Perspectives on Mobile Cellular Telecommunications

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Paper presented at the
Digital News, Social Change and Globalization Conference
11-12 December 2003
Hong Kong Baptist University

1. Introduction

This paper offers a short review of the mobile cellular telecommunications sector, suggesting key issues and parameters that are guiding its development under the headings of technology and business models. The paper takes a critical look at some of the data and how to use it and interpret it. The paper ends with some of the implications and challenges for policy makers and regulators in developed and developing countries.

2. Technological Issues

The array of technologies that characterize the industry are sequential and harmonious, for example the migration from GSM to WCDMA, or diachronic and competing, for example CDMA versus GSM, CDMA2000 versus WCDMA. Just like computer networks that involve machine-to-machine data transmission on a simultaneous basis, there is the risk of traffic collision and network congestion. Engineers came up with three standard methods to avoid this situation, frequency division, time division and code division multiple access, or FDMA, TDMA and CDMA. Like all engineering solutions to specific problems each has advantages and disadvantages in terms of how efficiently they use radio spectrum, how many 'multiples' of traffic they can handle at any one time, cost of developing the equipment, and so forth. [1]

Standards

In a non-market economy an organization would rationally choose whichever system represented the best trade-off of benefits over costs, but in a market economy competition sets winning standards based upon market share and the economies of scale that result from that market share. The winner takes all. Because the market in this case is a global market, national and regional governments intervene to back one standard 'national' against another. This has the effect of protecting or 'ring-fencing' the domestic market against 'foreign' standards, and at the same time offering economies of scale in domestic production to launch an assault on overseas markets. The well-known examples are the European Community's backing of GSM and WCDMA developed by European

[1] The original analogue circuit-switched systems were replaced by second-generation (2G) digital circuit-switched networks and most recently by digital packet-switched 2.5G and 3G networks offering connections to the Internet and with built-in web-browsers, access to the Web.

companies such as Alcatel, Ericcson, Nokia and Siemens, Japan's backing of NTT's PDC and NTT's DoCoMo iMode and 3G FOMA standards, USA's backing of Qualcomm's CDMA standard, and most recently China's support for its own TD-SCDMA 3G standard.[2]

Spectrum Allocation
The second and closely related issue is the allocation of spectrum. The technologies above have also been developed to conform to different allocations of radio frequencies for use by the mobile cellular network operators. These allocations are determined by policies of the respective national regulatory agencies and authorities, and by means of non-harmonized allocations each major national economy further protects is local market. While it is against the interests of users it works very much in the short-to-medium term interests of the vendors.[3] But the cellular market is now global and the long-term has arrived. Global business users in particular are inconvenienced by lack of global standards and the need to buy dual or tri-band handsets and wireless access devices when they travel abroad.

Handsets
The inconvenience issue extends to handset and other access devices. Because the wireless cellular sector got out early from under the shadow of the fixed line telecommunications industry and was one of the first sectors to be opened to competitive entry, the strict regulation of all aspects of equipment design was not so tight. So long as the handsets conformed to network standards they received type approval from the testing laboratories. But the design of the navigational tools – which keys to press to initiate different functions on the handset – and the application interface protocols (api's) – the technical specifications allowing access to content and applications embedded in the handset or on a Website – were entirely left up to the manufactures and vendors.[4] This gives vendors the opportunity to brand themselves and differentiates their product, but it also fragments the industry for the independent creators and producers of content and applications who have to redesign their products for every handset. This is now becoming a problem as the industry moves from voice-centric to data-centric markets.

2.1 Harmonization, Inter-operability, Roaming, the Internet
A lack of standards harmonization is a mixed blessing. It seems a curse to users and developers of content and applications and to network operators who do not try to brand

[2] Signatories to the WTO are under pressure to ensure their regulations give national treatment to foreign companies, including access to spectrum on the same basis as domestic companies. Policy makers are also under pressure to adopt technology-neutral regulations that open domestic markets to the use of different standards, leaving to individual service providers with the decision and commercial risk as to which technology to adopt. Global commercial pressures also seem to be working in this direction.
[3] The International Telecommunications Union (ITU) is supposed to promote and facilitate harmonization of standards, but the only obligation of Member States is to avoid cross-border radio interference. All other ITU recommendations are just that, and domestic allocations of spectrum are sovereign decisions. For a lucid account of the procedures of spectrum allocation and assignments, see David Withers (1999) 2nd edition *Radio Spectrum Management*, IEE, Stevenage, UK.
[4] The vendors are usually the owners of the brand names, such as Nokia or Motorola, who also carry out the R&D on handset designs. Vendors may also manufacture but they outsource much of it, especially to companies in China and Taiwan.

their own handsets. To network operators who do brand their handsets, for example Vodafone and more recently Orange, and to leading the vendors the situation allows them to differentiate their product. To the industry as a whole a lack of harmonization is seen as holding back its growth, and delaying the mass production of next generation handsets,[5] but a multiplicity of standards has one potential advantage if it keeps open different technology options that could eventually prove superior.

Inter-operability

The immediate answer to a lack of harmonization is the inter-operability of networks. The first step was inter-operability between FDMA, TDMA and CDMA voice networks, a form of roaming between systems necessary both for connectivity within and across geographical boundaries. Roaming involves revenue-sharing arrangements between networks as well as technological arrangements and this raises opaqueness in the commercial relations between network operators. On the one hand, a network that fails to offer connectivity to other networks within its local market would soon lose customers, so in smaller markets networks usually interconnect without cost to the user. In larger or less developed markets on-net calls – that is calls made to users of the same network – are not charged extra while intra-net calls to or from users on other mobile networks and off-net calls made between fixed and mobile networks are charged extra. China, where a mobile party pays (MPP) billing system operates – also known less accurately as receiving party pays (RPP) [6] – is an example.

Roaming

International roaming is a more complex issue because it is not subject to domestic regulations. This offers operators an opportunity to develop cartel-type billing arrangements whereby they charge each other bilaterally agreed roaming fees for call origination and termination and pass them on to their respective customers. In theory customers can check these charges when travelling abroad and can even select which foreign network to log onto, but this requires cost-conscious and technically aware customers who know how to programme their handsets. Even then they have no say over the fees agreed between the operators. In the European Union, where a regional regulatory authority has emerged, the issue of high roaming fees and the charges made by mobile operators to terminate fixed line calls has been the subject of investigation and control. In Asia Pacific no such regional authority exists and roaming charges have never been raised as an issue on regional bodies such as the APEC and PECC telecommunications working groups. [7]

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[5] Hutchison failed to meet its year-end 3G target to roll out networks in 10 countries because of delays in handset deliveries. In the case of one manufacturer, NEC of Japan, the delay was largely due to it 'being tested for interoperability among networks.' *Asian Wall Street Journal*, 18 November 2003, p.A3.

[6] In fact, by dropping incoming call charges for on-net calls the system becomes calling party pays (CPP).

[7] By contrast to the high costs of leasing international bandwidth into the USA to carry Internet traffic from Asia Pacific economies became a very contentious issue within APEC. Australia and Singapore led the complaints, arguing that arrangements similar to those for circuit-switched telecommunications traffic should apply whereby the Asian and US carriers share the cost of a half-circuit each. The US responded telling Asian economies to liberalize their markets to stimulate high volumes of local traffic on the grounds that a higher volume of traffic to the USA would increase the negotiating power of Asian carriers with their

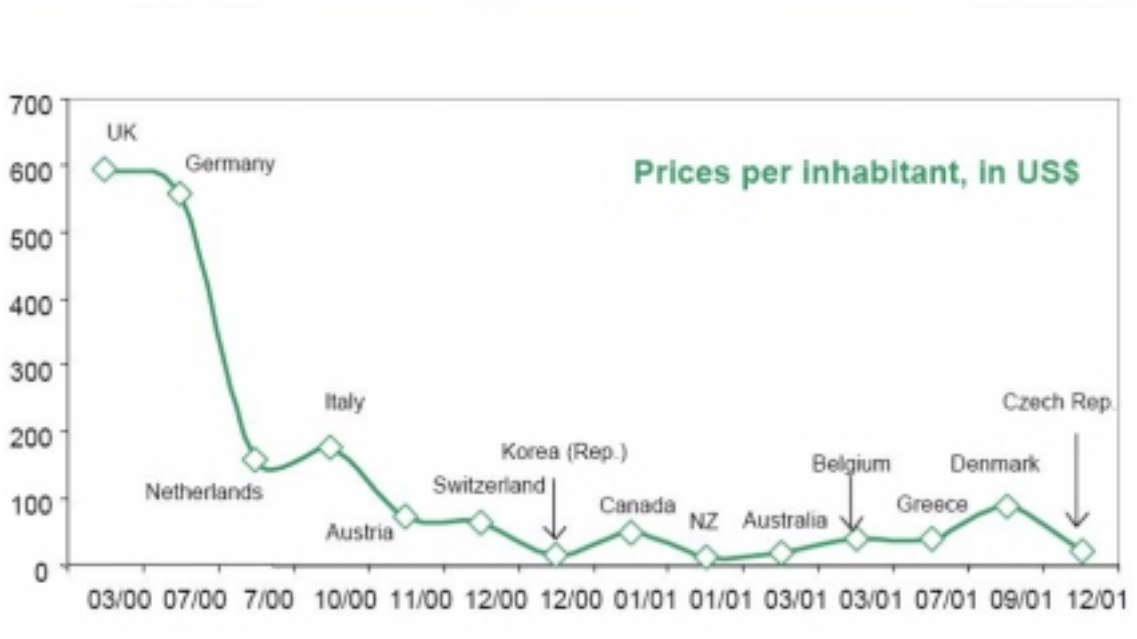
Mobile Internet

The next step towards inter-operability concerns the shift from voice to data. The first step in the transition is towards text messaging or short message services (SMS) and then to image messaging or multimedia messaging services (MMS) and using an Internet enabled wireless mobile device, instant messaging (IM) through a website and mobile email or what may be called me-mail. Connectivity to the Internet implies inter-operability by definition, so roaming becomes instantly global. Making the transition is not a simple matter for network operators as it involves software programming in the network, and yet again lack of standards results in compatibility issues. For example, new software may clash with a network's billing system or data referral system to authenticate a user. Trials and tests have to be conducted within networks and between networks. These problems are familiar to any telecommunications network, but mobile cellular network operators are beginning to face them on a grander scale as revenues from customers who download content and applications become crucial to their business plans.

3. Business Issues

In 2000, not long before the dot.com bubble burst would-be operators of 3G mobile cellular networks in Europe bid around US$100 billion in auctions for licences. In the two outstanding cases, the UK and Germany, the winners bid the equivalent of almost US$600 per inhabitant. Subsequent auctions in the Netherlands and Italy netted only US$160 and US$175 per inhabitant respectively, while later auctions brought in less than

Costs of 3G Licences



Source: ITU Internet Report 2002

US counterparts. Also a growing number of Asian websites would eventually bring about an equalization of traffic volumes between the USA and Asia.

US$100 per inhabitant, although France charged operators the equivalent of US$180 per inhabitant in a beauty contest. The UK bidding probably exceeded net present value (NPV) by a factor of ten, and figures of this magnitude take some explaining. [8] Apart from simple over-bidding, the figures either point to some interesting strategic thinking about the business case for 3G or little strategic thinking at all. There were several factors that seemed to those bidding at the time to support high valuations. On the rational side was the availability of the spectrum and what could be done with it. Placing an option on its future use and a value on that option is one way to handle commercial uncertainty. The concept of uncertainty differs from the concept of risk. Whereas risk has a known probability attached to it, like tossing a coin, uncertainty doesn't.

Valuations

There is no known probability attached to the future of 3G as a technology or as a business,[9] the business models developed by various investment banks and stock analysts made simple extrapolations of revenues streams from new 'data' services that could be delivered over 3G networks. In doing so they overlooked the fact that where these services can be delivered over the Internet they do not require a licence of any kind, and therefore including them in the valuation of a 3G licence is misguided. In the extreme, analysts were building into their spreadsheets annual average revenue per user projections of US$600 and US$700 at a time when Vodafone, one of the most successful, was making no more than US$300 EBITDA (earnings before interest, taxation, depreciation and amortization). A particularly frank account of the methodology can be gleaned from a report of Hong Kong-based Jardine Fleming Research that was trying to place a value on the UK 3G licence won in the auction by the US company, TIW.

> The question is: Is a 14% rise in EBITDA per subscriber achievable in view of the new revenue streams coming down the line in 3G? As we have shown earlier in the report, we see ample evidence that EBITDA per subscriber can grow significantly in the coming years, but believe in a competitive cellular provision environment, a rise of this magnitude is too aggressive and that TIW overpaid. Nevertheless, our current forecasts look extremely stingy in the light of the aggressive gambles just undertaken by the world's leaders in cellular. We find the fact that these operators are ponying up here and now a major comfort factor as we view our cellulars.[10]

The 'comfort' referred to in the final line of this citation was short-lived for most, but for one or two of the cellular operators such as Vodafone the 'aggressive gambles' may have paid off. Two business strategies have so far emerged, one by design and the other maybe by *de fault*. Companies like Vodafone from the UK, NTT DoCoMo from Japan and

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[8] John Ure (2003) 'De-constructing 3G and Reconstructing Telecoms' *Telecommunications Policy* v.27.3/4 April/May pp.187-206. See also: http://www.trp.hku.hk/papers/2002/deconstructing3g.pdf. For a justification of the prices paid using options theory approach, see Marcello Basili and Fulvio Fontini (2003) 'The option value of the UK 3G Telecom Licences; was too much paid?' *Info*, v.5.3, pp. 48-52

[9] When industry watchers say something 'will probably happen' they are not assigning a specific probability to the event, rather they are making informed judgments on the data available at the time.

[10] See John Ure (2003) above.

SKTelecom from Korean are each in their own way establishing themselves as market leaders. Vodafone by buying spectrum, as in Europe and Australia, and by buying companies, such as J-Phone in Japan, and through partnerships, as with Verizon in the USA, is striving for global presence that will hand the company the benefit of international roaming revenues from both ends of the traffic in addition to all-important brand-recognition, equivalent to Nokia in the handset market. NTT DoCoMo has also sought to become global by exporting their iMode standard through partnerships with Hutchison in Hong Kong, KPN of the Netherlands and AT&T Wireless in the USA. But reliance on partnerships seems a weak strategy in this intensely competitive market, and both DoCoMo and Vodafone have found that partners are reluctant to drop their own brand names. SKTelecom has yet to make major investments or acquisitions overseas, but dominance in the South Korean market positions them to do so, while Hutchison Telecom are attempting a similar global branding strategy with up to ten "3" networks in different countries.

Convergence

The *de fault* alternative strategy is national presence, high volume, low prices and support for all brands of network-compatible handsets and a steady progression towards higher network speeds. Convergence is also expected in three senses: first, to support a multitude of wireless platforms and access devices, such as Wireless LAN or WiFi convergence with 2.5G and ultimately 3G; second, there is every likelihood that the division between fixed line and wireless networks will dissolve. In China and India fixed line operators are already deploying fixed wireless systems that compete with mobile cellular networks in urban areas at much lower prices, and it is only a matter of time before regulators drop the distinctions in their licensing polices.[11] Third, mergers and acquisitions between mobile networks (horizontal consolidation) and between mobile and fixed line networks (with elements of both vertical and horizontal consolidation) are likely to happen, subject to regulation and competition policy. The technologies are beginning to allow these trends to become real, but driving them will be the business case offering the widest possible range of services to the widest possible range of customers using network resources to their fullest extent.[12] Economies of scale and of scope will become all important due to the fact that in an IP-based data-centric market Internet and web-based services cut across national boundaries creating scale and scope.[13]

[11] The other potential advantage of fixed-mobile convergence from an operator's viewpoint is that by bundling services and unifying the billing system they may reduce the churn rate of subscribers who leave to join other networks.

[12] Maximizing the use of network resources offers a role for mobile virtual network operators (MNVOs) who resell network bandwidth under their own brand name, such as Virgin Mobile. There is scope here also for niche market makers, that is companies that serve specialist enterprise markets, wholesaling handsets, reselling dedicated bandwidth and customized applications such as inventory software or customer relations software, and possibly managing virtual wireless networks on behalf of businesses.

[13] Voice over IP (VoIP) which means sending voice in packets across conventional circuit switched networks, and Internet Telephony, which means sending voice in packets over a packet-switched next generation networks, also broke the national boundaries and controls over voice traffic. Before VoIP other mechanisms, such as callback and refile, had already begun the process.

Pricing

These alternative trajectories of strategy highlight the transitional nature of the industry with uncertainty playing a greater role than risk.[14] In periods of uncertainty trial and error is much in evidence and the multitude of different pricing schemes service providers offer is a good indicator. The pricing of voice services is fairly standard, being bundled into packages of tens or hundreds of minutes so they are in effect flat rate within zones, the key difference being between calling party pays and mobile/receiving party pays systems.

Charges for non-voice traffic such as messaging or data downloads are variously charged by the volume, for example by the number of SMS, or by the byte. Volume charging may reflect the principle, if not the reality, of cost in terms of the use made of network resources, but the business models used to value 3G licences imply a very different approach, namely value-based pricing. Volume pricing fails to differentiate between traffic of different market value, so as Minges points out, citing Telstra, one megabyte (MB) is roughly equivalent to '250 emails (of 200 words), 20 emails with attachments, 20 pages of spreadsheets and 10 web pages.' [15] Demand for each of these would presumably be different at different prices, and one likely development is the emergence of flat rate charging for different categories of data. For example, emails with attachments that use more network resources could be charged at a higher rate than emails without attachments, but the rate will be determined by the state of demand and of competition.

Hong Kong

As the following table shows for Hong Kong in early January 2003, pricing for similar services differs considerably between operators, but at least the pricing structure is consistent. While SMS and MMS charges differ quite a lot, the structure of pricing is almost identical. In the case of downloading games the charges are also quite similar.

Tariffing Schemes of Hong Kong Operators for Some Data Services

Operator	SMS	MMS	Games download
SmarTone	$50 for 200 messages, thereafter $1 per message	Free until 3/31/03 2 cents per KB thereafter	$15-18 per game
CSL	$38 for 120 messages, thereafter $0.5 per message	$3-$15	$15 per game
Orange	$28 for 100 messages, thereafter $0.5 per message	$3-10 per MMS download, $9 monthly	$15-20 per game

[14] This used not to be the case. It became evident from the launch of 1G and 2G systems that demand would follow certain fairly predictable patterns. Sooner or later uncertainty will evaporate around a data-centric mobile wireless industry and predictability will return as a new paradigm establishes itself.

[15] Michael Minges (2003) 'Is the Internet Mobile? Measurements from Asia-Pacific' Telecommunications Development Bureau, ITU (forthcoming in *Telecommunications Policy*) and Telstra Mobile 'CDMA 1X – Your Office Unplugged' at: http://www.teslstra.com.au/mobile/business/plans/cdma1x.htm

		subscription fees	
SUNDAY	$0.3-0.8 per message (package charge)	$3	$ 15 –20 (game content only) + $ 5 download charge
Peoples	$20 for 70 messages	$3-$15	$15 per game, additional charges of $0.09 per Kb for Java games
New World Mobility	$30 for 100 messages, thereafter $0.5 per message	$5-20	$10 monthly fees and $0.1/KB data charge

Source: TRP research.

4. International Comparisons and Trends

The aim of social science in making international comparisons is to abstract from the empirical data causally-related events from which to derive or test and extend hypotheses that tell us something useful about how things work in the world. In the case of the mobile cellular industry many of the hypotheses come from marketing perspectives using diffusion models, or models of consumer loyalty and switching behaviour. Bodies such as the International Telecommunications Union (ITU) stop short of modeling but do tabulate the growing volume of industry statistics looking for what may be correlations, especially on the public policy side. In particular, ITU studies frequently use mobile cellular penetration rates as a surrogate for the degree of market liberalization and as a measure of competition. In this context it is worth noting that since 2002 there are more mobile cellular phones in use in the world than fixed line phones, and for this reason Melody, for example, has suggested that 'For the future, mobile is the vehicle for achieving universal access to voice-related services.'[16] Part of the reasoning here is that whereas mobile offers opportunities for call substitution in developed economies where most people also have a fixed line phone, mobile offers the opportunity for line substitution in developing economies where network resources are scarce.

Data Problems

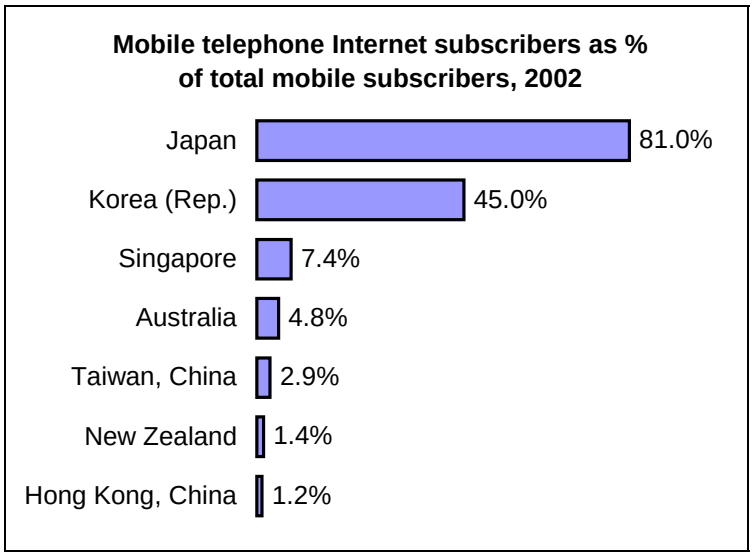
One of the problems the social sciences face in making global or regionally comparisons for the mobile cellular industry is the lack of standardized data, yet another lack of standards. Minges examines this issue in relation to Mobile Internet where he notes that as the industry shifts from voice-centric to data-centric services there is no universally adopted standard of reporting access, usage or revenues from usage.[17] For example, the Hong Kong regulator OFTA reports monthly statistics on the 2.5G adoption rate which refers 'to those customers who have joined the service plans for 2.5G services (including

[16] William Melody (2003) 'Stimulating Investment in Network Development: Roles for Telecom Regulation' WDR Paper 0301, p.3 at: http://www.regulateonline.org/pdf/wdr0301.pdf

[17] Michael Minges (2003) 'Is the Internet Mobile? Measurements from Asia-Pacific' Telecommunications Development Bureau, ITU delivered to the International Telecommunications Society Asia-Australian Regional Conference, Perth, Australia 22-24 June 2003. (Forthcoming in *Telecommunications Policy*). See power point. at: http://www.itu.int/ITU-D/ict/papers/2003/Measuring%20MOBILE%20Internet.pdf

GPRS and IS-95B services) or used the 2.5G services at least once for the month being reported on.'[18] This is a fairly robust definition, but still leaves room for exaggeration if it includes non-registered users who have accessed 2.5G services, nor does the data give any measure of the extent of usage by registered users. Cross country data comparisons are problematic because many operators but not all include under 'data services' messaging services and messaging revenues. According to Minges, in Asia Pacific only two governments publish the volume of SMS measured by the numbers sent and received on-net, off-net (between fixed and mobile) and intra-net (between mobile networks) where messages received outnumber messages sent owing to cases of multiple recipients. What is hardly ever reported is the percentage of mobile users using SMS, nor is the volume of MMS disaggregated from SMS. MMS contains images and another measure would be the number of bytes sent and received.

Where Mobile Internet is involved the measure adopted for circuit-switched mobile cellular networks is the duration of the connection, but on packet-switched networks it may be the volume of bytes. The following table from Minges is a rough guide to the spread of mobile Internet adoption in the Asia Pacific region, but as he also points out surveys in third quarter of 2002 found in Japan only 44.1 per cent of mobile subscribers actually using mobile Internet as against the official figures that show 78.7 per cent of total mobile subscribers are mobile Internet subscribers. The equivalent figure of actual users of mobile Internet in South Korea is 32.2 per cent, far closer to Japan's usage than the official figures would suggest.



Source: Michael Minges (2003) ITU

[18] OFTA Telecom Facts at http://www.ofta.gov.hk/frameset/facts_index_eng.html

Whither Mobile?

A popular measure of the transition of the industry is the speed of growth of revenues from data services as opposed to voice services, but the figures are misleading for several reasons. First, messaging services are usually included, but these are quite distinct from other forms of data content and applications. Their closest equivalent is perhaps the download of ring tones, horoscopes and the like, what may be called 'trivial pursuits' that nevertheless generate healthy revenue streams, but only in the sense they occupy comparatively little bandwidth. However, a crucial distinction is that SMS are composed and created by the subscriber as a close substitute for voice, and there is no content partner adding value to claim a share of the revenue from the service provider. The consulting group Ovum estimates messaging and me-mail represent 85 per cent of mobile data revenues globally, with information and entertainment services making up 10 per cent and 15 per cent respectively. This suggests the growth of mobile content and applications remains very much in its infancy.

A second reason for treating these statistics with care is that they do not reveal whether the proportion of data revenues is rising because voice revenues are falling, because data prices are high or because data volumes are rising. Again Ovum research suggests that while messaging traffic continues to rise strongly, revenues are not keeping pace.[19] Third, the composition of data usage patterns differs across economies, so for example in Japan and South Korea gaming and gambling and girls (3G) are all very popular, as are stock market transactions. In Singapore and the Philippines and China SMS is enormously popular, but not in Hong Kong where voice calls are relatively much cheaper. Consumption patterns as well as consumer adoption rates would seem to be influenced by both local cultural factors and local market conditions, such as the level and structure of prices.

As a percentage of revenue, data services in Hong Kong remain minimal and growth uncertain. The following figures come from the Annual Reports of Telstra,[20] SmarTone and Sunday. [21]

Data Revenues as Percentage of Total Service Revenues of Three Listed Hong Kong Operators

SmarTone (Dec. 2001)	Sunday (Dec. 2001)	CSL (Dec. 2001)	CSL (June 2002)
4.3 %	2.3%	2.75%	2%

Source: Oracle Market Research, Telstra Annual Report.

[19] See various articles at http://www.ovum.com

[20] Telstra bought full ownership of CSL from PCCW HongKong Telecom in 2002. See http://www.telstra.com.au/investor/cfo_presentation_02.pdf

[21] Data revenues for Peoples Telephone were 5 per cent by October 2002 compared with 4 per cent over five months to May 2002. Reported South China Morning Post, Technology Post, 21 January 2003, p.1

These estimates can be compared with those from the Gartner Group for the Asia-Pacific region. According to this table, data revenues were 1.6 per cent of total service revenues in Hong Kong in 2000, and Gartner's forecast of 3.9 per cent by 2001 was not realized.

Cellular Data Service Revenues in US$M and as Percentage of Total (Voice + Data) Service Revenues Years 2000 and 2001(E) and 2003

Economy	2000[1]		2001 (estimated)[1]		ITU 2003
	Revenue	% Service Revenue	Revenue	% Service Revenue	% Service Revenue
Asia-Pacific	$4.1m	4.7	$10.2m	9.5	12.1[2]
China	$104m	0.6	$630m	3.1	
Hong Kong	$28.8m	1.6	$75.6m	3.9	2.5
India	$10.3m	1.7	$39.2m	3.7	
Indonesia	$7m	1.1	$16m	1.6	
Japan	$3,424m	7.7	$8113m	15.0	19.3
Malaysia	$25m	1.9	$47.9m	2.6	
Philippines	$124m	14.9	$278m	19.6	
Singapore	$44m	5.5	$67m	7.3	13.0
South Korea	$140m	1.5	$369m	3.4	10.6
Taiwan	$87m	1.8	$169m	2.8	
Thailand	$4m	0.5	$18m	1.5	
Rest of Asia	$20m	1.6	$52m	3.3	
Australia					10.0
New Zealand					5.0

Source: 1.Gartner Group, August 2001; 2. Gartner Dataquest 2003; ITU 2003

5. Policy and Regulation

Several issues arise from the foregoing industry review. First, as the sector undergoes a transformation policy adjustments are required to facilitate the transition to a more convergent industry. These include flexible licensing policies that foresee both fixed-mobile convergence and general service wireless platform operators incorporating WiFi and cellular and other services based on wideband technologies. Second, these policy adjustments require a more flexible and reformist view of spectrum allocation and assignment. Spectrum pricing, the re-allocation of spectrum and spectrum trading are all issues that need reconsideration.

Third, in the case of developing economies the use of wireless is beginning to come into its own. Although principally deployed in the urban and suburban areas, the use of fixed-wireless technologies and the imaginative combination of fixed and wireless technologies in rural areas offer new opportunities to spread access to telecommunications, the core component of networked ICTs. Technology costs may fall, but the key to development is a set of flexible policies and strong regulatory controls that promote new entry into poor

areas, including requirements on the incumbent carrier to interconnect and revenue-share with local operators on long distance traffic to and from poor remote rural areas.

Finally, there would seem to be an important role for governments in the adoption of wireless technologies for mobile communications between the state and civilians in both developed and developing economies. In a recent short paper for Development Gateway, Zálešák outlines various applications. [22] These include the use of mobile communications to send out alerts and warnings, for example to inform populations of typhoons, and to allow citizens to request information, such as the location of the nearest emergency services, or to report dangerous or threatening incidents. Online bookings of appointments and access to government statements and useful statistics are other examples of government-to-citizen, or G2C possibilities. Areas such as health and safety, education, travel, work and leisure all have their applications. Online transactions are more complex as they normally involve some level of security and the encryption of messages, especially the higher value transactions usually associated with government-to-business or G2B. M voting is another topic of debate, for example in the United States, although it raises difficult issues of authentication, but using the mobile phone as a means of consultation is certainly possible.

Wireless technologies such as mobile cellular telephone networks are already more used in some developing countries than fixed line telephones, and the same is true of an increasing number of developed economies, such as Hong Kong. Put another way, wireless is extending the ICT infrastructure and access to that infrastructure, and the social and economic consequences and opportunities are only just beginning to be seen.

[22] Michal Zálešák (2003) 'Overview and opportunities of mobile government' at http://www.developmentgateway.org/download/218309/mGov.doc

Appendix

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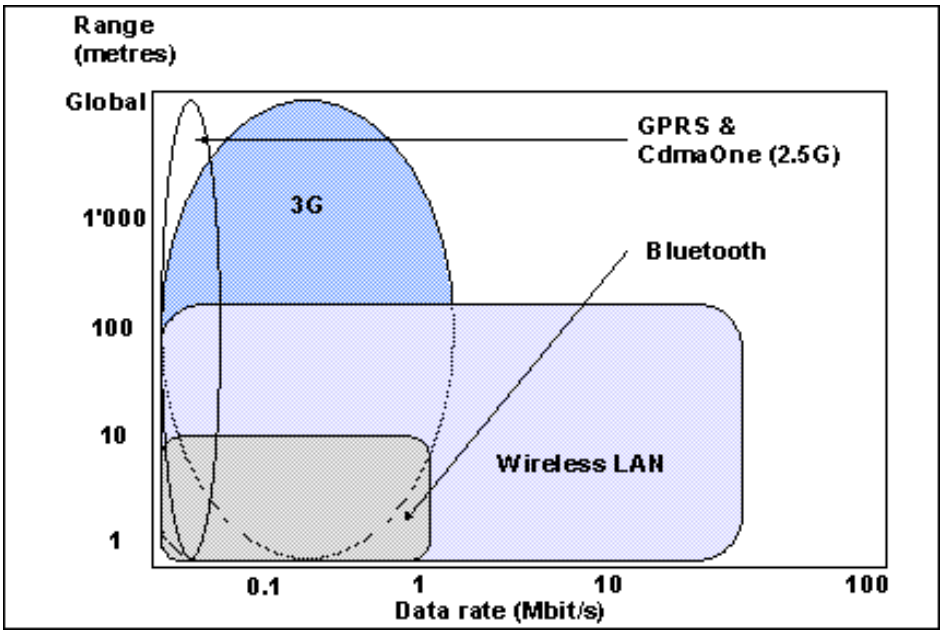
Range and Data Rates
(logarithmic scale)



Source: ITU, adopted from European Information Technology Observatory 2002