PCS: REGULATION AND MARKETS

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Paper Delivered to the IEEE PCS Symposium
Hong Kong Convention and Exhibition Centre
Hong Kong, 7th June 1995

ABSTRACT

Wireless personal communications technologies are about to enter their second decisive stage of development. Stage one was incremental, supplementing wireline communications networks. Stage two is radical, offering both synergy and substitution, and heralds a third, revolutionary stage in which all that is fixed becomes mobile. Stage two will be one of transition from an environment of limited bandwidths and small but rapidly growing markets, to a world of re-usable and re-assignable spectrum interconnecting with broadband networks for a mass market.

Regulating the transition is a controversial process. Spectrum is regarded as a scarce resource which requires careful management in the public interest, yet Hong Kong policy moves in the direction of market solutions. The regulator is therefore required to perform a balancing act between the interests of different parties: the existing wireline and wireless operators, the new entrants, future new entrants, existing customers and future customers, and Hong Kong's reputation as a progressive free market.

Introduction

Up to six PCS (personal communications system) and four CAS (cordless access system) licences are to be authorized by the Telecommunications Authority (TA), the Director-General of Telecommunications, and issued by the Office of the Telecommunications Authority (OFTA) in the very near future. More could follow in the years to come. According to OFTA's stated principle of technology-neutral regulation, PCS and CAS are understood to embrace the technologies associated with the European DECT and DCS 1800/PCN concepts and the Japanese PHS technology as well US technologies such as PACS.

Technology-neutral regulation is a logical progression for Hong Kong, where previously both North American and European cellular standards have been

accepted. In occupying a special position in the nexus of regional and world trade, Hong Kong has stood to benefit from having technologies which are compatible with those of its major trading and investment partners, and I would venture to forecast that Hong Kong will set the pattern for the rest of Asia in this regard. Especially so as integration into the world market is the necessary condition for economic growth across the region.

The aim of this paper is straightforward. It is to understand the requirements of regulation, in the broadest of terms, in the context of a communications revolution which will overhaul the entire structure of telecommunications in the twenty-first century. I am aware that today the Director General of Telecommunications will be making his own presentation as well as chairing some sessions, so I have avoided a superfluous effort to examine the issues of regulation in detail. Instead, I wish to draw attention to what appear to be key trends in the development of wireless telecommunications, to locate PCS within those trends, and to consider some of the implications of the changing relationship between fixed wireline and wireless technologies.

Back to Square One With Wireless

Microwave technology was for the first time used commercially for long-distance telecommunications in 1950. The technology, developed by Bell Labs, rapidly supplanted all other means of long-distance telecommunications, so by 1980 in the USA over 1000 million long-distance voice circuits were carried by microwave against only 400 million by coaxial cable and less than 200 million by T carrier. In otherwords, wireless technology was converging on an area of communications long-dominated by wireline, and Huber, et al.[1] make the important point that this example of convergence threw a spanner into the works of existing regulation. Wireline telephony had always been a monopoly business, whereas commercial radio had not.

> Already accustomed to distinguishing the competitive world of radio from the 'natural' monopoly of wireline telephony, the FCC concluded that this new use of radio technology did not necessarily have to be left to a phone company monopoly. The Commission accordingly began issuing microwave licenses to individual (albeit large) private users, and not just to the (very much larger) Bell company. (p.1.3)

Huber et al. go on to record the rise of Microwave Communications Incorporated (better known today as MCI) as the most important of the pioneer new entrants into the markets dominated by Ma Bell. Even today, throughout Asia, the first new entrants to break the monopoly of national carriers are the wireless-based paging, trunked-radio and mobile telephone and data service operators.

[1] P.W.Huber, Kellogg K, and Thorne J. 1993. *The Geodesic Network 11*. The Geodesic Company: Washington, D.C.

What came next was the solution to a basic capacity problem. A radio transceiver could handle no more than the equivalent of 12 voice calls - although multiplexing would increase this number. Although Bell Labs had invented the idea of radio cells at roughly the same time as microwave, it was only in the 1970s that the idea of multiple low-powered radio transmitters serving adjacent cells with re-usable frequencies as users move out of one cell and into the next was raised as a practical commercial technology. The concept of microwave telecommunications technology was transformed. It was no longer confined to long-distance traffic, but now offered local network mobile functionality.

The invention of the 1940s, and development of the 1970s, became the application of the 1980s. But at exactly the same time fibre optical cables were transforming the economics of high-volume long-distance telecommunications away from microwave and back towards fixed-line transmission. The focus of application of wireless and wireline were about to reverse, and the timing was full of irony from the regulatory point of view. The turning point in the history of telecommunications regulation was undoubtedly the divestiture of AT&T in 1984, a decision to open long-distance to competition while retaining effective local monopoly in the USA. The principle economic argument underpinning this decision was the claim that long-distance telephony could no longer be considered a natural monopoly.

Economies of Scale and Scope

A necessary condition for natural monopoly is the decline in average costs as output increases, giving rise to economies of scale and of scope. [2] Since microwave transmissions required the duplication of facilities (transceivers) to cope with growing traffic volumes, it was argued that few economies of scale or scope arose, so little would be lost through competition, and much gained. The situation in the local loop was quite different, because there additional traffic volumes require only incremental increases in investment. [3] Average or unit costs were therefore either constant or, with the advent of digital equipment, falling.[4]

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[2] Output can increase in two ways. First, the product or service can increase in volume, giving rise to economies of scale. Second, output can increase in terms of the product or service range made available. For example, whereas the old analogue semi-electronic switches could really only offer voice traffic and little else, a digital switch can offer voice, fax, data and intelligent network services. When switching costs are spread over a growing range of service outputs, this gives rise to economies of scale.

[3] Investment in the local loop tends to be 'lumpy', coming in steps as new exchange areas are required to service new business and population centres. But the expansion of existing exchange capacity to cater for the regular growth in demand is made easy today because digital switching equipment is delivered in modular units which can be easily added on to existing switch cabinets.

[4] In the pre-digital electronic switching age telecommunications engineers were divided between those who argued that unit costs rose with traffic volumes and those who argued they remained constant. The arguments were difficult to test empirically because in telecoms, as in many lines of business, the identification of specific costs and their

Therefore the local loop retained significant elements of a natural monopoly, and the benefits lost through the introduction of competition would outweigh the gains made. Such was the conventional wisdom of the day, and long-distance was opened to competition at just the time when wireless was about to lose its competitive advantage in that sector, and start gaining it in the local loop.

In the 1990s the challenge to the conventional wisdom of the 1980s has been given added weight by technology development and shifting economic realities. The local loop has begun to open to mobile telephony as a substitute, rather than as a complement of, the PSTN. Or at least that is the claim from Huber, et al., and the technology experts they cite. (This is not the place to go further into the arguments of Huber, et al., for example into the claims that long-distance remains a 'natural' monopoly, despite new entry, but *The Geodesic Network 11*, like *The Geodesic Network 1* that came before it, is highly recommended reading.)

In short, we are back to square one, to the original vision of Marconi,[5] of wireless communications providing essentially mobile (in his case, ship-to-shore) telecommunications rather than fixed line-of-sight long distance communications hops.

Two Squares Forward

The diffusion of modern wireless telecommunications technologies has accelerated during the 1990s, marking a radical shift in marketing positioning. The first stage, during the 1980s when cellular mobile telephony was first introduced commercially, was incremental in character. Cellular telephony was complementary to the PSTN (public switched telephone network) in two senses. First, in the technical sense it relied upon the PSTN for call delivery. Second, in the commercial sense the customers were the wealthier members of society, very often business people, who were already hooked up to the PSTN. In many Asian countries today, where wireline telephones are scarce, it remains the case that cellular users are those customers who can afford, and are lucky enough to have been supplied with, a fixed-line telephone.

The technology has now entered its second stage. Techniques of digital compression and frequency re-assignment not only greatly increase the effective capacity of wireless networks, which in turn makes these networks economically more efficient and cost-effective to use, but they also offer increasing

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allocation to specific services, was never unambiguous. The classic reference is S.C.Littlechild. 1979. *Elements of telecommunications economics.* Peter Peregrinus Ltd on behalf of the Institute of Electrical Engineers: London.

[5] By 1895 Guglielmo Marconi (1874-1937), had accomplished ship-to-shore communications of over one mile, and in 1900 he succeeded to establish direct wireless communications across 1,700 miles of the Atlantic Ocean. In 1909 he was the joint winner of the Nobel Prize for Physics.

opportunities for these networks to supplant the fixed-wire option. For example, the use of DAMA (Digitally-Assigned Multiple Access) for satellite rural communications in mountainous regions now offers a real alternative to the expensive business of bringing either wireline or line-of-sight terrestrial HF radio telephony to remote parts of a country - for example, in the Philippines. In practice, in many areas this makes the difference between DAMA or no telephony at all. Similarly, in less mountainous regions, cellular radio systems are being introduced as an increasingly cost-effective means of providing rural communications with or without cable-laying. Telekom Malaysia, for one, is experimenting in this way with rural radio communications.

A similar trend towards the *relative* autonomy of wireless communications can be seen in the increasing facility to send fax and data as well as voice-messaging by radio to and from a growing range of terminal devices, ranging from pagers and mobile telephones to personal organizers and notebook computers. I use the word *relative* because contemporary patterns of usage still usually involve calls or messages which either originate or terminate on equipment with fixed-wireline connections. But, if I read the technological documentation correctly, I also understand that the first generation of PCS technology will remain dependent upon the PSTN for network intelligence, although 'enhanced PCS' will evolve its own network intelligence capability. [6] So this second stage of development of modern wireless telecommunications exhibits both elements of growing substitution of the PSTN and continuing synergy with the fixed wireline network.

Wireless Local Loop in Developing Economies

It is speculated that while, in North America, Western Europe, Japan and other OECD economies, sunk capital investment in wires and cables is already considerable, in the developing economies the option of leap-frogging directly to wireless solutions is now wide open. This, the argument runs, applies not just to rural and remote area communications, but also to local loop applications. Indeed, most of the cellular radio systems - the so-called wireless local loop or WLL - which have been developed over recent years seem to rely upon fairly high-density populations for their cost-effectiveness. WLL clearly represents an attractive short-term option for service to urban and sub-urban areas, and is being installed in major cities such as Jakarta as a quick way to reduce the lengthy PSTN waiting lists. But there is more to the adoption of such technologies than the technology itself.

In developing countries the scarce resource is just as much capital as it is access to technology, and because of its low capital construction costs relative to ducted cabling, and the modular architecture of the systems' components, wireless access provides an opportunity for low-cost entry into the telecommunications market by local companies with no previous experience. In Indonesia,` for example, in exchange for capital investment, the local company, Bakrie

[6] *PCS and The PACS Standard: Joint Presentation by Bellcore, Hughes and Motorola*. Sponsored by the Telecommunications Industry Association (USA). September 1994.

Electronics, is permitted a revenue-sharing arrangement with PT Telkom, an approach which opens the door to, but falls short of, independent market entry. If entry depended upon building out wirelines then capital expenditure would be high, and access to the technology more complicated. For example, in Thailand TelecomAsia and TT&T have contracts from the TOT (Telephone Organization of Thailand) to build out 1 million wirelines for Bangkok and the rest of Thailand respectively, and both the local companies behind these groups (Charoen Pokphand and Loxley) have found it necessary to joint venture with world major telecommunications companies (the US company Nynex and Japan's NTT).

Of course, joint ventures are also an option for Asian companies entering the market using WLL and other radio-based communications systems where local experience in the operation and management of a communications system is in short supply, but examples from around the region indicate - see Ure[7] - that, in the area of radio communications systems, local companies prefer to own the equity and engage the services of equipment and systems suppliers - such as Alcatel, Ericsson, Motorola, NEC, Nokia, Siemens - on a management consultancy basis. For the most part, the technology can be set up and started running without too long a lead time.

Wireless and the PSTN

But it is by no means certain that radio-based communications solutions to the basic service will become long-run substitutes, as opposed to stop-gap measures, for wireline PSTN in the local loop.[8] Just as wireless technologies are making radical strides forward, so are fixed-line PSTN technologies. For example, digital compression techniques are permitting PSTN operators to offer many new services such as video-telephone and duplex ringing for phone and faxlines, as well as low-speed data connections for Internet and other onlines services. Digital switches have opened the era of intelligent networking, which is producing a veritable explosion of new value-added services, many of which, such as call-waiting and call-forwarding, are close to becoming 'basic' services in the more advanced networks. Where competition in the PSTN is opened up, as in Hong Kong from 1st July 1995, the drive to gain or defend market share will see the acceleration of value-added services and their promotion through bundled-service packages to different categories of customers in different market segments.

Broadband capacity, especially associated with optical fibre cabling, is a further technological leap for the PSTN. SDH (or SONET) transmission technology, and ATM switching technology, is just making its appearance, but in the world's key

[7] J.Ure ed. 1995. *Telecommunications in Asia: Policy, Planning and Development.* HongKong University Press: Hong Kong. The role of local Asian capital is stressed in the book.

[8] However, Singapore's Telecommunications Authority (TA) disagrees. They forecast an absolute decline in the number of fixed wireless telephones by the year 2000 as mobile and cordless units replace them. (Personal interview, September 1994).

business locations these technologies will become standard requirements within the decade. Wireless communications cannot match these developments in capacity or, therefore, services, and are therefore not to be *generally* regarded as substitutes for wireline networks. The use of wireless systems to plug the gap in PSTN service in developing countries is likely to prove transitory.

But this is the viewpoint from the development perspective, that is to say, from the perspective of an economy that is making the transition from no PSTN to PSTN. What of the market perspective? That is to say, from the perspective of subscribers who have become customers in an environment in which telecommunications has ceased to be a utility - there when you need it but otherwise unobtrusive - and has instead been transformed into a commodity, to be promoted and marketed in the most obtrusive fashion? (Is there anything *more* obtrusive in Hong Kong than the cinema-goer who receives and makes calls on his - it always is a *his*! - cellular telephone while the film is showing?). In Japan and the four little dragon economies, and among the richer parts of Asian societies, the role of enhanced functionality, or what economists like to call a superior good - that is, a good the demand for which is positively related to income levels by a factor > 1 - creates a new dimension to the analysis of the future role of wireless telecommunications.

The Squaring of the Circle

My argument up to this point has been that the radical shift in the role of wireless communications has introduced elements of substitution alongside the necessary synergy that exists between wireless and wireline networks. Interconnection between these networks is, of course, a major issue of regulation, since the quality of the interconnection, and the price paid for it, is fundamental to the economic viability of the wireless network and the commercial success of its operator. For the period when telephony was a utility, an ordinary good for which the rise in demand did not exceed, or even match, the rise in real incomes, the economic space available for wireless telecommunications remained restricted.

A combination of technological and industrial transformation of the world's economies has changed all that. The digital/micro-electronics revolution - as radical as the agricultural, commercial, scientific and industrial revolutions that preceded it - has shifted the computer-telecommunications sector to centre stage. Few, if any, modern commercial or social activities are not involved in it to some degree. It erodes - some would say corrodes - boundaries between traditional industrial sectors, between the public and the private, between academic disciplines - although universities, inherently conservative like all bureaucratic institutions, spend as much time resisting it as they do researching it - and the outcome is that telecommunications, and what are now referred to as multi-media services, have become essential business and social tools. (The word 'tool' perhaps also suggests the erosion of the boundary between work-time

and leisure-time. Homeworking, assisted and accelerated by information technology, being a case in point.)

As a result, telecommunications has entered directly into the value-chain, whether measured in input/output dollars, or in the work/leisure trade-off, or any other cost/benefit calculation. In turn, that means that different consumers of telecommunications services will identify much more specifically their own usage patterns and business, social and personal needs; and different service providers and operators will identify and target these market segments much more clearly and specifically. Two related processes will emerge. First, accelerated product differentiation. Second, accelerated product development.

From Incremental to Radical Change

Production differentiation is usually about incremental change. The Hong Kong pager market is a good example. Over thirty paging companies somehow exist and still more apply for licences. Product differentiation is the key to their success, with the introduction of new services and the re-packaging of old ones, mostly concerned with messaging, and information services, such as gold and stock market and currency prices, and, of course, horse-racing results. But some new services are quite radical in nature. For example, the future may well bring GPS (Global Positing System) technology to the simple pager or cellular handset. At least one bidder for the upcoming PCS licences has promised a service providing the shortest direct route to the nearest pizza bar for their subscribers![9]

Product development holds out the prospect for more radical changes. It is not clear to me that PCS, in itself, is such a radical change. Handsets will become cheaper - that is to say, cheaper to manufacture, and hopefully competition will ensure they are cheaper for the subscriber - and the range of services wider because at 1.8 GHz and above transmission capacity is so much greater. Functionality will be greatly extended. For example, cordless access seems to offer a marked increased in mobility for residential and small business customers. But these are technologies which essentially build upon existing cellular and cordless telephone concepts, and therefore in technological terms they seem predominantly incremental, however radical some of their inner components may be.

But in market terms their combined impact may yet be radical These are improvements and enhancements that will act primarily upon widening the market for wireless telecommunications, converting more and more people to the benefits of wireless telecommunications. For this reason the argument that the Hong Kong market is too small to bear so many new entrants is almost certainly wrong. In static terms the market is too small, but dynamically the market is likely to respond positively because these new technologies build upon patterns of

[9] Richard Siemens, managing director of Mandarin Communications, describes the 'pizza button' in the *South China Morning Business Post* 6 April 1995 p.B6.

business and social activity which are already becoming dominant as Hong Kong shifts from a manufacturing to a service-based economy.

The scarce resource in Hong Kong will not be effective demand but effective supply. The supply of spectrum is, of course, an ultimate constraint, although one with shifting boundaries. But the supply of appropriate terminals and services, and service innovations will also be a continuing challenge. At the same time market opportunities will expand as China develops its own telecommunications infrastructure and information economy. My prediction is that China will eventually follow Hong Kong's lead in developing towards a technology-neutral approach in wireless technologies, and a plurality of world standard technologies will emerge, which will stimulate the search for bridging techniques between them.

It may be noted in passing that China's State Radio Regulation Commission (SRRC) issued a warning earlier this year[10] to provincial PTAs (Post and Telecommunications Authorities) not to adopt or implement cellular, PCS or CAS technologies and standards without prior approval of the SRRC. This suggests that many PTAs are seriously interested in exploring the possibilities, and will become a lobby for systems and technologies they consider most appropriate to their local needs, At the same time, China's State Council is backing the Golden Cellular project which heralds two developments. First, China wants to ensure nation-wide compatibility between systems for purposes of inter-provincial roaming. Second, China places high priority on building its own capability in components and systems manufacturing. To achieve this, China has an interest to carefully control the transfer of standards and technologies, such as CDMA and B-CDMA, PHS, PDC, DECT, DCS 1800/PCN and PCS, and to regulate their diffusion within the PRC.

Squaring Up to Regulation

Hong Kong is about to license up to six personal communications systems and four cordless access systems, with the prospect of more licences being issued at a later date. To protect existing cellular telephone operators the TA has determined a "No Looking-Back" rule which prohibits new entrants from utilizing 800/900 MHz cellular technologies in their networks, and to protect the three new Fixed Telecommunications Network Service Licence (FTNS) operators, who begin their competition with HongKong Telecom from 1st July 1995, the new mobile operators will be issued with a revised version of the Public Radiocommunications Service Licence (PRSL).This will restrict them to using and offering the public only mobile technologies, but OFTA has undertaken to review this restriction beyond 1998.

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[10] China Telecommunications Construction CTC News 20 February 1995, v.1.3, p.3

This last point signals the really radical nature of the challenge the PCS era promises to bring to the market. I have stated already that I see no reason to view PCS technology as inherently radical rather than incremental, but the challenge it represents is the challenge of the transition from one communications age to another. The dependence of PCS technologies upon the PSTN is only partial. Stage two in the development of radio mobile technologies, identified above, saw a phased growth of mobile communications as part-complementary to the PSTN and in part a substitution.

PCS is really the last phase of stage two, accelerating the demand for, and creation of, mobile services for an increasingly segmented market. CT2 was the most recent technology to have ploughed this furrow, extending mobile communications with limited functionality to younger people at lower prices, and extending the functionality of pagers. Now Cordless Access and PCS will further this process by attracting customers from residential units, for example, people who work at home during the daytime, such as mothers, fathers, maids, telecommuters and other homeworkers, as well as small and medium-sized enterprises, such as shops and kiosks, delivery workers, and so on, all of whom could benefit from low-cost neighbourhood telecommunications mobility.

Since these systems do interconnect with the PSTN, and promise to become quite popular modes of access to the PSTN, the question naturally arises, what is the essential difference between one form of access (a fixed-wireline telephone at home, in the office, in a kiosk or public call box) and another (CT2, cellular, DECT, PCN, PHS, etc)? Ultimately, of course, the answer is: none, except where the regulator imposes a distinction and a restriction. And where the regulator lifts such a restriction, the telecommunications industry becomes truly one of competitive entry. At that point, everything that was solid about it melts, like clay turned to putty, because whoever controls access to the network controls the network. Distributed access means a distributed network, because a modern telecommunications system is essentially a universal network of interconnecting computer networks, functioning intelligently, and that intelligence can be distributed across the network at any or all of its node points.

In short, anyone with a computer could be a stand-alone telephone network, and if they have interconnection, then they are part of the world telecommunications system. Of course, the intelligence necessary to provide a standard and range of service required to operate on a large commercially scale limits who can become a telecommunications company, but the implications the PCS era hold out for of distributed access are really radical. The role of the regulator is to oversee the transition involved.

Regulating a Square Deal

Regulating the transition is not without its difficulties. An obvious early one is deciding how many licences to issue and when. The TA took the decision to

issue six PCS licences on the basis of market forecasts of 1.11 million telepoint and cellular users by 1998, and of spectrum available, with spectrum held in reserve.[11] Future licences will no doubt be based, as a rule-of-thumb, on the rate-of-return that is observed and the number of companies eager and willing to bid for new licences.

In this context the recommendation to open spectrum to tendering [12] is likely to be a useful guide to private sector assessments of market worth. But there numerous minefields ahead for OFTA. For example, the TA has the powers to require the surrender of unused spectrum, but the exercise of this power will almost certainly give rise to claims that property are being violated. Is the allocation of spectrum like the leasing of land, where the lease becomes the private property of the leaseholder? Land, or space, is a scarce resource, but its supply can be augmented through redevelopment , reclamation from the sea, and by building higher. Spectrum cannot be so easily augmented, although digital compression, frequency re-assignment technologies and frequency allocations based upon probabilistic models of usage patterns, can all help to squeeze more juice from the lemon. Clearly, here there is a potential for public interests and private interests to clash.

OFTA has flagged other areas of policy which will require review. Structural and financial separation is one such. Should FTNS licence holders be required to financially separate their mobile services? Predatory pricing is the issue here. Should fixed-wireline operators be able to cross-subsidize their mobile operations, and if not how to prevent them under a future regime which allows all licence holders to operate telecommunications services with any technologies they choose? Should the sales outlets of mobile terminal equipment be structurally separated from PCS and other PRSL licence holders? Exploitation of consumers is the issue here. A case can be made for separation, but in the Hong Kong context the argument that seems to prevail is that restrictive practices by operators is an acceptable price to pay for market stability, so long as the trend is towards a more competitive market environment. On the face of it, this argument has some validity,[13] but organizations like the Hong Kong Consumer Council [14] have a duty to remain skeptical, and undoubtedly the proof of the pudding will be in its eating.

Squaring Up to the Future

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[11] OFTA. 1994. *Report on the Future Regulation of Mobile Telecommunications Services in Hong Kong. A paper for the Industry Workshop to be held on 1 July 1994*. Hong Kong.: June. (See paras 5.18 and 5.23)

[12] *Executive Summary of the Consultancy Study on the Introduction of Pricing Mechanisms to Spectrum Management in Hong Kong*, OFTA December 1994.

[13] These issues are raised in OFTA. 1994. *Competition in Retail Mobiles Telecommunications Services*. Hong Kong: September.

[14] The author is a co-opted member of the Hong Kong Consumer Council Telecommunications Steering Group.

But undoubtedly the real revolution will come when OFTA finally dissolves the distinctions between fixed-wireline licences and wireless licences. From the regulatory perspective, that is the agenda item raised by the advent of PCS.

The PCS era will mark the transition to a third and potentially revolutionary age in telecommunications. As Karl Marx said of the effects of capitalism on pre-capitalist societies, [15] all that is solid melts into air, and that is the promise of wireless technologies on telecommunications. We can already glimmer the future. For example, GPS, referred to already above, is a technology that will enter all walks of life, from traffic monitoring units in private vehicles to help drivers choose uncongested routes, to personal communicators which will locate friends and colleagues across the map. The Future Public Land Mobile Telephone Service (FPLMTS) remains a concept at this stage at the ITU/TSB standards committees, but the focus of research and development is already there. Closer on the horizon are the LEOs (Low Earth Orbiting Satellite) and MEOs (Medium Earth Orbiting Satellite) systems currently under development by consortiums such as Globalstar, Imarsat, Iridium, Odyssey and others. These promise truly autonomous global mobile communications facilities.

These systems will challenge further the regulatory rules. Already Richard Li's company, Pacific Century, is lobbying hard in Asia to persuade governments to permit self-provisioning through the use of Vsats. The 'network of networks' concept is already with us. (Of course Internet is exactly that, but its role as a telecommunications network is likely to remain marginal, although the role of e-mail as a substitute for voice and fax communications is already significant.) This is the future, and in the PCS development we are witnessing a major nudge in that direction.

Of course, special pleading will always be forthcoming from existing operators of networks for protection of their market, usually in the name of their commitments to existing customers, and from potential new entrants, equally in the name of giving customers a fair deal. The nature of special pleading is usually the gross exaggeration of a genuine point, and in the realm of telecommunications there is plenty of scope for it because rapidly changing technology implies high levels of investment risk. What is likely to change as a result of PCS, and future generations of wireless technology, is the shrinkage, not to say disappearance of, a specific hard core of technology which remains closed to entry due to either technological constraints or costs of entry. Currently, the intelligent digital switch retains a critical mass which gives rise to economies of scale and of scope in the local loop, but for how much longer?

The postmodernist view of the world, in art, architecture and literature, is already well established. In a world evolving towards totally distributed

[15] *The Communist Manifesto*, 1848. Marx understood capitalism far better than many who came after him.

telecommunications access, personal numbering and mobility, it seems that a material infrastructure is being built to sustain it.