Telecoms Infotechnology Forum

Hong Kong: A Test-bed for Third Generation (3G) Wireless?

A TIF position paper

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Telecoms Infotechnology Forum (TIF)

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Credits

This position was researched and written for the Telecoms Infotechnology Forum by the Telecommunications Research Project, a research organization specializing in Asia's information technology and telecommunications industries.

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Where will the money come from for new third generation wireless services? Or, more specifically, what is the business model for mobile telephony as it transitions from second generation to third generation?

The promises of what will be offered seem remarkable and everyone within the converging multimedia world appears to want to be involved, from Microsoft to Rupert Murdoch. But the difference between second and third generations is the difference between narrowband and broadband communications; it is not simply a difference in speed, convenience or fashion (different color handsets for different outfits?). Broadband represents an entirely new of thinking about communications access. If you are connected to the network all the time, then you won't be charged for per-minute usage. So mobile telephony tariffs are out. But if not tariffs then what? Advertising? Transactions? Bits?

No-one has come up with a business model that makes sense of the transition from narrowband to broadband communications, *particularly if you are in the carriage business*.

In this position paper we look at the business proposition of third generation mobile telephony: what is on offer; what is driving the various players; and what are the challenges faced. We suggest that Hong Kong is perhaps quite a good indicator of where the industry is heading and the challenges that policy-makers will face if they are to help provide a sustainable environment for the next generation of mobile service uptake.

This paper resulted from the September 1999 meeting of the Telecoms Infotechnology Forum, a quarterly forum which discusses telecommunications and information technology issues that affect Asia.

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It is appropriate that Smartone, one of Hong Kong's three cellular GSM and six PCN operators, and Ericsson, Smartone's strategic equipment supply partner, were the sponsors of this the September 1999 Telecoms Infotechnology Forum on third generation mobile as they will be pioneers of Generalised Packet Radio Service (GPRS) in 2000. This has a double meaning. On the one hand, they are establishing Hong Kong at the forefront of mobile cellular global development. Hong Kong's tricky high-rise and densely populated environment make it a testbed for all kinds of radio-equipped communications products and services, and as of September 1999, according to OFTA, there were 3.6 million mobile telephones to serve a population of 6.5 million in Hong Kong. The other meaning of GRPS is that a 'two-and-a-half generation' mobile development, offering rates up to 168 Kbps, will mark the transition to Universal Mobile Telecommunications System (UMTS) or genuine 'third generation' universal mobile tele-communication services.

In the forum, Ericcson gave emphasis to the switch to packet networks, with a forecast of up to 350 million packet-switched wireless subscribers globally by 2004. However, in Ericsson's view, the key to successful wireless business development in the future lies not simply in subscriber growth, but in the growth of traffic volumes. The example was given of wireless revenue in Europe, where 20% now comes from non-voice traffic, such as messaging. As this change kicks in, services and applications will shift from being integral to the networks themselves, to become a new layer within the network. In effect, the entire GSM/Wideband CDMA network will come to be seen as an access network, interfacing with an IP transport layer, an applications and services layer, and a control layer where most of the intelligent functions will reside.

While third generation broadband is unlikely to substitute for fixed wireline or home and office access devices, a new value chain is emerging and "to take the right position here is the major and most costly decision that needs to be taken by operators." The primary task of equipment suppliers such as Ericsson is to support operators in making the transition from 2G through 2.5G and on to 3G, in the most cost-effective and commercially viable manner.

Smartone made the important point that "3G by itself is not thought to be a success. It needs a lot of enablers together." What will be the drivers of 3G? One is the increasing demand for interactive multimedia services, "especially the growth in the Internet application environment." Another is the strong demand for personalization combined with mobility. Among the enablers that will be required, particular stress was given to voice-recognition "in the coming two to three years." Also stressed was the likelihood of service operators such as Smartone becoming increasingly involved in the provision of content. Indeed, with the world moving unambiguously towards IP, data traffic will rapidly take over in importance from voice communications. To this end, Smartone (like other operators in Hong Kong) is already forging partnerships with content providers, such as CNN, and web-access providers, like Yahoo, and perhaps even with terminal development.

Summary and contents

I. 3G: The leading edge or the bleeding edge?

With third generation mobile phone systems about to launch and to transition from mobile voice service to mobile Internet services, the mobile phone industry appears to be riding the wave of convergence better than any of its communications brethren. But even while mobile subscriber numbers keep growing ever upwards, many of the operating companies are struggling to make the profits that they once took for granted. And to reap the benefits that 3G promises – always on connectivity; high speed data services – mobile companies are going to have to spend large amounts on infrastructure development. With revenue per subscriber falling how can they justify such investments? Then again, with competition increasing and customer churn rates showing no signs of slowing, how can they afford *not* to invest in new services?

II. The mobiles phenomenon

Initially it was believed that mobile phones were an elite good; a business tool for wealthy executives and successful tradespeople. But as both subscription and use began to take off, mobile phones instead began to be seen as a *complementary* good to fixed-line telephony. In developed countries, you had a mobile phone once you had a fixed-line telephone and were after the extra convenience that mobility provided. In developing countries, you acquired a mobile telephone as a way around the waiting lists that inevitably determined the communications structure.

But as the numbers have kept rising, and mobile teledensity levels have begun to pass the 'magic' 50% mark, complementarity has given way to substitution. Many in the industry have begun to believe in the mobile phone as an untethered access device in its own right.

III. Third Generation

The first generation of mobile telephony was analog cellular. Digital networks were the second generation. But third generation is more than a technological upgrade – although it is certainly that, as 3G systems promise to provide always-on connectivity and broadband access.

Third generation is, in fact, the mobile industry's attempt to get to the centre ground of convergence first. In other words, to be the personal access device of choice. The initial convergence debate centred upon the TV vs the PC as the access device. But both of these items are fixed. And neither has the user-base of the telecommunications industry – the infrastructure upon which all of the new media and new communications are to travel. Third generation data and voice communications represents the convergence of mobile phones and the Internet, high-speed wireless data access, intelligent networks, and pervasive computing

IV. A whole new model?

In first and second generation mobile systems, revenue streams were generated by high handset prices, high usage tariffs, or a combination of the two. But mobile phones have become mass market commodities and tariffs have dropped markedly. In addition, marginal revenues from new subscribers continue to decline. What has made this equation problematic for mobile operators is that marginal costs have not turned out to be as negligible as many in the industry thought they would be. Maintenance costs and high customer churn, has meant that equipment costs, advertising and marketing costs, and service innovation demands are far higher than was anticipated.

If this were all there were to the case, we could expect to see a wave of industry consolidation followed by market segmentation, as different operators chased different parts of the market. But the transition from narrowband to broadband threatens to upend all of these market assumptions. In an on-all-the-time world pricing will not be on a per-minute basis, challenging the entire revenue structure of the industry.

Not only has no-one yet identified where the new revenue streams will be generated, no-one knows how to look for the new revenue. While the new technology offers wireless operators the chance to tap into the booming Internet business (which has been dominated thus far by fixed-line service providers), it is a business which is notoriously not generating revenues yet.

V. Ubiquitous access: the possibilities

The perception within the industry is that data services will provide the answer to the slide in marginal revenues. But will they? And, if so, what will these data services be? Can mobile providers renew their revenue streams by pumping entertainment, information and e-commerce services out through the air? If so, they will first need to identify just what these services might be. They will also need to work out how they are to charge for them? (Indeed, will it be the network operator who is doing the charging for such services?)

VI. The role of government: Hong Kong as a test-bed?

Hong Kong provides a good case to study for all of these developments because it stands at the forefront of many of the changes identified above. With six companies operating 11 mobile networks in such a compact territory, Hong Kong has long been a weather vein for industry change.

With compression techniques the spectrum available should support between 3 and 5 operators, but should it be assumed there is no room for new entrants? Or should new entrants be given special consideration, particularly given the content-driven nature of the forthcoming broadband model? Will interconnection offer an answer? Or should an entirely new model be introduced, such as a wholesaler-retailer arrangement?

I. 3G: The leading edge or the bleeding edge?

Most industries can only dream about the wireless industry's growth rates of the last decade. Its success has been a true social phenomenon. Get off a plane almost anywhere in the world and you will see people reaching for their small plastic handsets to check that they are still in contact with their friends and family, or work colleagues and contacts. The success of the mobile industry has been attributed to a variety of factors, from the technological (digitization, smaller chips, longer-lived handset batteries), to the economic (falling prices, network access in developing countries), to the social (greater convenience, globalization, prestige and social acceptance). Undoubtedly, success has resulted from some combination of all three.

And yet, despite the fact that cellular mobile has become a true global phenomenon, and that wireless usage rates continue to rise along with penetration levels, wireless service providers are no longer reaping bumper profits as a matter of course. Indeed, profit per customer is *falling*, and along with it go operator profits. Why?

The answer is simple enough: for the first time in the short history of wireless, subscriber growth alone isn't enough to generate profits. Indeed, the industry as a whole appears to be becoming a victim of its own success. Plunging prices, relentless customer churn rates, and high capital expenditures have combined to create a vortex of "profitless prosperity" in which power has shifted from wireless companies to their customers.[1]

There may be more wireless customers and wireless customers may be using their mobile telephones more often, but they are becoming less and less valuable to the service providers. Commoditisation of the product has happened so quickly that we appear to have stepped through the entire business cycle before anyone realized just how much of an impact the industry was going to have. So. Where will the profits now come from?

The answer, from within the industry, is: third generation systems and data services.

Admittedly, predictions for some time have been that mobile data was going to be big. Really big. And for quite some time the predictions have been wrong. By early 1999 there were still only some 2.5 million mobile data users in the US, compared to more than 70 million voice subscribers, and data represented less than 2% of all wireless traffic.[2] The difference in the equation now is higher transmission speeds and the impact of the Internet.

The newly designed microbrowsers built into the next generation of mobile phones – the so-called third generation (3G) of mobile phones – allow for specially formatted Web information to be viewed on cell phone displays. Thus, the transmission speeds associated with 3G will make data exchange more feasible than they have been, *and* the Internet and the Web have already opened the public's eyes to what is possible and what is accessible. How many people now feel unable to live without access to their email?

But market creation is not a given. Many questions remain if the success of first and second generation telephony is to be seen all over again. Data transmission, and the provision of information and entertainment services, promise to generate new revenue streams – but this is far from assured. And there is a more fundamental question which now challenges the business models of mobile service operators. Next (3rd) generation cell phones will provide 'always-on'

[1] Arnold, Scott Greg A. Reed and Paul J. Roche, 1999. "Wireless, not profitless," *McKinsey Quarterly*, No.4.
[2] Lowenstein, Mark, "Wire Cutters," *Business 2.0*, August 1999, 84.

wireless Internet connectivity – initially at 115 kbps, climbing through 384 kbps and onto the long-awaited 2 Mbps. Cost, currently undetermined, will be based on the *amount of data* rather than on the *time connected.* We are moving from a minutes world to a bits world, and the question becomes how – and for what – will mobile service providers charge?

Our position in this paper is that the industry is in the midst of a paradigm shift as the world begins the transition from a narrowband (time-charged) communications model to a broadband (on all the time) model. The fundamental notion of the business is changing, and as such, success (indeed survival) will not simply be about providing new services or different coloured handsets. It will depend instead upon the ability of operators to package access, rather than providing access. Access to broadband applications and content will drive the market, and while cellular mobile will certainly have its market share, the wireless application, rather than the mobile function, may prove to be the success factor.

For the last several years the average revenue per user of mobile phones has been falling precipitously, such that in competitive markets like Hong Kong, operators find themselves running just to stay in place. In earlier, first and second generation mobile systems, hefty revenue streams were generated by high handset prices, high usage tariffs, or a combination of the two. Now consumers have come to expect comparatively cheap handsets, marginal usage costs, and – when mobile Internet access arrives – flat-priced (and in some markets, free) Internet access. No-one has yet identified where the new revenue streams will be generated, but the new technological and social opportunities mean that the push for market penetration is already happening in earnest. In this position paper we examine the questions faced by the jockeying contenders; questions of technological and manufacturing standardization, regulatory facilitation, and both inter-national and inter-network interconnection. In addition there are issues of content for the new platforms, and of funding to build the new platforms. Section II reviews the phenomenal growth of the mobile industry through its first and second generations. Section III provides an overview of the emergence of third generation technology. Sections IV and V examine the economics of the industry and where the money is to be made in an 'on-all-the-time' world. In Section VI we advance the case that Hong Kong is at the forefront of many of the changes now challenging the industry and provides a weathervane for where the industry is heading and the options facing it. Section VI also provides an overview for policy-makers of the standards bodies which are currently determining the direction of 3G development.

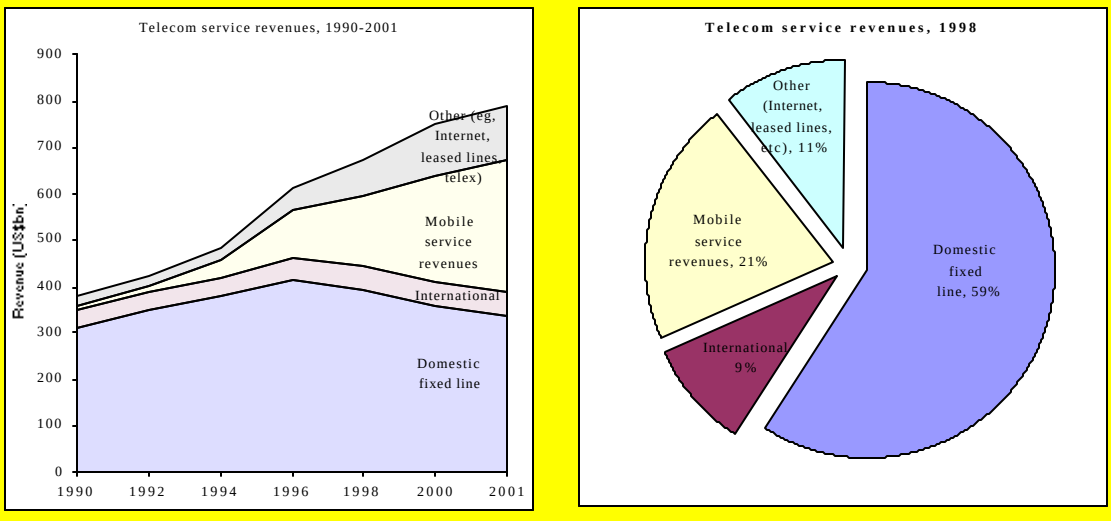
II. The mobiles phenomenon

"The number of mobile subscribers worldwide has been doubling every 20 months since the start of the decade."

— ITU, 1999[3]

By the late-1980s who would have thought it would play out so? But by the late-1990s, the number of new wireless subscribers each year had well and truly surpassed the number of wired additions. And, by sometime late in the next decade the total number of mobile phone subscribers will be larger than the fixed-line population.[4] Already this is the case for certain countries. Moreover, mobile has been – and continues to be – the sacred cash cow of the industry. Indeed, according to the ITU, without the mobiles section of the industry, telecommunications would be a *shrinking industry* in dollar terms by the late 1990s (Figure 1, left side). And despite everyone's recent fascination with the Internet and those amazing Internet market capitalizations, the Internet economy is still only a fraction of mobile telephony (Figure 1, right side).

Figure 1: A cash cow



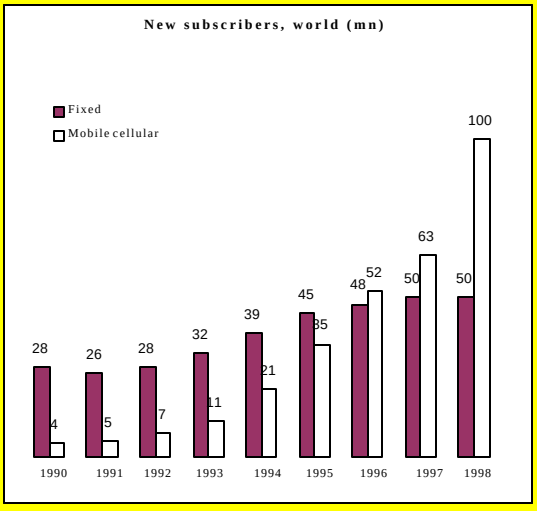
Source : ITU.

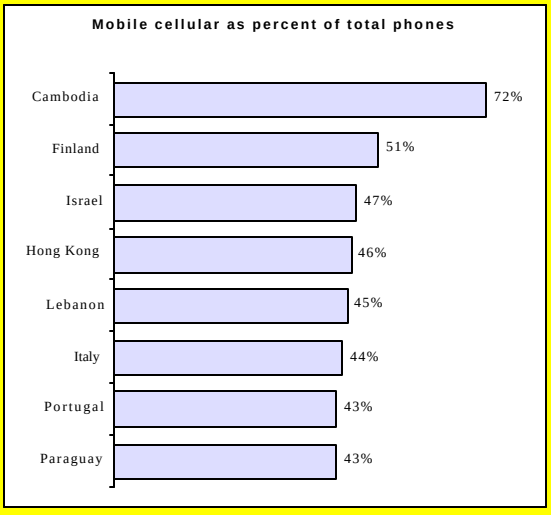
By 1999 there were more than 300 million mobile telephone subscribers worldwide – up from about 10 million just a decade earlier (Figure 2, left side). And this growth is not slowing. In 1998 alone, the total number of new mobile users grew by some 100 million; more mobile phones were

[3] ITU, *World Telecommunication Development Report 1999: Mobile Cellular,* Geneva: ITU, 1999: 5.
[4] The ITU estimates that the estimates the number of mobile subscribers worldwide will overtake users of traditional phones by 2010.

sold worldwide than the number of automobiles and personal computers combined. Ericsson estimates that the total number of wireless subscribers will grow to 700 million by 2002,[5] while Motorola estimates that there will be one billion subscribers by 2003.[6] For the International Telecommunication Union (ITU), the estimate is that by the end of 2000 the number of users will already exceed half a billion. That would represent a compound annual growth rate of more than 50% throughout the 1990s.[7]

Figure 2: Not a luxury…. a commodity





Source : ITU.

For many markets – particularly a number of developing countries – the level of wireless teledensity has rapidly come to challenge the level of fixed wire teledensity, putting paid to the idea that mobile phones are either simply a complementary technology or an elite or luxury good (Figure 2, right side). But even in developed markets such as Hong Kong or Japan the level of wireless penetration has grown well beyond early expectations.[8] In Finland and Cambodia the number of subscribers to mobile phone services has already overtaken the number of fixed line subscribers. In Finland it's not uncommon for consumers to skip the house line altogether. Many in the industry believe that pattern is set to develop in the rest of Europe. More than 50% of the European population is expected to have a mobile phone by the end of 2001.[9] That's up from

[5] In Asia, EMC forecasts that the number of mobile phone users will treble between 1998 and 2003, to reach 353 million. See www.emc-journal.co.uk
[6] Cited in *Wired*, September 1999, 136.
[7] ITU, *World Telecommunication Development Report 1999: Mobile Cellular*, Geneva: ITU, 1999: 5.
[8] As of September, there were more than 3.62 million mobile phone users in Hong Kong, with a market penetration of about 50% according to OFTA (www.ofta.gov.hk).
[9] Salomon Smith Barney estimates. See Kate Norton, "Mobile poses challenge to Europe's traditional phone companies," *Total Telecom*, 11 October 1999.

24% at the end of last year. Increasingly it seems that, if given the choice, why pay for a phone that has to stay in one spot when you can have one that is portable?

These sort of growth numbers have meant that mobile has emerged as a mini-industry in its own right with 1998 service revenues of US$154 billion. Mobile revenue surpassed international revenues in 1995 and is now worth more than twice as much. Again according to the ITU, at current trends the value of mobile revenue will overtake total fixed-line revenue worldwide (international and domestic) in about the year 2004.

Of course, there are a variety of different reasons why mobile telephony has taken off to the extent that it has. In developed countries, mobile service has often been provided by private start-ups who provide attractive and varied services, along with compelling incentives to subscribe – a stark contrast to the dour service of most fixed-line incumbents. In developing countries, mobile phones have often provided the only means of network access, with fixed line waiting lists often years long – again, a stark contrast being provided to the fixed-line incumbent. However, despite the important role that cellular mobile companies have played in introducing competition and market liberalisation, it is in walking and talking – communicating on the go –where cellular phones have come into their own. But now the Internet, along with the convergence of data, voice and image, are on the verge of changing the economics and the dynamics of the mobile phone market, just as they did previously to the PC market. Cellular phones, which were once used almost exclusively for voice, now promise a host of new service opportunities for operators.

As a result, traditional phone companies who are naturally eager to protect their turf are aiming to steal a march on pure mobile operators by integrating their mobile and conventional phone services. British Telecommunications and Viag Interkom (Germany), for example, have introduced services whereby customers have one phone number they can use both at home and on the go. And while mobile operators have been successful in grabbing a significant and increasing share of voice traffic, it remains to be seen whether they can carry this success over to data. To do so they have had to deal, in the first instance, with issues of access speeds and network quality. Hence the introduction of third generation technology.

III. Third generation

"Mobile is the Internet with billing built in."

— Mato Valtonen, founder of WapIT.

The Holy Grail of global mobile telephony for at least for the next five years, is the third generation (3G) standard commonly called Universal Mobile Telecommunications System (UMTS) and referred to in ITU Recommendations as IMT-2000. In telecom-speak, analog cellular was the first wave, and digital networks the second. The third generation of data and voice communications represents the convergence of mobile phones and the Internet, high-speed wireless data access, intelligent networks, and pervasive computing (Table 1). It is suggested that because of its increased accessibility and convenience, this new generation of mobile technology will not only shape how we communicate, but how we work, shop, do our banking, pay our bills, send our messages and schedule our appointments. But that is only the thin edge of the wedge. It will also shape how we gamble, have sex, conduct war and write poetry .[10]

Table 1: Mobile Market Evolution

Generation	***1st***	***2nd***	***3rd***
Signal	Analog cellular (single band)	Digital (dual-mode, dual-band)	Multi-mode, multi-band
Telecom service	Voice only	Voice + ltd text data	Voice + multimedia data
Cellular pattern	Macro cell only	Macro/micro cell	Satellite/macro/micro/pico cell
Coverage	Mostly outdoor	Indoor/outdoor	Seamless global roaming.
Relation to fixed PSTN	Distinct	Complementary	Integrated
Customer focus	Business	Business + consumer	Communications subscriber
Main access technology	FDMA	TDMA	CDMA
Major standards	NMT, AMPS, TACS	GSM, IS-136 (D-AMPS), PDC.	Three mode wideband-CDMA (W-CDMA); direct-sequence (DS), multicarrier (MC), and time division duplex (TDD).

Note: AMPS (Advanced Mobile Phone System), NMT (Nordic Mobile Telephony), TACS (Total Access Communications System), TDMA (Time Division Multiple Access), VPN (Virtual Private Network).

Source : Adapted from ITU.

In effect, this is because 3G is being sold as broadband. But then, in the age of Internet, many new telecommunication access technologies are being pushed as broadband. (Ironically, of course, the Internet has, until now, been a largely narrowband phenomenon.)

[10] See Silberman, Steve, "Just Say Nokia," *Wired*, September 1999, 138.

'Broadband' traditionally referred to anything above a T3 (45 Mbps) or E3 (34 Mbps) link.[11] Nowadays it is much more casually used to refer to anything above a 64 kbps circuit. In reality the distinctions between narrowband (<64 kbps), wideband (<45 Mbps) and broadband services have become blurred by technology as much as by marketing hype. For fixed wire connections, throughput has become a function not just of raw bandwidth, but also compression technology. Similarly, carriers looking to use multiple channels to provide mobile customers with higher bit rates will run into problems if they attempt to charge for incremental airtime on a pro-rata basis. This is the first issue in the transition to 3G: speed. The second issue is standards. The third defining issue is the services that will be delivered over an 'always on' high speed connection. We take the first two (speed and standards) one at a time, before turning out attention to the issue of ubiquitous access in the next section.

The need for speed

The next wave of telecom products will employ three kinds of data and voice transmission. The comparatively slowest layer of coverage will be available anywhere a mobile phone can be used. A series of upgrades to mobile-phone networks in the next couple of years will bring bit rates from the current 9.6 kbps to three times the speed of ISDN connections, or 384 kbps. The next notch up in speed, but with more limited areas of coverage will be wireless local wide area networks (WANs). To this end, telecom companies such as Nokia, Ericsson and Motorola are pitching wireless WANs to hotels and airports to create high-bandwidth 'hot spots' where business travelers can log on. The third layer is a limited-range, low-power radio network that will allow every device carried in a user's pockets or briefcase to communicate with every other device in the immediate area.

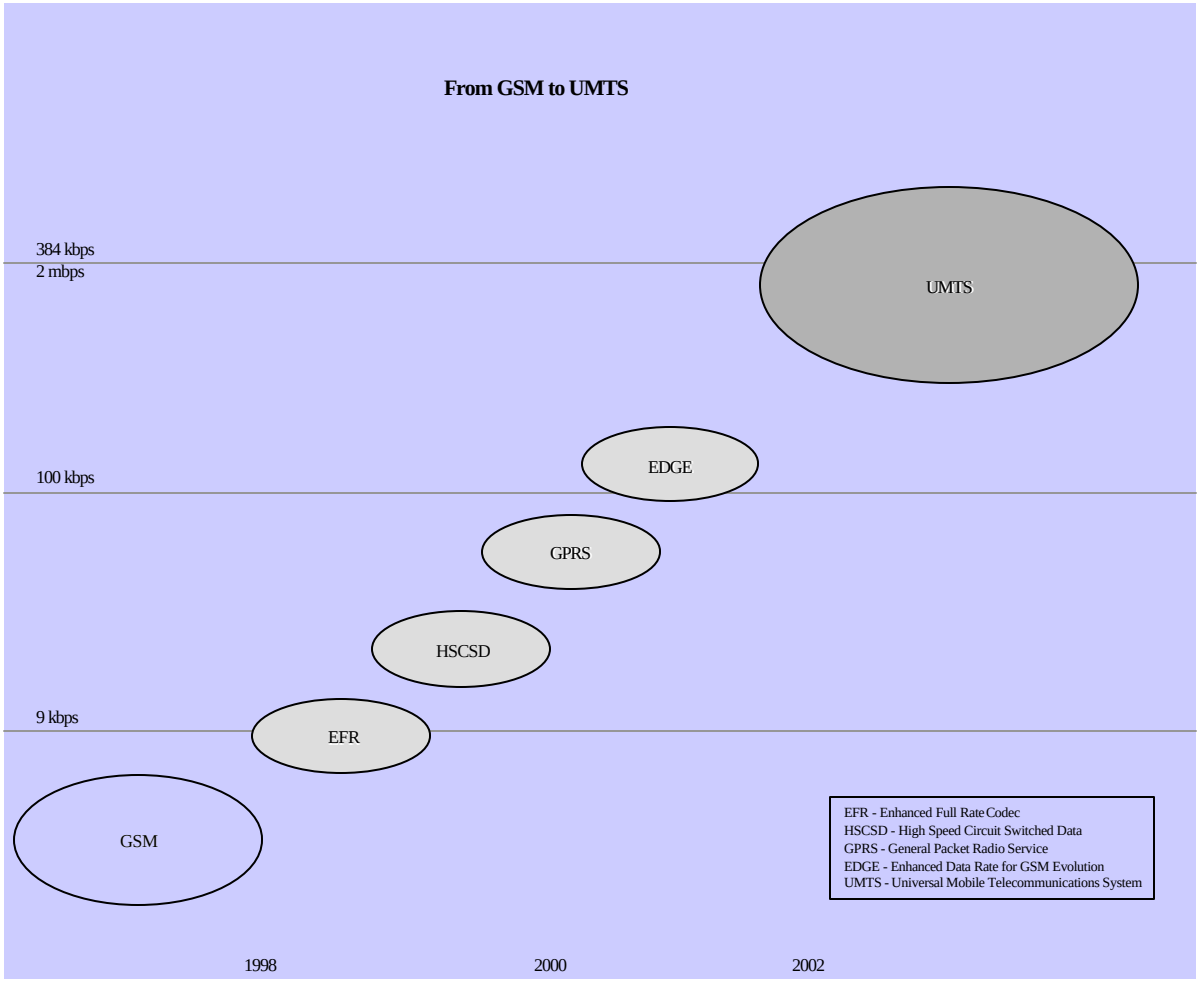
High Speed Circuit Switched Data (HSCSD) transfer, which is already online from some European operators and should become widely available next year, will boost wireless data access speeds on phone networks from 9.6 kbps up to 57.6 kbps. General Packet Radio Service (GPRS), rolling out on GSM networks in 2000, will jack up bit rates to at least twice that. More impressively, GPRS will also allow devices to stay connected to the network all the time, while users are billed only for the time actually spent sending or receiving bursts of data. With higher-speed continuous connections, users will be able to do on their mobile devices what they've gotten used to doing online – have real-time conversations with databases, and scroll and click through menus that live not on their terminals but on the Net.[12] Thus, when a user picks up their mobile, email will be there waiting for them.

Another cellular network upgrade, Enhanced Data rates for Global Evolution (EDGE) EDGE, will boost bit rates on GSM and TDMA networks up to 2 Mbps, and will also allow for the introduction of true 'world phones' – phones that roam anywhere without falling off the map.[13]

[11] There are, in fact, numerous definitions of broadband. Some define the term as any communication channel with a bandwidth wider than 3 KHz (voice grade); others put the boundary at 20 KHz. The CCITT (Comite Consultatif Internationale de Telegraphie et Telephonie) recommendation I.113 defines broadband as "a service or system requiring transmission channels capable of supporting [transmission] rates greater than the primary rate." The Gemini C4 Lab (strategy.gemconsult.com/resources/) defines broadband as any service where transmission rates exceed 1.544 Mpbs (T1).

[12] See cover stories in *Wired*, September 1999 and *Business 2.0*, August 1999.

[13] Gruber, Harald and Marion Hoenicke, "The road ahead: towards third generation mobile telecommunications," *info*, June 1999.



Transmitting data over cell phones isn't entirely new – Short Message Services (SMS) in existing GSM networks,[14] and AT&T's PocketNet news and weather retrieval service have been around for some time. But, generating revenue out of many of these value added mobile services will not be easy. Early mobile data technologies have been clumsy to use, and wireless access to information services has been limited.

And while standards for wireless data are still evolving (there are almost a dozen technical solutions to handheld data access), the driving force in handheld data access has been the Wireless Application Protocol (WAP).

[14] Many existing GSM users have already had a taste of what is to come. SMS lets users send and receive messages of up to 160 characters on their handsets, and has proved to be increasingly popular, especially among young Europeans. More than one billion SMS calls were being made each month in Europe by early 1999. In fact, the mobile unit of Sonera Ltd. (Helsinki) was registering more SMS calls than voice calls. Blau, John, "A Movable Feast – WAP Technology Has Enticed Mobile Operators To Whip Up A Banquet Of Wireless Content Services," *Communications International,* August 9, 1999.

Mobiles get 'wappified'

In 1998, Nokia, Ericsson, Motorola and Psion formed the Symbian alliance, a private consortium for the development of 3G wireless systems. Symbian has been behind Wireless Access Protocol (WAP) as the driving force in handheld data access. WAP is an application environment designed for handheld devices that can be built on any operating system. (WAP is technically a new set of the four OSI layers above the Network layer in the OSI model (see glossary), plus additional security and transaction layers). WAP-compatible mobile phones translate incoming Internet data to match the capabilities of the small screen mobile phone by turning HTML, the computer language in which Web sites are written, into wireless markup language (WML), which has been designed for mobile phones. In industry jargon, existing Web sites will be 'wappified'. WAP essentially functions to minimize graphics and many of the Web's other bells and whistles, so as to accommodate the limited screen size and functionality of mobile terminals. The technology requires a WAP server at the operator's end and a WAP-enabled handset at the user's end.

A de facto global WAP standard, version 1.1, was approved in June by the WAP Forum (www.wapforum.com), an association of vendors and service providers promoting the protocol.[15] The WAP Forum, established at the beginning of 1998, has more than 130 members including the cooperation of software vendors Microsoft, Oracle and Sun Microsystems.[16] But more importantly, manufacturers responsible for 95% of the world's handsets have announced the launch of WAP phones,[17] and several service providers have already begun to integrate the technology into their networks.[18]

The Symbian alliance's protocol of choice for the 'personal networking' layer is named 'Bluetooth'.[19] Bluetooth (www.bluetooth.com) is built around a simple concept: lodging a radio transmitter in a chip.[20] The aim is to enable cable-less communication between any two or more Bluetooth-enabled devices, from phones to printers, from PDAs to peripherals, and on to essentially any other digital device. Bluetooth will allow a PC to 'zap' documents directly to a printer, for example, or to contact the user's list in the nearby Palm Pilot so as to automatically 'sync up' with the PC database as soon as the user walks into their office.[21] And then, when there's new mail, the computer will notify the user's cellular handset, which will display an alert message. Moreover, users could stay wired whenever they are – in the car, on the train or just in someone's waiting room.

According to the consortium, the WAP concept itself will be further strengthened once Bluetooth has been implemented in other small electronic devices. The combination of WAP and Bluetooth technologies will enable content providers, such as banks for example, to distribute small, branded calculators with keys that are dedicated to different services. To bank then, a user will be able to press a certain key on the calculator

[15] WAP is bearer independent, meaning that it runs on all network systems, such as GSM, CDMA and TDMA.
[16] Microsoft, along with Qualcomm, initially went their own way in creating a joint-effort known as Wireless Knowledge.
[17] As many as 525 million WAP handsets are forecast to be sold in the US and Western Europe between 1999 and 2003 (see www.wapforum.org/new/990629_gateway). In March, Finland was the first country to award licenses to operate the next-generation cellular phone system. While Nokia sees 600 million WAP phones being sold by 2003, Ericsson expects 400 million users to have mobile Internet access by 2004. See Jonas Dromberg, "Ericsson doubles 3G phone sales outlook," *Total Telecom*, 11 October 1999.
[18] Japanese cellular carriers DDI and IDO, for example, have launched mobile Internet services based on an early WAP technology from Phone.com, formerly Unwired Planet.
[19] The codename comes from King Harald Bluetooth of Denmark who united Denmark and Norway in the late 10th century.
[20] The Bluetooth technology is based upon a small, integrated radio transceiver which has a unique 48-bit address derived from the IEEE 802 standard. It operates in the unrestricted 2.45 GHz ISM (Industrial, Scientific, Medical) 'free band', which is virtually available worldwide, and transmits data using a time division duplex scheme. The transmission range for Bluetooth is set at 10 meters at a gross transmission rate of 1 Mbps. There are plans for second generation Bluetooth to go up to 2 Mbps.
[21] In theory, as a Bluetooth-enabled device moves within the 10 metre range of another Bluetooth device, they will self-discover each other and, depending on security settings, begin to swap data and provide services the other might use.

to retrieve their bank balance; by pressing another key and entering the appropriate account number, the user will be able to transfer money to or from the account.

However, while Bluetooth-enabled products are already beginning to come to market, adoption of the technology is not a foregone conclusion. Neither Microsoft nor Apple, which combined make more than 90% of operating systems that run on computers today, are part of the consortium developing the radio technology, nor are they in the list of companies which pledge to support the technology.[22] Moreover, Bluetooth devices from different vendors are, in many cases, not yet interoperable – defeating much of the ubiquity argument which underlays the Bluetooth appeal. Indeed, the major Bluetooth consortium partners have yet to agree on an 'interoperable' Bluetooth logo!

The need for standards[23]

To accommodate competing commercial interests and infrastructure, IMT-2000 will probably be a set of three optional airlink interfaces:

(i) Direct Sequence Frequency Duplex Division (DS-FDD), a type of CDMA based on ETSI UTRA and supported by GSM carriers;

(ii) Multi-Carrier Frequency Duplex Division (MC-FDD), a second type of CDMA based on cdma2000 and supported by cdmaOne carriers; and

(iii) Time Duplex Division (TDD), a third type of CDMA based on a second mode of ETSI UTRA and 'harmonized' with TD-SCDMA, an approach favored by China (see below).[24]

As determined by the ITU, the main objectives for UMTS and the IMT-2000 airlink interface are:

(i) full coverage and mobility for 144 kbps, preferably 384 kbps (except satellite coverage at 9.6 kbps);

(ii) limited coverage and mobility for 2 mbps;

(iii) improved spectrum efficiency; and

(iv) adaptable to new services.[25]

We examine the standards organizations in greater detail in Section VII, below.

China's Third Generation leadership promotes Third Generation mobiles

The Chinese government has targeted 3G mobile technology as a part of its campaign (gaining increasing momentum) to encourage the development of indigenous intellectual property, including new specifications and technologies. The Ministry of Information Industry (MII) and the Ministry of Science and Technology are coordinating industry participation.

In 1998, the China Academy of Telecommunication Technology (CATT) urged the MII to propose the China-developed TD-SCDMA format to the International Telecommunications Union (ITU). China's TD-

[22] Microsoft is said to have backed away from the SIG because of a requirement that all members release the rights to any patents on which the technology is based.
[23] For full acronym and reference explanations see the glossary at the end of this position paper.
[24] George Darby, "Mobile Phones as Desktop Computers" TIF Briefing Paper (www.trp.hku.hk/tif), 7th September; PTC conference paper, Honolulu, Hawaii, January 2000.
[25] See the ITU's site at www.itu.int/imt.

SCDMA proposal includes several key technologies such as a smart antenna and uplink synchronization. The Chinese government and industry also established the China Wireless Telecommunications Standard group in April to promote a Chinese 3G specification. The group's backers are leading a Chinese delegation that will seek to make TD-SCDMA the main radio interface for IMT-2000.

The sheer size of China's telecom market is giving it influence in international 3G standards-setting. China operates the world's largest GSM network, with over 35 million subscribers and one million new users being added each month. 3G mobile system field trials are scheduled for the end of 2000 based on the Chinese TD-SCDMA proposal and commercial operations are scheduled to begin in 2002.

China's 3G push has stimulated domestic equipment suppliers, research institutes, design houses and universities to jump into the emerging market. Huawei Technology has hired over 200 engineers in its Shanghai institute to develop mobile phone technologies, and plans to begin 3G trials next year. The company's system will be based on the Chinese TD-SCDMA specification as well as on both wideband CDMA and CDMA 2000 standards. Zhongxin Telecom has also launched a broader telecom research effort. Along with 3G, it is participating in national projects focusing on wideband CDMA transmission and receiving units. Zhongxin also has more than 200 researchers on its 3G and CDMA teams. Other suppliers working on 3G standards are Datang. Great Dragon, and Eastcom (Hangzhou). Shanghai Bell, a joint venture with France's Alcatel, is also investing heavily in 3G research.

China's national 3G development project also has 10 universities and research institutes cooperating in their research efforts. As such the drive to develop a Chinese version of the 3G standard marks one of the first joint efforts by local institutions to create a new technology standard. And by mid-1999, China had invested more than US$500 million in 3G research. The efforts have been spurred in part by high royalties charged by CDMA patent holders like Qualcomm Corp. and by DVD firms. To avoid royalties, the Chinese governments and state-run enterprises have moved aggressively to invest in new standards and technologies. The results are expected to include intellectual property for core technologies, specifications and patents.

Source: Liu Sunray, 1999. "China promotes homegrown 'smart' 3G Spec", *Electronic Engineering Times*, 11 Aug, p.36.

Bringing the industry up to speed and into line is only the first step in the development process. No-one yet appears to have thought of a business model for the mobile Internet. The existing *business* model for mobile telephony is essentially the same as that for narrowband fixed-wire telephony: a per-minute tariff scheme. By contrast, the existing Internet business-to-consumer model is a combination of advertising and transaction pricing. One thing would appear to be fairly certain, applying old content models to a new paradigm is a sure recipe for disappointment.

Specifically, charging against simplified information services is unlikely to work when users will have an increasingly sophisticated source at the desktop. And many in the industry doubt whether advertising can replace tariffs in the mobile world. But if advertising is not the alternative, then operators are going to have to find other revenue streams. And, in either case, operators will have to change their pricing model, for in an 'on-all-the-time' world, customers won't pay per-minute – and this challenges all of the principles of the existing business models. We move into these gray areas in the next two sections.

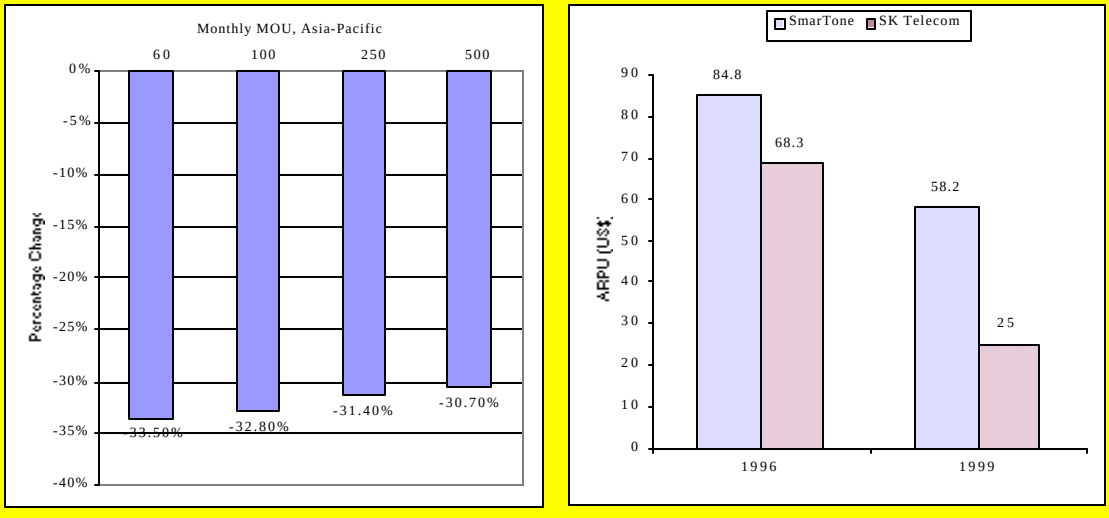
IV. A whole new model?

"This will mean the end of the circuit-switched telecommunications world."

– Filip Lindell, Ericsson

A booming number of wireless customers may be using their mobile telephones more often, but they are becoming less and less valuable to the service providers. Potential customers perceive wireless offerings to be more or less equivalent and therefore buy on price, helping drive tariffs down (Figure 3, left side). In order to understand the economics of mobile communication operations, one really needs to look at those operators which offer only mobile services rather than those which also offer fixed-line services, in order to disentangle costs common to both mobile and fixed-line networks, such as marketing, billing or customer service. Common wisdom suggests that the start-up costs of a mobile network will be significantly lower than for fixed-line because there is no necessity to create a direct path to the subscriber which, for a fixed-line network, usually means digging up the road. Furthermore, in a mobile network, more of the network intelligence is embedded in the handset, which is an investment decision made by the customer, rather than in the network provided by the operator.

Figure 3: Declining mobile revenues



Source: Yankee Group (left side); Credit Suisse/First Boston.(right side)

This isn't, however, how the game has developed. The lower capital expenditures that wireless providers had hoped for when they deployed digital networks have failed to materialize; in fact, expenditures are well above expected levels because companies have had to "overinvest" to deliver high-quality service in what are increasingly competitive markets. Such is the competitive pressure in mobile, that charging for services has become increasingly dependent upon service innovation. To put this another way, the cost of acquiring and retaining customers is turning out

to be much higher for mobile operators than for fixed-network operators.[26] With 3G, this unwelcome trend is certain to continue with requirements for improved voice capacity and quality, as well as high-bandwidth data services, will call for even larger incremental capital expenditures.

Moreover, industry analysts estimate that each service provider will have to initially invest between US$1 billion and US$3 billion, depending on the size of the network, before 3G fulfills its destiny, of which network build-out costs will take 50%, with sales and marketing costs taking the other 50%.

For mobile operators, a critical indicator is average revenue per user (ARPU). For mobile users, ARPU has been declining over time (Figure 3, right side).[27] This is the result of two principal factors: price cutting in competitive markets; and growth in the number of subscribers. The decline in ARPU would perhaps be not of such great concern if marginal costs were negligible, but as we have seen, they turned not to not be when quality of service issues, coverage, and handset and service innovation issues were addressed. So, while ARPU may well be increasing among existing subscribers, the lower usage patterns of marginal newer subscribers is sufficient to drag down the overall level of ARPU. And this has brought the business proposition of mobile operators increasingly into question.

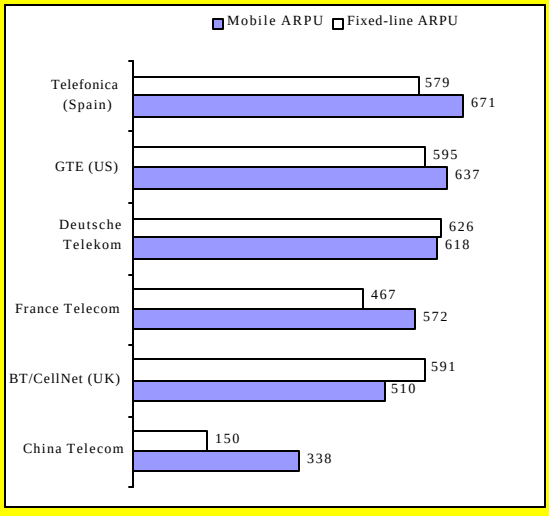
For mobile operators as a whole, there has been a convergence over time between the average spending of fixed-line and mobile users (Figure 4, left side). (But as the ITU notes, "features available on mobile handsets – such as caller identification, voice mail, call forwarding and transmittal and reception of short text messages – are typically made available free of charge [on mobiles]. On fixed-line telephones, these features generally cost extra".[28]) This is well-illustrated in the case of Japan where, in 1990, the average mobile user was spending three times more per year than the average fixed-line subscriber. By 1997, mobile users were still spending more, but only by 20% (Figure 4, right side). Critically, convergence was the result of mobile spending falling rather than fixed-line spending rising. Why the dramatic decline? Cheaper handset prices combined with cheaper mobile services combined with rising market penetration (and therefore increasing acceptability) brought many new, more *marginal*, users onto the mobile network. Thus, while growth numbers keep going upwards impressively, and even though the overall industry revenue has continued to grow, *marginal revenues* have deterioriated – in many cases alarmingly.

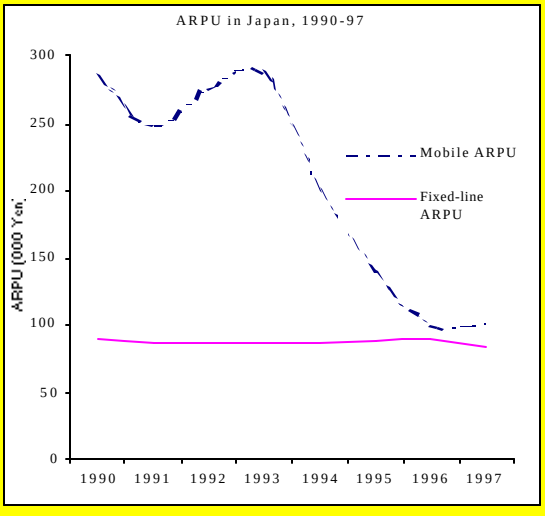
[26] In Hong Kong, some 200,000 mobile users changed their suppliers in the three months following implementation of mobile number portability.

[27] As Ure notes, "The trend for mobile revenue growth to slow, or even reverse, is worldwide. The reasons are various, including cyclical issues such as the economic recession which probably reduced revenues from cellular around Asia by about one-third over the past two years (and sent many cellular operators in developing Asian economies deep into the red); the higher-than-anticipated costs of network rollout, maintenance and upgrade; equipment and equipment-supply problems; and, more importantly longer-term, market penetration into lower income segments of the market." See "Broadband: Broadening Horizons, not just Bandwidth", TIF Briefing Paper, December 1999, www.trp.hku.hk/tif.

[28] ITU, 1999. *World Telecommunication Development Report*, p.1.

Figure 4: Falling ARPU





Source : ITU.

As we suggested at the outset, the perception within the industry is that data services will provide the answer to this slide. But will they? What will they be? And how will mobile operators charge for them? (Indeed, will it be the network operator who is doing the charging for such services?)

In earlier, first and second generation mobile systems, hefty revenue streams were generated by high handset prices, high usage tariffs, or a combination of the two. Now consumers have come to expect comparatively cheap handsets, marginal usage costs, and – when mobile Internet access arrives – flat-priced (and in some markets, free) Internet access. No-one has yet identified where the new revenue streams will be generated.

Certainly, the new technology offers the wireless broadband pipe that mobile companies need to carve a chunk off the booming Internet business, which has been dominated thus far by fixed-line service providers. And to this end, service providers appear eager to open their wallets. On the other hand, broadband wireless promises to also help the likes of fixed-wireline giants Nippon Telegraph and Telephone (NTT), AT&T and Deutsche Telekom establish a global footprint in the mobile communications market. Companies such as Orange, for example, have already announced that they intend to use 3G licenses to increase their multinational presence by bidding for licenses alone or in consortia, as providers did when GSM cellular networks were first introduced.

Can mobile providers renew their license to print money by pumping entertainment, information and e-commerce services out through the air? If so, they will first need to identify just what some of the killer mobile applications might be.

Microsoft gets mobile

The old Microsoft mission statement read:

"A computer on every desk and in every home."

The new Microsoft mission statement reads:

"Empower people through great software any time, any place and on any device."

Senior strategic staff at Microsoft are saying that the telecoms sector has moved dead center of the software company's sights. For the first time in its 25-year history, the company has re-written its vision statement. This has been done to free Microsoft from its dependence on the PC and to focus in on wireless. As such, Microsoft is ready to buy direct stakes in UMTS network operating companies.

Until now, Microsoft's telecoms ambitions have centered on broadband fixed networks such as cable TV systems operators Comcast (USA) and NTL (UK). However, Microsoft has set up technology positions in mobile data. Last year, it formed the Wireless Knowledge joint venture with chipset vendor Qualcomm. This year it bought applications developer Sendit and plans to open an Internet portal with wireless operator partner Nextel Communications.

And according to industry reports, the new mission statement has been re-written to "be inclusive of wireless." Two days after Telecom'99 closed, Deutsche Telekom MobilNet announced that it would standardize on Microsoft Windows CE and Microsoft Exchange in its mobile services platform. The main reason for siding with Microsoft was to "have Microsoft's cash to build out the networks." This, despite the opinion that "CE isn't optimal for wireless devices, especially wireless Web access devices. With wireless you need to design systems to cope with shared bandwidth. If part of a Web download fails, then with EPOC and the Wireless Application Protocol you have robustness in making the most of what's left. With CE, you risk losing everything."

Microsoft is playing a strange game. The Microsoft push to get its operating system standardized will exclude other developers' technologies that could effectively make Microsoft's own technology work better in the crowded network. This is because even shared spectrum will be limited for wireless data operators, and cannot be created, as it can in fiber networks. The Microsoft vision says that long term they don't need to treat wireless any differently. But even Bill Gates admits that wireless won't have the bandwidth available.

Before it is concluded that Microsoft has seen the pot of gold that exists at the end of the 3G rainbow, their strategy needs to be put in a broader context. Microsoft has been chipping away at the telecoms market for a few years, hoping to displace Unix servers in operators' back-end systems with its own NT operating system. Microsoft has also worked with operators as distributors for its software, such as Deutsche Telekom, which back in 1997 started marketing products based on Microsoft's BackOffice and Microsoft Commercial Internet Systems to business customers. The new emphasis on putting its operating system on every device broadens the relationship to include telecoms equipment manufacturers, such as Nokia, Ericsson and Motorola, from which the company has yet to garner much support.

V. Ubiquitous access: the possibilities

"Once the novelty of ubiquitous access to the network and anytime, anywhere communications wears off, we'll wonder how we ever got along without it."

— editorial, *Business 2.0* , August 1999

"We're going to see a lot of media companies enter the mobile sector, largely because they view handsets as the ultimate device to target personalized information."

— Rory Maguire, content service manager, Orange PCS.

In early 1999, a number of vendors – such as Ericsson, Nokia and Motorola – began to express the concern that even though the networks were being upgraded and the hardware was ready to ship, that by the time the systems were ready for launch, there wouldn't be any content. Internet time, however, meant fast development: over the past nine months there has been a steady stream of services and content announcements.

Examples include Omnitel, which launched a Web portal in June with 150 different services – including news, stock quotations and travel information – accessible by a PC or a mobile phone (using WAP). Telecom Italia Mobile SpA began testing similar services. In the UK, Orange's Internet-based media and information services over its PCS network include an exclusive partnership with the broadcaster Independent Television News for news and entertainment programs and news and financial feeds from Reuters; a cooperative effort with Associated Newspapers to provide a restaurant review guide, cinema and theater listings and local news; and a travel service that lets customers access traffic reports and information on rail and air schedules. The rollout of the new wireless Internet services is being accompanied by the launch of Orange's new HSCSD service, offering initial speeds of 28.8 kbps.

Ericsson has also revealed a range of services that will be available through its 'Mobile Internet' portal. Service providers include: online CD vendor Boxman; city information and services platform provider, Citikey; and Pactive, a news broker. US cable network CNN launched what it claimed as the first global wireless news and information service. CNN Mobile provides news to handsets either as short takes via SMS or in greater depth using WAP.

Are any of these content services making money? As we indicated above, network providers don't seem to *expect* to make substantial revenues on simplified information services. (Why will people watch their handsets for breaking news on the O.J. Simpson trial or the Kosovo conflict when they can get to a TV screen?) And while these services are not exactly seen as loss-leaders, they are seen to be interim moves until the *real* wireless access becomes available. (Moreover, since these information services have already been produced the marginal cost of providing them is almost zero.)

To bring streaming video to wireless devices, transmission speeds must get significantly faster. With 3G products not about to hit the market before 2001, there are a number of critical hurdles for 3G operators. The first of these is the need to build a market base fast enough to be able to amortize costs and enjoy the necessary economies of scale and scope. As the mobiles data market grows, consumers will undoubtedly begin to explore emerging interim products. At around 100 kbps – or slower – they lack 3G's multimedia capabilities, but are quick enough to send and receive email, check news, and trade stock. Will this erode the market for 3G, particularly given the cost of network build-out?

2.5G

A number of operators have begun focusing on what is known as '2.5G' technologies, such as GSM's GPRS and CDMA's IS-95B which are claimed to boost 2G cell phone data rates to around 115 kbps. In the words of a Motorola representative, "115 kbps is more than enough bandwidth to handle most of the 3G broadband services being proposed, with the exception of high-quality video".[29] 2.5G services could provide a convenient ramp-up position. On the other hand, this perspective could prove equally damaging to operators who invest in 3G only to find customers balking.

Wireless Home Networking.

The contenders for ubiquitous home device networking include:

- HomeRF (www.homerf.org),[30] which plans a 1.6 Mbps data rate to tie PCs and their peripherals together without wires; it will also handle four voice streams.
- Bluetooth (www.bluetooth.com) which is being designed to provide 1 Mbps links between all the 'smart' devices a consumer may be carrying, such as your notebook, pager, and PDA, allowing them to interact.
- Wireless Ethernet (IEEE 802.11), offering 11 Mbps over the 2.4 GHz band.
- Philips and Wi-LAN are promoting a wireless implementation of the IEEE 1394 (FireWire) very high speed port which currently is used primarily to connect digital camcorders and other video peripherals with PCs. Also transmitting in the 2.4 GHz spectrum and using a variant of IEEE 802.11, this solution uses Wide-band Orthogonal Frequency Division Multiplexing to provide a raw data rate of 46 Mbps (although by the time the significant overhead of several protocols is accounted for, the actual end-user data rate is down to a 'mere' 24 Mbps).

Source: "The Rapidly Changing Face of Computing" www.compaq.com/rcfoc.

Combined with network costs is the 'politicization' of the spectrum management. Distribution of new broadband wireless frequencies has been used in some markets as a competitive tool, whereby incumbent operators have been excluded from auctions in the interests of developing alternative local loop services. In addition, some governments are motivated to enhance the value of spectrum – and government revenues – regardless of the business case for 3G.[31] As regulators begin the licensing processes for 3G operators, carriers need to understand now how the evolving broadband wireless environment is likely to affect their 2G investment decisions and how the development of 3G services will change the operating environment in, say five years' time.

[29] South Korea's SK Telecom launched the world's first high speed wireless multimedia service, a 115 kbps wireless voice and data capability based on IS-95B technology, in early 1999. Using new multimedia handsets SK Telecom subscribers are able to send and receive voice and data transmissions through the new service.

[30] See also the site for the Digital Enhanced Telecommunication Standard (www.etsi.org/DECT/dect.htm). In Europe, DECT is becoming established as the standard for wireless connectivity in the home. HomeRF's technology is based on DECT.

[31] In the US, it should be noted, spectrum value has declined from as high as US$208 million per MHz for a nationwide license to less than US$1 million per MHz. If auction prices truly reflect the economic value of the particular usage of spectrum on offer, then this is further evidence of the declining profitability of mobile telephony.

On the other hand, the potential pitfall of 2.5G is that it may distract operators from the path to 3G – like 2G GSM CDMA and D-AMPS, 2.5G technologies are proprietary, and their adoption might make eventual migration to 3G more difficult and costly – particularly if 2.5G vendors don't bear IMT-2000 migration in mind.

Phone/computing convergence: The operating system

The next challenge involves providing "payload and protocol conversion services" and mobile network access that is equivalent to an end-user's wireline access (Internet Protocol Convergence). Payload conversion services involve converting speech to email, email to speech, email to fax, fax to email, and other conversions between two message types. Internet Protocol (IP) Convergence involves:

1. reducing the need for *protocol* conversions for a given payload type (voice, data, or video) as a message shuttles among circuit-switched, packet-switched, wireless, and wireline facilities (fixed/mobile integration), and
2. developing multimedia mobile terminals that approach or equal the functionality of desktop computers.

How smart must a smart phone be to support IP convergence? Smartness depends upon the graphical user interface (GUI), software applications, operating system, processing power, storage, memory, network and peripheral interfaces, and power management. At a minimum, smartness requires voice telephony, Web browsing, email, and a personal information manager for contacts and notes (PIM). At a maximum, smartness requires desktop computer equivalence.

One of the major challenges to be addressed by manufacturers is how a user takes notes or revises stored information during a conversation If a mobile user wishes to do more than non-trivial amounts of text entry, the requirement will be for a smart phone with keyboard. The 'handheld personal computer' (HPC) accessories (keyboard, display, earset, etc.) could be cabled to the HPC or they could have a wireless interface, such as Bluetooth.[32]

Desktop computer equivalence may seem far-fetched, but it is largely a matter of whether the user composes non-trivial amounts of email and prefers a legible, HTML-based Web browser. For use in smart phones, a battery power managed, instant-on operating system is needed, such as PalmOS, Symbian EPOC, or Microsoft Windows CE. (Smaller HPCs that run the Windows CE operating systems are the same size as sub-notebook PCs that run the Windows 98 or Windows NT operating system used in desktop computers.)

The use of microbrowsers and small display screens in handsets has prompted the server-side processing of HTML WebPages to remove graphics and animation (to reduce Kb/Webpage transmitted over the airlink and to reduce the RAM footprint of the microbrowser in the handset); and to better fit the low pixel count of the average smart phone LCD. The most common solution for this task is the combination of Wireless Markup Language (WML) and WAP. In broad terms, WML is analogous to HTML, and WAP is analogous to HTTP.

Source: George Darby, "Mobile Phones as Desktop Computers" TIF Briefing Paper, 7th September, www.trp.hku.hk/tif; PTC conference paper, Honolulu, Hawaii, January 2000.

[32] Palmtop computers that lack a dedicated keyboard are generically referred to as "palm personal computers" or PPCs to distinguish them from HPCs.

VI. The role of government: Hong Kong as a test-bed?

If the early adoption of 3G services is to be successful – and by this we mean transparent, competitive and comparatively painless – two major issues need to be dealt with by national regulators. The first is harmonisation, where possible, with international standards. International standards are of fundamental importance to 3G developments but as we have shown, they are already heavily politicised. Below we provide a roadmap of some of the central bodies involved in the process. The second issue for regulators and policy-makers is how to create the right competitive incentives to jump-start the new market for wireless broadband services.[33] The third issue to be dealt with is by what means to allocate spectrum and how it should be paid for (see 'Auctioning' below). With compression techniques the spectrum available should support between 3 and 5 operators, but should it be assumed there is no room for new entrants? Or should new entrants be given special consideration, particularly given the content-driven nature of the forthcoming broadband model? Will interconnection offer an answer? Or should an entirely new model be introduced, such as a wholesaler-retailer arrangement?

The big challenge facing national regulators is how to attract the right blend of players. Governments usually have two basic options: (1) give licenses to the incumbent mobile operators so that they may use precious spectrum to resolve capacity problems with their second-generation networks; or (2) reserve a few licenses for new players and run the risk that newcomers may fail to capture substantial market share from the incumbents.

First movers

Finland has already issued four wireless multimedia licenses, deciding against auctions in favor of a technical evaluation model. The country, which boasts a mobile penetration of more than 70%, apparently doesn't want to stop the mobile revolution. By comparison, the United Kingdom has decided to auction five licenses early next year, hoping to raise around UKP2.5 billion (US$4 billion). The telecommunications minister has indicated that the government will reserve the largest portion of available radio spectrum for a newcomer. The United Kingdom currently has four cellular operators. New entrants will be able to roam – i.e., have their calls and data traffic carried by at least one of the existing mobile networks – until their own infrastructure is in place.

The German regulatory agency, RegTP, is expected to pursue auctions and will also allocate spectrum for a number of new players. Germany currently has four mobile operators. Competitive local service providers in the country are lobbying intensively for regional licenses. In its 91-page proposal, RegTP says the spectrum has been divided up to give as many licenses as possible. RegTP explains that it will divide the available 2x60 megahertz paired and 1x30 MHz unpaired spectrum into five frequency packages, each consisting of 2x10 MHz. These packages will then form the basis of five national UMTS licenses. The remaining frequency, five packages of 2x5 MHz, will provide the basis for an unspecified number of regional UMTS licenses. Under the German model, existing mobile operators would have no automatic right to a 3G license, unlike

[33] Although the ITU, among others is seeking to design a global standard, the process is still very much in the hands of national agencies. As a result, don't expect a common worldwide licensing model. The only common criteria established by the European Commission (EC), so far, is that member states must approve licensing schemes no later than Jan. 1, 2000, for 3G networks to be introduced by Jan. 1, 2002. Everything else – the number of players, the amount of spectrum awarded to each, the level of national coverage, national roaming rights for second-generation voice and data services – has been left up to the individual governments. The amount of spectrum *needed* also varies – depending on whom is asked.

in the United Kingdom where incumbents will be allowed to upgrade. However, the German regulator has so far attracted strong criticism from mobile operators for proposing to offer UMTS licenses that do not allow the full multimedia capability of third-generation technology. The new licenses package quantities of spectrum that the UMTS Forum says fall well below what operators need in order to offer rich voice, data and video applications.

The UMTS Forum argues that the proposed 2x10 MHz is not enough frequency for operators to provide the promised range of broadband multimedia services at user bit rates of up to two megabits per second for the future mass market.[34] In a 1998 report prepared by the Spectrum Aspects Group of the UMTS Forum, the organization concluded that 2x15 MHz paired plus 5 MHz unpaired is the "preferred minimum spectrum requirement per public operator in the initial phase."

Still foggy are the plans of the Japanese regulator, which has been pushing for the launch of next-generation mobile services by January 2001, one year earlier than Europe. The Ministry of Posts and Telecommunications (MPT) initially indicated in draft guidelines (1998) that it planned to grant up to three nationwide licenses based on a technical evaluation model. It has subsequently announced that it will follow the recommendation of the Telecommunications Council that both competing standards for third-generation cellular networks be approved. Thus, both W-CDMA, which was co-developed by Japanese cellular giant NTT DoCoMo, and rival standard cdma2000, which is backed by US company Qualcomm and the CDMA Development Group will likely be licensed.[35]

Auctioning the Spectrum

The radio spectrum has generally been regarded as a valuable natural resource with unique characteristics. As a result of this perception it has been the government's responsibility to manage radio spectrum for the greater good of the public. Indeed, a principal reason for the establishment of the US Federal Communications Commission (FCC) by the US Congress was "to manage the radio spectrum so that the public could receive maximum benefit from its use". Therefore, when certain governments began proposing to auction off the spectrum supply in the early-1990s, it was seen to be a radical break with tradition. Why was this path pursued? And how successful has the initiative been?

The motivations behind auctioning are fairly straightforward: communication ministries want to see the resource allocated efficiently; governments (and taxpayers) want to see a healthy return from the sale; while the telco's (or 'cellcos') who bid want to be able to realise a return on their investment. The theory behind auctions assumes that the market will provide a more efficient allocative process than the deliberative processes of government bureaucracies; it assumes that a country's financial markets will enable individuals or corporations with sound business plans and superior talent to obtain financing at competitive terms.

If successful, auctioning can serve the public interest in several ways:

[34] In March 1999 a milestone agreement of the International Telecommunication Union paved the way to free an extra 160 MHz of spectrum for all mobile services in preparation for the WRC meeting in 2000. There must also be agreement on which services will benefit from extra bandwidth. To complicate matters even more, any decision taken by the WRC cannot be effective before 2005 at the earliest - and that date is long after the expected launch of UMTS services in 2001 and 2002. See Peggy Salz-Trautman, "Mobile Operators Say German UMTS licence proposals will limit services," *Communications Week International,* 25 October 1999.

[35] "Japan to allow both 3G Standards", *TelecomAsia,* 29 September 1999.

1) A well designed competitive bidding approach is better able to get spectrum into the hands of those who value it highly. Moreover, where the auction process is handled efficiently, this approach is seen by advocates to facilitate spectrum aggregation rather than causing fragmented secondary markets.

2) Users who are not required to pay market value may have an incentive to acquire licenses on a speculative basis simply to resell these licenses, thereby wasting valuable resources in rent seeking. (This occurred on a widespread basis in the US when the FCC awarded cellular licenses by lottery.)

3) Auctions vastly reduce the administrative delay in allocating licenses when there are multiple applications.

There are, however, also problems inherent in the auctioning process. A frequently voiced concern is that unqualified companies will over-bid in order to acquire an asset – the license – which may be of considerable speculative value. Having secured the license, such companies look to investors for a fast return on their capital commitments. Indeed, if all goes to plan, they end up with no commitments at all, but if all does *not* go to plan they can end up not being able to meet their bid installments. Both India and the US have had this experience.

In the US, the so-called C-Block auction for entrepreneurs, went awry when smaller participants ratcheted up their bids to almost three times those of big companies, such as AT&T Wireless and Sprint Spectrum, in an earlier round. Financial breaks from the FCC allowed the bidders to gamble and bid prices up sky-high. For example, NextWave Telecom Inc. pledged $4.2 billion while Pocket Communications bid $1.4 billion. They, and other similar start-ups, could then not find the investors they needed to back them, and were subsequently forced to declare bankruptcy.

Another danger is that over-bid prices will be recouped by being passed on to customers, although this probably implies that the policy design is poor and competition is ineffective in forcing prices to reflect operating costs.[36] If the design of auctions is faulty - in large markets they can be complex – or if the market environment is inappropriate, auctions may not deliver the best outcomes.

Below we provide more detailed descriptions of certain particular country assignments.

New Zealand - In June 1990, New Zealand auctioned three new cellular licenses simultaneously using a sealed bid. It used a second price sealed-tender auction, which meant that the highest bidder won the license, but only paid the amount bid by the second highest bidder. This meant that one winner bid NZ$101 million, but only paid NZ$11 million.

Greece - In July 1992, Greece auctioned two national GSM licenses. Participants submitted a single bid for one of the licenses and the highest bidder won the first license. The rules stated that if the second highest bidder was within 10% of the highest bid, then it had the sole right to match the highest bid. If it decided not to match the highest bid, then it and the remaining participants could participate in another round of bidding for the second license. The second highest bidder actually bid 91% of the highest bid and elected to match the highest bid, thus winning the second license.

United States - The Omnibus Budget Reconciliation Act of 1993 authorized the FCC to use competitive bidding procedures to award certain electromagnetic spectrum licenses. The FCC used a simultaneous multiple round auction for its first spectrum auction of Narrowband Personal Communications Services beginning on July 25, 1994 and an oral outcry design in its auction of Interactive Video and Data Service (IVDS) licenses beginning on July 28, 1994. Subsequent auctions have included: Regional Narrowband PCS (6 licenses in five regions), MTA Broadband PCS A & B (99 licenses) and C (493 licenses-BTA), Direct Broadcast Satellite (2 licenses), Multichannel Distribution Service (493 licenses), and 900 MHz Specialized Mobile Radio (1020 licenses).

[36] Opposition to auctions on these grounds have been expressed by the European Union's 1994 Green Paper on a Common Approach in the field of Mobile and Personal Communications, and more recently by the International Telecommunications Users' Group (INTUG – draft response to the European Commission's 1999 Review – personal communication).

Columbia - In January 1994, Columbia auctioned a second cellular license in each of three regions. The rules allowed consortia to bid in all of the regions. In a simultaneous single round auction, the highest bidder in a region won the license. The first licensee in each region was then required to pay 95% of the total amount bid by the second licensee.

India - In August 1995, India held an auction for two GSM licenses in each of 20 regions ('circles'). The rules allowed consortia to bid in any and all of the regions. The highest bidder won the first license in each region and had to pay the amount it bid in an up-front payment and subsequent annual payments. The second highest bidder had to match the highest bidder if it wanted to receive the second license. If it declined, the right to the second license fell to the third highest bidder, which had to match the highest bidder in order to receive the license. If no bidder matched the highest bid, then the second license would be re-auctioned.

Panama - In January 1996, Panama held a single round auction for a national cellular license in which the highest bidder received the license. The Panamanian authorities pre-qualified applicants based on technical, financial and business criteria before allowing them to submit a single financial bid at a public bid-revealing event. The highest bidder won the license.

In contrast to the single-round method employed in the majority of the examples cited above, *simultaneous multiple round auctions* work by having all interdependent licenses put up for bid at the same time. (Activity rules are used to ensure that bidders do not hold back from bidding until they see what values other bidders place on the licenses.) Some observers believe that single round sealed bid auctions generally raise less revenue, lead to complicated bidding strategies, produce inefficient outcomes, and pose winner's curse problems (i.e., the bidder ends up feeling that they overbid). When there are value interdependencies because of the possibility of geographic aggregation, such as was the case in India and Columbia, a sequential auction is a poor design because bidders must attempt to forecast future prices in order to bid sensibly, thus complicating the bidding process.

Source: Gregory L. Rosston and Jeffrey S. Steinberg, 1997. "Using Market-Based Spectrum Policy to Promote the Public Interest" www.fcc.org/wtb/auctions/papers; National Broadcasting Co. v. United States, 319 U.S. 190, 210-14 (1943); John McMillan, 1995. "Why auction the spectrum?" *Telecommunications Policy*, v.19.3, April.

Hong Kong

Hong Kong provides a good case to study for all of these developments because it stands at the forefront of many of the changes identified above. With six companies operating 11 mobile networks in such a compact territory, Hong Kong has long been a weather vein for industry change.

As Ure notes in a recent article[37]:

> For the first time since its listing in 1987, Cable & Wireless HKT posted a fall in profits for the financial year ended March 1999, from HK$17.02 billion (US$2.2 billion) to HK$11.5 billion (US$1.5 billion) in profits attributable to shareholders, while operating profits were down from HK$13.3 billion to HK$11.8 billion. The chief causes were a drop in revenue from international traffic by twenty-two per cent, and from mobile cellphone services, down by three per cent. …. By contrast, Internet and multimedia services earnings were up 146 per cent, but as yet they account for only two per cent of total revenue. The significance of these results extends beyond the purely financial,

[37] John Ure, 2000. "The Era of International Simple Resale: not waving, but drowning?" *Telecommunications Policy*, vol.24, no.1 (January).

> as they encapsulate the changes overtaking the entire telecommunication industry globally.

Ure goes on to point out that where "in the second wave, the digital wave, revenues from basic carriage were no-risk, and revenues from value-added services low-risk. In the third wave, the Internet wave, revenues from basic carriage, including cellphones and Internet access, will fall to the point of disappearance, while new sources of revenues will involve considerable risk (because of copyright piracy, exchange rate and payment risk, etc.) and high uncertainty (because of new entry, of process and product innovation, etc., on the supply side, while the hierarchy of future needs and desires is unknown on the demand side). In the Internet wave, the only certainty is uncertainty, and this 'principle of uncertainty' is expressed in many ways, for example in haphazard industrial restructuring, in the valuation of company assets, in the price of Internet stock.

The full implications of this shift are as little understood – yet – in Hong Kong, as in the rest of the world. However, circumstances place Hong Kong very much in the forefront of these developments (albeit on a far smaller scale than in the US).

The standardisation process: A roadmap and reference guide

The standardisation process is being led by the ITU under its International Mobile Telecommunication 2000 (IMT-2000) initiative(www.itu.int/imt/). As a part of this initiative, the regional bodies, ARIB, ETSI, T1, TTA and TTC are working towards the production of Technical Specifications for a 3rd Generation Mobile System based on GSM core networks and certain specific radio access technologies. Within this, the Third Generation Partnership Project (3GPP: www.3gpo.org) consists of six Standards Development Organizations (SDOs) and three Market Representation Partners (MRPs) from around the globe. Under the 3GPP agreement each SDO agrees to publish agreed to standards following the approval process.

The six Standards Development Organizations are:

- The Association of Radio Industries and Businesses (ARIB: www.arib.or.jp), Japan has about 300 members including both Japanese firms and overseas firms.
- China Wireless Telecommunication Standard (CWTS) is the Standard Development Organisation (SDO) responsible for wireless standardisation in China.
- ETSI (www.etsi.org) unites nearly 700 members from 50 countries, playing a major role in developing a wide range of standards and other technical documentation as Europe's contribution to world-wide standardisation in telecommunications and information technology.
- CommiteeT1 (www.t1.org) develops standards and technical reports related to wireless and/or mobile services and systems, including service descriptions and wireless technologies. This committee develops and recommends positions on related subjects under consideration in other North American, regional and international standards bodies.
- TTA (www.tta.or.kr) is the SDO authorised by the Ministry of Information and Communication for standardisation activities in Korea and represents 150 members.
- TTC (www.ttc.or.jp), Japan contributes to standardisation in the field of telecommunications by establishing protocols and standards for connection between telecommunications networks, terminal equipment and a telecommunications network. It has 160 members.

The three Market Representations Partners are:

- The GSM Association (www.gsmworld.com) represents 347 members which is comprised of GSM Network Operators and Regulators with more than 165 million GSM subscribers in 133 countries world-wide.
- The Global Mobile Suppliers Association (GSA: www.GSAssociation.org) has a cross industry representation worldwide of GSM infrastructure, terminals, customer care, billing suppliers.
- The UMTS Forum (www.UMTS-Forum.org) represents 182 members from over 30 countries representing operators, regulators, manufacturers, IT and contents providers.

Commercial UMTS services are expected to be launched from 2002. Licenses have already been awarded in several European territories and experimental systems are now in field trials with leading vendors worldwide. The Forum has published a series of eight, management level (www.umts-forum.org/reports.html), covering the development, licensing and technological issues related to introducing UMTS technology.

Other bodies related to the process include the Operators Harmonization Group (OHG). The OHG, an ad hoc group of cellular operators and manufacturers, put forward a way of technically aligning cdma2000 and wideband-CDMA - both proposed 3G standards - to create a single three-mode CDMA standard.

Key Proposals made to ITU

Japan (ARIB)
- UTRA (TDD & DS-FDD)

Korea (TTA)
- Korea 1 (DS-FDD)
- Korea 2 (DS-FDD)

China
- DS-TDD

Europe (ETSI)
- UTRA (TDD & DS-FDD)

Americas (TIA)
- UTRA (TDD & DS-FDD)
- cdma2000 (TDD, DS-FDD & MC-TDD)
- WIMS (DS-FDD)
- IS136 EDGE

Glossary

AMPS – Advanced Mobile Phone System.

Bluetooth – The Bluetooth technology is based upon a small, integrated radio transceiver which has a unique 48-bit address derived from the IEEE 802 standard. It operates in the unrestricted 2.45 GHz ISM (Industrial, Scientific, Medical) 'free band', which is virtually available worldwide, and transmits data using a time division duplex scheme. The transmission range for Bluetooth is set at 10 meters at a gross transmission rate of 1 Mbps. There are plans for second generation Bluetooth to go up to 2 Mbps. In theory, as a Bluetooth-enabled device moves within the 10 metre range of another Bluetooth device, they will self-discover each other and, depending on security settings, begin to swap data and provide services the other might use. The codename, Bluetooth, comes from King Harald Bluetooth of Denmark who united Denmark and Norway in the late 10th century.

CDMA – Code Division Multiple Access is a spread-spectrum approach to digital transmission. With CDMA, each conversation is digitized and then 'tagged' with a code. The mobile phone is then instructed to decipher only a particular code to select the correct conversation from the signal.

cdmaOne – is a brand name, trademarked and reserved for the exclusive use of CDG (CDMA Development Group: www.cdg.org) member companies, that describes a complete wireless system incorporating the IS-95 CDMA air interface, the ANSI-41 network standard for switch interconnection and many other standards that make up a complete wireless system (see www.cdg.org/library/cdmaWorld/).

cdma2000 – is a name identifying the Telecommunications Industry Association (TIA) standard for third generation technology that is an evolutionary outgrowth of cdmaOne**.** cdma2000 offers operators who have deployed a second generation cdmaOne system a seamless migration path to 3G features and services within existing spectrum allocations for both cellular and PCS operators. The network interface defined for cdma2000 supports the second generation network specifications (cdmaOne, IS-136 TDMA, or GSM).

D-AMPS – Digital Advanced Mobile Phone Service (US standard), also known as IS-136 TDMA.

DS-FDD – Direct Sequence Frequency Duplex Division

EDGE – Enhanced Data Rate for GSM Evolution. Packet data using one to eight GSM timeslots. Single timeslots should achieve a throughput of 48 Kbps to 70 Kbps. Higher data rates require better radio conditions and closer proximity to cell center. EDGE uses a better modulation scheme (16 quadrature amplitude modulation, or QAM) compared to that of GSM and GPRS (gaussian modulation shift keying, or GMSK), but maintains the use of 200 KHz bands. EDGE is designed for service providers that may or may not (perhaps because they lack a UMTS license) migrate to UMTS.

ETSI – European Technical Standards Institute (www.etsi.org)

FDMA – Frequency Division Multiple Access.

GPRS – Generalised Packet Radio Service. Packet data using one to eight GSM timeslots. Not store and forward. Variable latency. Requires major upgrade of carrier's software and hardware to a support node and gateway node architecture. Requires new handset. There are

four radio channel coding schemes defined for GPRS to allow data rates to be increased when coverage is good, and ensure packet loss is not too great when coverage is poor. These coding schemes allow between 9Kbps and 21Kbps per GSM timeslot in use. Given 8 timeslots per 200KHz GSM carrier, the maximum data rate for GPRS is 8 x 21Kbps/slot or approximately 168Kbps. Higher data rates require better radio conditions and closer proximity to cell center. Bandwidth used for GPRS is dedicated to packet access and is not available for use by circuit switched (dial access) services.

GSM – Global System (for) Mobile (Communications). The European standard for digital cellular systems. The earlier name was *Groupe Spécial Mobile*. GSM uses narrowband TDMA (see below), which allows eight simultaneous calls on the same radio frequency. GSM was first introduced in 1991. As of the end of 1997, GSM service was available in more than 100 countries and had become the *de facto* standard in Europe and Asia.

GSM 'Data' – Uses a GSM data card, a codec (erroneously called a GSM cellular modem) or the equivalent in software that adapts a computer's serial bitstream to the GSM airlink interface. The codec can be built into a mobile phone, in a computer, or a separate device. The link between the computer and mobile phone can be a cable, infrared, or proximate RF (e.g, Bluetooth, IEEE 802.11, HomeRF).

HSCSD – High Speed Circuit Switched Data. Permits bonding of up to 4 GSM circuits. Circuit encoding controlled by manufacturer. Ericsson HSCSD provides 38.8 Kbps throughput. Nokia HSCSD provides 57.6 Kbps throughput. Not store and forward. Dedicated circuit provides reduces data latency. Simple carrier software upgrade. Requires new handset. Sonera, in Finland, is now providing HSCSD service using a Nokia system.

ITM-2000 – See UMTS below.

MC-FDD – Multi-Carrier Frequency Duplex Division

MExE – Mobile Station Application Execution Environment is one or more Java Virtual Machines and applications. The primary purpose of MExE is to provide wireless carriers with a means of executing operator or service provider specific applications, e.g., provisioning Intelligent Network and Customized Application for Mobile Enhanced Logic (CAMEL) functionality in the smart phone. A smart phone running MExE could also run a Java version of PIM, WAP, third party applications. Motorola, Nokia, Lucent Technologies and Nortel are the leaders in MExE.

NMT – Nordic Mobile Telephony.

OSI – Open System Interconnection, an ISO Standard for worldwide communications that defines a networking framework for implementing protocols in seven layers. Control is passed from one layer to the next, starting at the application layer in one station, proceeding to the bottom layer, over the channel to the next station and back up the hierarchy. At one time, most vendors agreed to support OSI in one form or another, but OSI was too loosely defined and proprietary standards were too entrenched. Except for the OSI-compliant X.400 and X.500 e-mail and directory standards, which are widely used, what was once thought to become the universal communications standard now serves as the teaching model for all other protocols.

OSI Model

Layer	*Name*	*Function*
7	Application Layer	Program-to-program communication.
6	Presentation Layer	Manages data representation conversions. For

		example, the Presentation Layer would be responsible for converting from EBCDIC to ASCII.
5	Session Layer	Responsible for establishing and maintaining communications channels. In practice, this layer is often combined with the Transport Layer.
4	Transport Layer	Responsible for end-to-end integrity of data transmission.
3	Network Layer	Routes data from one node to another.
2	Data Link Layer	Responsible for physical passing data from one node to another.
1	Physical Layer	Manages putting data onto the network media and taking the data off.

Palm – PalmOS started in the Palm PDAs and has been announced for use in smart phones only by Qualcomm. Qualcomm/Palm developed a microbrowser, but Qualcomm has now licensed Phone.com's WAP code and microbrowser. All Palms and the pdQ have only 2 MB RAM, which seriously limits the applications and interfaces supported.. Microsoft and Palm have formed a joint venture called WirelessKnowledge, a file storage and serving company for wireless data users. See www.wirelessknowledge.com.

Piconet: a collection of devices connected via Bluetooth technology in an ad hoc fashion. A piconet starts with two connected devices, such as a portable PC and a handset, and may connect up to eight devices. All devices are peer units of each other and are implemented in identical fashion. However, when establishing a piconet, the first unit to start up a connection will be known as the master and the others as slaves for the duration of the piconet connection

Scatternet: multiple independent and non-synchronized piconets form a scatternet

SIM Applications Toolkit – Development environment and software utilities that extend the capability of the Subscriber Identity Module (SIM card) used in GSM phones. Nearly all current GSM phones use the ARM7TMDI microprocessor. The SIM Application Toolkit targets a given microprocessor and has most often been used to create and administer new SMS applications. Motorola, Siemens, and Alcatel have launched phones that use SIM Applications Toolkit, but not Ericsson and Nokia.

SMS – Short Message Service. Single 160 byte messages, can be terminated and/or originated on the mobile terminal depending on carrier and terminal (handset) equipment.

TACS – Total Access Communications System.

TDD – Time Duplex Division

TDMA – Time Division Multiple Access. TDMA works by dividing a radio frequency into time slots and then allocating slots to multiple calls. In this way, a single frequency can support multiple, simultaneous data channels.

UMTS – Universal Mobile Telecommunications System, aka International Mobile Telecommunications System-2000 (ITM-2000). Higher data rates require better radio conditions and closer proximity to cell center. Wide area coverage will be at 384 Kbps; cell centers will have 2 Mbps data rates. UMTS will include both circuit switched and packet switched components (with a network architecture derived from GPRS), and will permit a single handset (or equivalent) to be used for cordless, cell-based, and satellite services.

USSD – Unstructured Supplementary Data Service. Up to fifteen, 183 byte messages can be concatenated.

UTRA – UMTS Terrestrial Radio Access is an air interface based on the combined use of Japanese W-CDMA and European TD-CDMA technologies. One original feature of the UTRA concept is the existence of two different modes: FDD (Frequency Duplex Division) and TDD (Time Duplex Division), each one based on a different, but related, access technology. UTRA FDD is a 'pure' direct sequence (DS) CDMA system where the orthogonality between two different air connections is ensured by codes. It can be broadly compared to existing CDMA systems such as cdmaOne albeit with some differences relating to the implementation of the codes' management and the need for synchronization. Key design characteristics are the use of asynchronous operation, with optional support for synchronous cells, and the use of time multiplexed downlink pilots.

VPN – Virtual Private Network.

WAP version 1 – Version 1 of the Wireless Application Protocol (WAP) specification provides scripting, animation, text messaging, a microbrowser with weak security, and a server-side architecture for converting HTML WebPages to WML WebPages and for serving smart phones with "WAPped pages". Motorola, Nokia, Ericsson and Phone.com developed WAP. WAP version 1.0 will support USSD and HSCSD. See www.phone.com. The WAP Forum now also includes Matsushita, Nortel, Philips, Qualcomm, Samsung, Uniden, Bosch, Intel, and NEC, plus many large wireless operators and software publishers (including Microsoft).

WAP version 2 – Version 2 of the WAP specification will include the SIM Application Toolkit and improved browser security to support financial transactions and credit storage. Version 2 will also support GPRS, EDGE and UMTS, and various input devices (keyboards, touchscreens, styli) in addition to keypad.

W-CDMA – Wideband – Code Division Multiple Access is a name identifying the ETSI and NTT DoCoMo standards for third generation technology submitted to the ITU as part of the IMT-2000 3G process. This standard encompasses an air interface that uses the CDMA technique but it is not compatible as defined for both air and network interfaces with cdmaOne**,** cdma2000 or IS-136. The air interface specification is not compatible with GSM and therefore does not support evolutionary migration.

Main differences between cdma2000 and W-CDMA

	cdma2000	**W-CDMA**
Base station synchronization	synchronous	asynchronous
Base station acquisition and detection	Time-shifted PN correlation	3-step parallel code search for base station detection and slot/frame synchronization
Frame length	20ms	10ms
Chip rate	3.6864 Mcps	4.096 Mcps
Forward link pilot for channel estimation	CDM common pilot	TDM dedicated pilot
Antenna beam forming and spot beams	CDM dedicated auxiliary pilot	TDM dedicated pilot

Source : www.cdg.org/tech/cdma_term.html

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