide bandwidth transceivers are harder to realise technically than narrow band transceivers but the overall trend towards wider bandwidth system options can generally be justified in terms of reduced RF component and system cost. Similarly TDD systems can yield system cost savings though sensitivity will generally be lower than equivalent FDD systems.

This overall trend is shown in the table below.

Table 2 UMTS, WiMax and UTRAN/LTE channel spacing

Cellular	**1G**	**2G**	**3G**	**UTRAN LTE**
	25/30 KHz	200 KHz	5 MHz	1.25 to 20 MHz
WiMax			1.25 to 20 MHz	1.25 to 20 MHz

WiMax is presented by it's vendors as a complementary technology but viewed by a

cross section of UMTS vendors as a competitive technology being deployed into common spectrum (at 2.5 GHz) or new spectrum (3.5GHz). Most UMTS vendors would be happy if WiMax had never been invented.

Irrespective of whether Wi Max succeeds globally, the promotion of WiMax will shift price and performance expectations within the international network operator community.

The technical response to date from UMTS vendors has been to fast track present UTRAN LTE work items that include scalable channel spacing from 1.25 to 20 MHz and an OFDM multiplex

The parallel commercial response is likely to involve the aggressive pricing of UMTS handsets and network infrastructure as a defensive and/or offensive measure to limit Wi Max deployment.

This would suggest that present UMTS vendors are likely to be more aggressive in their efforts to encourage network operators to deploy UMTS into existing GSM spectrum, particularly the 900 and 850 MHz bands where a capital cost/coverage benefit can be clearly demonstrated over Wi Max at 2.5 GHz. Ultra low cost UMTS handsets are an essential part of this competitive story.

The impact of UMTS vendor consolidation
Ultra low cost UMTS handsets are also more likely as a result of UMTS vendor consolidation.

We can make the fairly confident assumption from present trends that will be three dominant UMTS infrastructure vendors, three dominant UMTS handset vendors and at most three to five dominant UMTS silicon vendors.

Most of these vendors are active in GSM and UMTS. This level of consolidation implies at least some ability to 'manage the market' in terms of pricing and product availability.

GSM to UMTS cross subsidy
There are, for example, opportunities to temporarily cross subsidise UMTS from present GSM activity. Vendors active in UMTS infrastructure have an interest in reducing UMTS handset costs to encourage faster market adoption. A similar strategy worked adequately in the early to mid 1990's in markets transitioning from ETACS to GSM.

Network operators have an interest in subsidising UMTS handsets if it can be shown that UMTS handsets can deliver additional incremental revenue and if it can be shown that UMTS networks can lower the cost of delivery.

UMTS will have to deliver on both counts to avoid a loss of market share to WiMax or alternative wireless broadband options.

The rationale for an Ultra Low Cost Single Mode UMTS (ULC UMT) Handset
So this prompts us to conclude counter intuitively that an Ultra Low Cost UMTS

handset may yield more political, social and economic value than an Ultra Low Cost GSM handset.

Conventional wisdom suggests that developing nations need low cost infrastructure and lowest cost handsets and that GSM delivers on both counts.

However let's go back 12 years and remind ourselves that similar arguments were put forward to justify AMPS and ETACS and NMT based network deployments into 'third world' markets (to use the now politically incorrect description).

In practice this was a bad deal for the recipient countries - an opportunity to ship near obsolete equipment at a knock down price.

It is perfectly plausible to consider that we could have single mode UMTS handsets available within two years that are lower cost than GSM, offer better power efficiency, better voice quality and enhanced data functionality. These handsets will work with UMTS networks which have a lower capital cost than GSM and significantly lower running costs.

It is misguided to consider that these products are in some way unsuitable for developing emerging nations. It is also misguided to think that these products will yield slimmer margins for vendors - the opportunities for component cost savings in single mode UMTS are potentially substantial.

The impact of the ULCH market on WiMax.
Single mode UMTS implies a need to deploy UMTS infrastructure into existing GSM bands. This might seem ambitious but the market volume realised from a technology deployed universally from 850 to 2500 MHz would deliver cost and performance benefits that would outweigh the temporary costs implicit in the transition process.

Effectively this would mean that UMTS was deployed into over 500 MHz of global cellular spectrum. This has to be considered as a substantial market advantage.

Present WiMax spectral deployments proposed at 2.3 GHz (adjacent to the WiFi and Bluetooth ISM band), 2.5 to 2.7 GHz (co sharing with UMTS), 3.3 and 3.5 GHz (co sharing with fixed access) are neither universal nor particularly favourable in terms of propagation characteristics.

Given these present spectral allocations, it is difficult to see how WiMax could ever achieve sufficient market volume to match potential UMTS ULCH price points.

Managing the transition process
In practice, a direct move from GSM specific ULCH to single mode UMTS is improbable. A three stage transition is more likely in which GSM ULCH is followed by dual mode GSM/UMTS ULCH followed by single mode UMTS ULCH.

Hybrid Release99/HSPA handsets are spectrally inefficient and power inefficient so there are persuasive technical reasons for making a move to single mode UMTS ULCH sooner rather than later.

Hybrid GSM/UMTS Rel 99 and UMTS HSPA access networks will also be inefficient providing additional reasons for a faster transition to single mode UMTS, preferably UMTS HSPA without Rel 99 support.

This does not invalidate present efforts to bring ULCH GSM products to market. Although it is possible that the GSM specific ULCH market may be smaller than expected, the political and public relations benefits of being active in this product sector are substantial and may outweigh short term market disappointment.

It does however suggest that it is well worthwhile to ensure that work invested in GSM ULCH at silicon level can be leveraged into dual mode and later single mode UMTS HSPA only devices.

Conclusion - the end of slumber mode in cellular - ULC UMT handsets as the catalyst for change

The industry has been in slumber mode for the past five years, battling with budgets and tumbling share price value. At last things are changing. R and D teams are revitalised and refocused, vendors are rehiring R and D and engineering staff and have a clear self interest in moving quickly on to new technology turf.

GSM has been a great technology which has served the industry magnificently for the best part of 15 years. It is now time to move on. Ultra Low cost UMTS (ULC UMT) handsets will be the catalyst for this process of change, underwriting a new wave of cellular investment in developed and developing markets and unleashing a new era of social, economic and possibly even political progress.

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If you would like more information on this work then please contact

geoff@rttonline.com

00 44 208 744 3163