Research Article

Preconditions for Effective Deployment of Wireless Technologies for Development in the Asia-Pacific

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Abstract

Wireless technologies play an enormously important role in extending access to voice and data communications by hitherto excluded groups in society, especially in the world's most populated region and now the largest mobile market, the Asia-Pacific. The present rates of growth and levels of connectivity could not have been achieved without wireless in the access networks, for mobile as well as for fixed, and in the backbone networks. But the solution is not simply wireless; it is wireless combined with new investment; it is wireless combined with other inputs and systems. Participation in the supply of services to meet pent up demand must be enabled by the removal of barriers to entry to hitherto monopolized markets. More than half the Asia-Pacific countries now allow some form of market entry in basic services (higher in mobile). However, even where entry is allowed, conditions are not optimal for investment. For innovations using wireless, the creation of a better telecom regulatory environment constituted by better policies, regulation, and implementation with regard to market entry, management of scarce resources, interconnection and access, and the enforcement of regulatory and competition rules is essential. In sum, wireless matters, but only when policy and regulatory preconditions allow it to matter.

Introduction

After much debate, it is now recognized that economic growth is a necessary condition for the alleviation of human misery (or for the achievement of human development). The relationship between the ability to communicate over distance using technological means and economic growth has been much discussed.[1] Correlation is beyond dispute, but the case for

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1. E.g., Cronin, F. J., Colleran, E. K., Parker, E. B. and Gold, M. A. (1991) "Telecommunications Infrastructure and Economic Growth: An Analysis of Causality', Telecommunications Policy, 15(6): 529–535. Cronin, F. J., Colleran, E. K., Herbert, P. L. and Lewitzky, S. (1993) 'Telecommunications and Growth: the Contribution of Telecommunications Infrastructure Investment to Aggregate and Sectoral Productivity', Telecommunications Policy, 17(9): 677–690. Cronin, F. J., Colleran, E. K., Parker, E. B. and Gold, M. A. (1993) 'Telecommunications Infrastructure Investment and Economic Development', Telecommunications Policy, 17(6): 415–430. Hardy, A. P. (1980) 'The Role of the Telephone in Economic Development', Telecommunications Policy, 4(4): 278–286. Mansell, R. and Wehn, U. (1998) Knowledge Societies: Information Technology for Sustainable Development, Oxford: Oxford University Press published for the United Nations Commission on Science and Technology for Development. World Bank (1999) World Development Report 1999, Oxford: Oxford University Press.

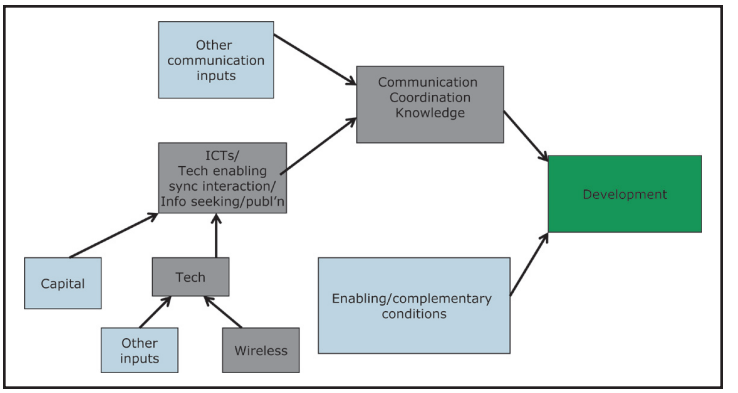


Figure 1. Development: Not by communication (wireless) alone
Source: Author

causation is unlikely to be fully established. Development requires many inputs; communication and knowledge being only some (see Figure 1).

Establishing causation was considerably more important prior to the 1990s, when public funds were still the main source of investments for expanding access to information and communication technologies (ICTs). There was a need to ensure that scarce financial resources were being spent on the services with the greatest public benefit. The burden of proof is much less at the present time because private capital is the main source of funding for expanding access. The always-beyond-expectations demand that has been exhibited by the unconnected when offered telecom services is reason enough for private investors. The available evidence of employment and tax generation and similar benefits is adequate to justify government action to facilitate private supply.[2]

Therefore, this article takes as a starting point the necessity of greater access to ICTs by hitherto unserved or underserved people of the developing world. The access networks that will connect these people are for the most part wireless, whether the services are described as fixed, mobile, voice, or data. Optical fiber plays an important role in backbone networks, even though satellite, digital microwave, and even some forms of unlicensed IEEE 802.11–type technologies play varying roles in the backbone.[3]

However important wireless is to modern ICT infrastructures in the developing world and in the developed world alike, it is not something that can be simply dropped in to yield magical results. Its effective use requires the satisfaction of several institutional preconditions. If anything, government has more of a role in enabling effective use of wireless than it does with wire-based telephony.

The Asia-Pacific includes South Korea, the country with the world's second-highest broadband penetration (after Iceland), and Macau SAR [Special Administrative Region], and Hong Kong SAR, which have more mobile connections than people, on one end of the connectivity continuum, and Myanmar and North Korea, with mobile teledensities of 0.17 and 0.02, respectively, on the other.[4] In many countries in Asia, mobile connections have overtaken fixed connections, underlining the importance of wireless. The very first country where mobile overtook fixed was the Asian country of Cambodia, as far back as in 1993.

In all Asia-Pacific countries where connectivity is growing rapidly, wireless is playing a significant role. India's recent growth spurt is driven not only by "pure" mobiles but also by CDMA 800 technology that began life in that country in the guise of "limited mobility" services (Figure 2). In Cambodia and Laos, the fixed network is being expanded, primarily for data, through deployment of wireless networks based on CDMA 450.[5] Sri Lanka's expansion of fixed

2. E.g., Lane, B., Sweet, S, Lewin, D., Sephton, J, Petini, I. (2006, April). The economic and social benefits of mobile services in Bangladesh: A case study for the GSM Association. London: Ovum.
3. Goswami, D. & Purbo, O. (2006). 'WiFi "Innovation" in Indonesia: Working around hostile Market and Regulatory Conditions,' World Dialogue on Regulation Discussion Paper WDR0611 http://www.lirneasia.net/2006/05/wi-fi-%e2%80%9cinnovation%e2%80%9d-in-indonesia-working-around-hostile-market-and-regulatory-conditions/ (consulted 12 July 2006).
4. ITU (2005) The Internet of things. Geneva: International Telecommunication Union. The teledensity figure for North Korea is from the World Bank.
5. Tanner, John C. (2004, August 7th), CDMA 450 to save fixed line in Laos and Cambodia, telecomasia.net. At: http://www.telecomasia.net/telecomasia/article/articleDetail.jsp?id?120365

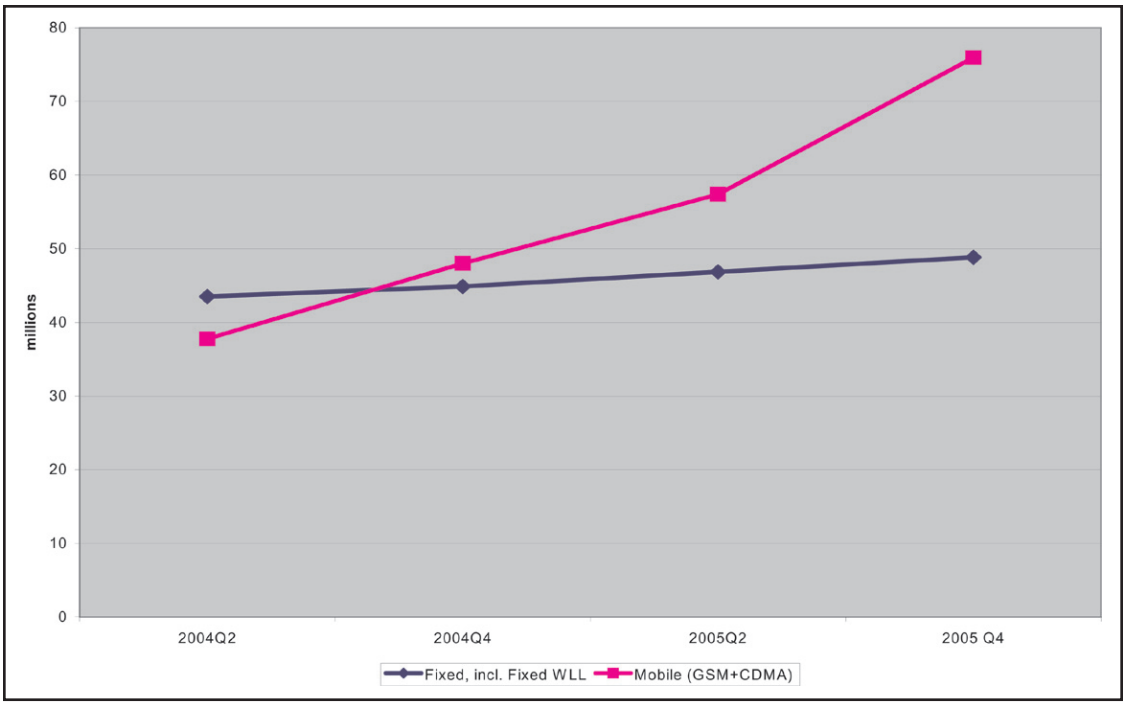


Figure 2. India, 2004–05, wireless-driven growth
Source: Telecommunications Regulatory Authority of India

connections in 2005–2006 was enabled by the refarming of frequencies for CDMA 800.[6] In this case, the customer equipment has the form of a conventional fixed telephone and not that of a mobile handset. It can be used anywhere within the range of the assigned base station by using a rechargeable battery.

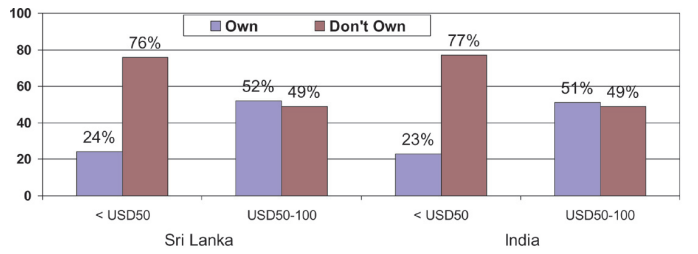
In light of the complexity of the relation between development and communication-knowledge and the fact that wireless is but one input into the process, it is not possible to weave a coherent narrative that is solely focused on wireless and development. What is attempted is the demonstration of the growing importance of wireless in the Asia-Pacific and the identification of the policy and regulatory pre-conditions necessary to realize its full potential.

Wireless in the Asia-Pacific

Mobile telephony is the most visible manifestation of the use of wireless technologies. In 2003, the Asia-Pacific became the world's largest mobile market, with 560 million connections, overtaking North America. The Asia-Pacific market grew at 31% a year in 2003, compared to 13% for North America. Despite this, the number of mobile connections per 100 people in the Asia-Pacific was only 16, compared to 52 in Europe and 35 in the Americas.[7] This suggests that Asia-Pacific mobile growth rates will accelerate even more, as the other two regions naturally slow down, making wireless even more important than it is today.

In the case of financially constrained groups in developing Asia, the role of mobile is still small. A sample survey of persons earning less than USD 100 per month in 11 locations in India and Sri Lanka revealed that only a minority owned the phones they used (61% in Sri Lanka and 57% in India), with mobile ownership among the less than USD 50 and between USD 50 and 100 groups being 4% and 14% respectively, in India and 22% and 32% respectively,

6. Jayasinghe, Amal (2005, August 14th), Hullo, hullo, Lanka Business Online, http://www.lankabusinessonline.com/new_full_story.php?subcatcode=20&catname=Research_Reports&newscode=2088815379
7. ITU (2004, September), Asia-Pacific Telecom Indicators, Geneva: International Telecommunication Union, p. 9.



What people own	Sri Lanka		India	
	< USD 50	USD50-100	< USD 50	USD50-100
Landline Only	2	20	19	37
Mobile Only	21	28	3	8
Landline + Mobile	1	4	1	6

Phone ownership doubles in higher income groups

Figure 3. Phone ownership among the financially constrained in India and Sri Lanka

Source: Zainudeen, Ayesha, et al. (2005). 'Telecom Use on a Shoestring: Findings from a Survey of Sri Lankan and Indian Users on Less than USD 100 a month.' Presentation slides at Research Presentation 'Usable Knowledge for Growing the Sector,' Colombo, 19 December 2005. http://www.lirneasia.net/2005/12/usable-knowledge-for-growing-the-sector/ (consulted 12 July 2006).

in Sri Lanka (see Figure 3). The greatest reliance was placed on public phones by this group.[8]

As stated above, wireless is found in all parts of the network and in all sorts of services, not in just the most obvious—that is, mobile services. In many cases, rapid growth in fixed also occurs because of heavy use of wireless in the access network. The Sri Lankan "fixed" growth of 2005 was driven by the use of limited-mobility CDMA services by fixed operators with the entrants being given a lead of a few months over the incumbent (Figure 4).

The Asia-Pacific is also a major player in mobile data. One consultancy firm calculated that 77% of the world's estimated 100 million

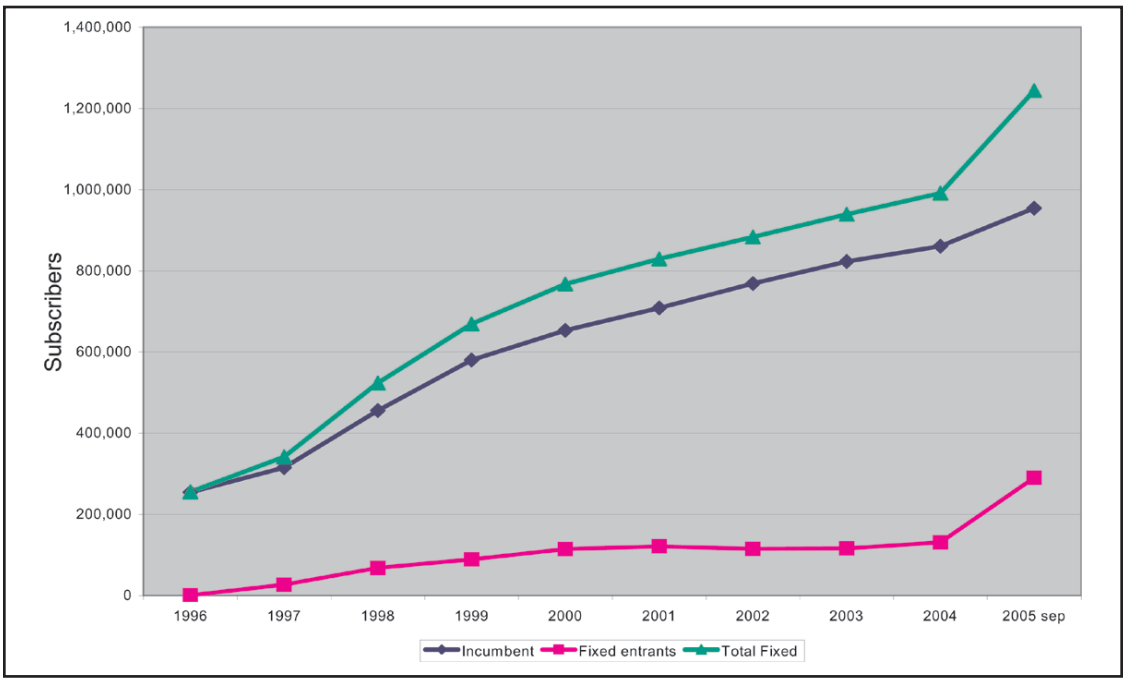


Figure 4 Fixed (wire line + wireless local loop) growth in Sri Lanka, 1996–2005

Source: Telecommunications Regulatory Commission of Sri Lanka. See: http://www.trc.gov.1k/pdf/statover1.pdf

8. Zainudeen, Z. A, et al. Telecom use on a shoestring: Some findings from a study of the financially constrained in South Asia, presentation at "Usable knowledge for growing the sector," event organized by LIRNEasia, Colombo, 19 December 2005. At http://www.lirneasia.net/wp-content/AZshoestringColNewsConf19Dec05.pdf (consulted 12 July 2006)

mobile data subscribers in 2003 came from the Asia-Pacific, principally Japan and South Korea.[9] The region was making significant progress on 3G mobile services as well, with more than 10 million subscribers in 2004.[10] The consultant estimate for WiFi deployments of more than 21 thousand hot spots in the Asia Pacific in 2003, reported by the ITU, has surely been exceeded.

In some cases, wireless substitutes for components that are unavailable from the incumbent. For example, in the early days of the Internet in Indonesia, the incumbent could not or would not issue leased lines to Internet service providers, who were also prohibited from building their own networks. An ingenious solution based on WiFi, used also for relatively long distances, was used as a stopgap measure.[11]

Policy and Regulatory Conditions

Until a government decides to permit entry by competitors, it is simply not possible for companies with the capital and the technology to participate in the market. For example, take Bhutan, a rugged and isolated Asian country that had a total of 40,000 fixed connections at the end of 2004, for a population reported as 734,340.

In November 2003, B-Mobile, a fully owned subsidiary of the fully government owned monopoly provider, started offering mobile service for the first time. "Much before the launch, B-Mobile registered about 2,255 subscribers and has almost sold out its 900 cell phones. Within just a little more than a year of operation, the subscribers have increased to around 20,000."[12] What this suggests is that the monopoly provider failed to anticipate and meet the expressed demand in the form of registered customers, because of either a lack of capital or a lack of imagination. In light of the reports of near riots by customers eager to obtain services that accompany competitive market entry in not dissimilar countries such as Bangladesh and Pakistan, one can only imagine what would have been the uptake had the royal government chosen to allow competition from the outset.[13] Alternatively, compare the uptake in Bhutan with that of Afghanistan, with more than 200,000 subscribers in 2004. In Bhutan, the lackadaisical incumbent was allowed to monopolize the entire industry, including fixed, mobile, and even the provision of Internet services until mid 2006.[14] Inserting wireless into this setting will not increase access or contribute to development, other than as a by-product of realizing an objective of the incumbent.

Wireless technologies require the use of frequencies. Frequencies are scarce resources that have to be well managed for optimal use. Improper use of frequencies (e.g., use of high-powered or badly tuned transmitters) can degrade the quality of service or require large guard bands. At present, frequencies are managed under a quasi-property rights regime with government-specified applications in assigned frequency bands. This means that, although it is difficult or impossible to dislodge an unwilling user from a frequency, the company that has been assigned the frequency does not have the right to alienate the frequency (except by selling itself along with the frequency) and in most cases is subject to various government-imposed limitations regarding power, polarity, and so forth. As a result spectrum users are heavily dependent on the propriety and efficiency of relevant government/regulatory agencies.

Providing communication services that use wireless technology requires paying attention to all as-

9. ITU (2004) Asia-Pacific Telecom Indicators, Geneva: International Telecommunication Union, September 2004, p. 10.
10. "IDC: 3G to Pick Up Pace in Asia/Pacific as Subscriber Numbers is Expected to Grow," Computerworld, 11(11), 25 March-7 April 2005. http://computerworld.com.sg/ShowPage.aspx?pagetype=2&articleid=584&pubid=3&issueid=33 (consulted 12 July 2006).
11. Goswami, D. & Purbo, O. (2006). 'WiFi "Innovation" in Indonesia: Working around hostile Market and Regulatory Conditions,' World Dialogue on Regulation Discussion Paper WDR0611 http://www.lirneasia.net/2006/05/wi-fi-%e2%80%9cinnovation%e2%80%9d-in-indonesia-working-around-hostile-market-and-regulatory-conditions/ (consulted 12 July 2006).
12. Dorji, Wangay (2005). Promotion of universal access to telecom and other ICT services in Bhutan. Master's Thesis, Technical University of Denmark.
13. BBC (2005). "Mobile phone riot in Bangladesh." 31 March. http://news.bbc.co.uk/2/hi/south_asia/4398493.stm (consulted 12 July 2006). Nasarullah, Nusrat (2004). "Stampede over free cell phones," The Dawn, 22 August. http://www.dawn.com/2004/08/22/fea.htm (consulted 12 July 2006).
14. Reuters (2006, June) "Bhutan: First private mobile license to be auctioned," http://www.regulateonline.org/index2.php?option=content&do_pdf=1&id=762 (consulted 12 July 2006).

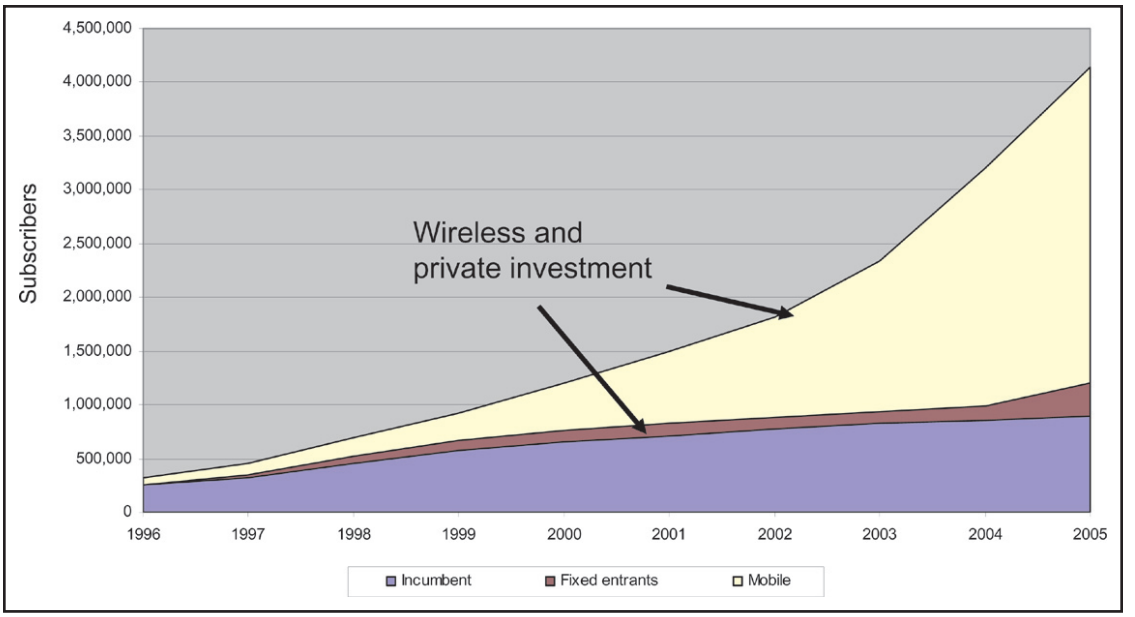


Figure 5: Telecom growth in Sri Lanka & the role of wireless & private investment, 1996–2005
Source: Samarajiva et al. (2005).

pects of the overall regulatory environment, not simply the spectrum management part. This is because the running of a viable communication business is bigger than using wireless. In a great majority of countries, government-owned, vertically integrated, monopoly telecom suppliers failed to provide services in rural areas and to nonelite groups. The normal incentives of monopolies to supply lower than optimal quantity and charge higher than optimal prices, exacerbated by the perverse effects of government ownership, led to this almost universal outcome. Where these groups were served, it was because the barriers to investment in the sector as a whole, or in particular geographical areas, were lowered. Because incumbents will not invest in serving underserved groups (except in exceptional circumstances), removing barriers to entry is key. This creates competition, which causes even the incumbent to serve groups it previously did not deem worthy of serving. In many cases, policy and regulation are major barriers. Their reform leads to the increase in supply of services.

Sri Lanka is illustrative. Market entry by mobile operators under unfavorable conditions was allowed, starting in 1989. The fourth mobile operator, as well as the two fixed competitors (limited by license conditions to using wireless), entered the market in 1995–1996. All were limited to using wireless. It is at this point that investment and connections took off (see Figure 5). The removal of the egregiously unfavorable conditions of interconnection in 1999 and authorization to originate and terminate international calls without being compelled to go through the incumbent in 2003 may have also contributed to the growth.

This growth was led by an increase in investment from fixed entrants and mobile operators as well as from the incumbent. Using privileged access to capital through government and the monopoly rents from its nominal exclusivity over international telecommunications services, the incumbent did make significant investments in the period up to 1999, which was the period of highest growth in connectivity. As those advantages dissipated, however, the investments went down sharply, with investments by entrants overtaking those of the incumbent in 2001, as shown in Figure 6. Although the data for the period after 2002 are not shown in Figure 6, in actual fact, investment, particularly by the mobile operators, increased significantly from 2003, when the international exclusivity was ended. It is noteworthy that in Sri Lanka both the mobiles and the fixed entrants, whose investments are shown in the two strips above the strip representing the investments

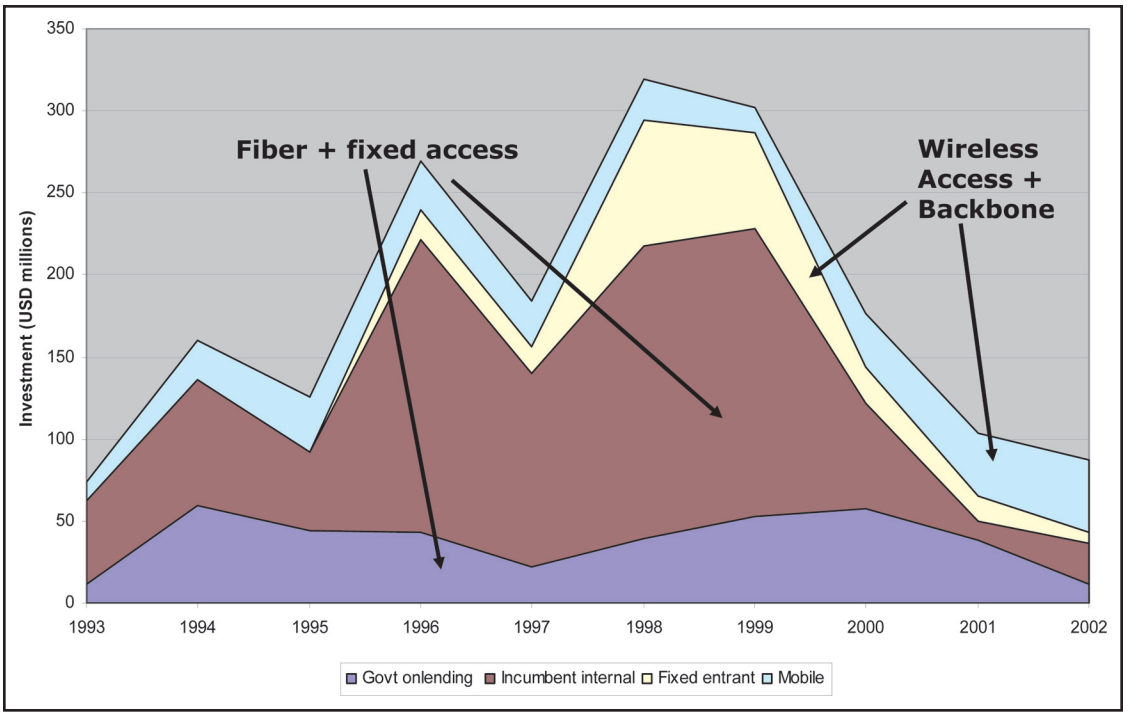


Figure 6. Investment in Sri Lanka, 1993–2002

Source: Samarajiva, R., et al. (2005), Regulation and investment: Sri Lanka case study, in Melody, W.H. and Mahan, A. (eds.). Stimulating investment in network development: Roles for regulators (Lyngby, Denmark: World Dialogue on Regulation) http://www.regulateonline.org/content/view/435/31 (consulted 12 July 2006)

of the incumbent, are entirely dependent on wireless for their access networks and for the most part for their backbone networks as well. The increase in wireless-based investment is shown in Figure 6.

Despite increased investments and growth, rural growth does not necessarily follow. Even after years of investment and rapid growth, telecom access in Sri Lanka was still skewed toward the highly urbanized western province, where the capital and much of the industrial base are located until the most recent burst of growth starting in around 2002, as shown by the 2001 household penetration figures in Figure 7.

It was only since around 2002 that the mobile operators began to serve the areas outside the western province in a significant way. The Central Bank of Sri Lanka's first consumer finance survey, which collected data at the provincial level (2004), provided the first comprehensive province-by-province data on telecom access (irrespective of fixed or mobile). In the absence of similar historical data, a calculation was made of household access in 2001, based on fixed phone distribution by province. In 2001, there were less than 700,000 mobile connections in the entire country, mostly concentrated in the urban centers of the western, central, and southern provinces. Provision of service by private operators (fixed or mobile) was not allowed in the northern and eastern provinces, which were affected by civil war. Therefore, it can be assumed that, even if data on mobile distribution by province were available, they would only serve to exacerbate the 12 : 1 disparity between the best-connected (western) and worst-connected (northern) provinces. If anything, the calculated data understate the disparity between the western and other provinces in 2001.

The northern province, which was in last place in 2001 increased household penetration by 440%. The northwestern province, which was fifth in 2001, showed an increase of 142%. The slowest growth was found in the first-place western province and in last-place Uva province. In the former, it appears that the expansion of mobiles simply added to the

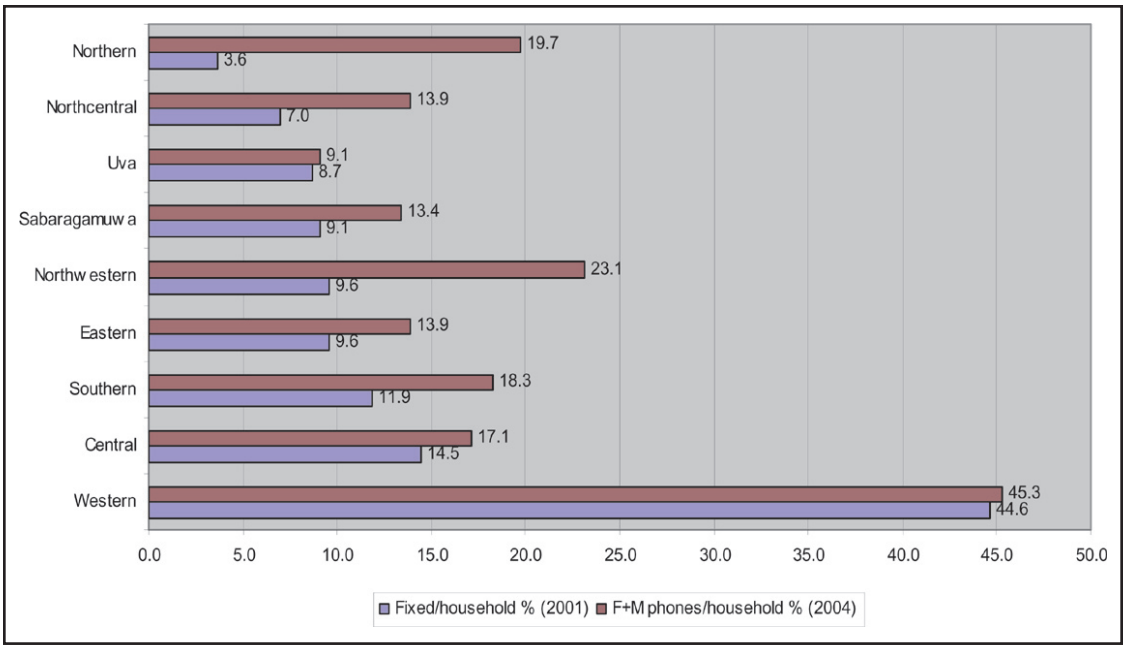


Figure 7. Access by households (%) by province, Sri Lanka, 2001–2004

Source: Calculated by author from Central Bank of Sri Lanka and Telecommunications Regulatory Commission of Sri Lanka data

number of phones per household, whereas in hitherto unserved or underserved areas such as the northern and northwestern provinces, the mobiles, serving as sole household phones actually increased household penetration. Even the last-place province showed growth, with the percentage of households with access to telecom increasing from 8.7 to 9.1.

The growth spurt that connected almost 2 million new connections that were given in 2001–2004 (almost 80% being mobiles) was a tide that raised all ships, but the growth strikingly favored the laggards as indicated by the narrowing of the gap between the most-connected and least-connected provinces from 12 : 1 to 5 : 1 and by the dramatic shuffling of the rank order. When private mobile operators were allowed to provide services after the ceasefire agreement of 2002 took effect, the war-weary populace of the northern province began to connect at a spectacular rate, moving the province from last place to third in three years. The northwestern province, endowed with a good industrial and agricultural base, moved up from fifth place to second in that same period.

The Sri Lankan experience shows that, although it takes several years for market opening and related actions to take effect, in the end wireless-enabled and competition-driven network expansion does result in services being provided to those living outside the metropolitan centers. Correct policy and regulatory actions can, of course, accelerate this process.

Policy and Regulatory Reforms

The interrelated nature of regulatory problems requires multipronged solutions. The optimal environment for rural supply by wireless or otherwise is constituted by

- Existence and enforcement of transparent market entry policies;
- Efficient management of scarce resources, primarily frequencies, numbers and rights of way;
- Effective, cost-oriented and nondiscriminatory interconnection and access to backbone capacity; and
- Effective enforcement of regulatory and competition rules.

Market Entry Policy

The above discussion demonstrated the importance of minimizing barriers to entry. Even after the mo-

nopoly of the government-owned incumbent is broken, governments tend to maintain control over market entry, using various rationales, ranging from national security to spectrum scarcity. The potential to collect rents either in the form of high auction proceeds to the government or in the form of bribes to key decision makers is a major factor in restrictive market-entry policies.

The market-entry principle that is now accepted as best practice is "licenses where scarce resources are involved; authorizations otherwise." The latter refers to standard procedures where the discretion has been stripped out or minimized, whereby entities that meet specified, publicly announced criteria will be authorized to provide services without numerical limit. Until the advent of unlicensed wireless services based on IEEE 802.11 standards, there was almost universal agreement that radio frequencies were scarce resources. Indeed, under most current technological standards, most wireless-based services require exclusive or heavily regulated shared use of frequencies, justifying the classification of frequencies as scarce resources.

Market entry with regard to wireless-based services is therefore inextricably connected to the assignment of appropriate frequencies. Bangladesh issued "authorization"-type licenses for fixed services (without numerical limit) but found all the licensees then asking for frequencies, for which the necessary planning had not been done. Even in India, the policy of unifying the mobile and fixed licenses first focused on license fees and termination charges. It was only later that attention was paid to the necessity of issuing the appropriate frequencies.[15]

What is important in terms of market entry are not frequency ranges in general, but specific frequency ranges for which equipment is manufactured on a large scale and that therefore offer both low costs of network equipment and handsets and availability of handsets and service functionalities. The success of the European GSM standard (900 and 1800) since the mid-1990s has driven down the costs of equipment and made a plethora of functions available on GSM networks. In addition, the networking economies offered by the existence of networks in most countries in the world, with few exceptions such as South Korea, provide additional features such as international roaming. As a result, GSM frequencies are extremely valuable and have in many countries been auctioned for high prices. The CDMA standard, which had a slow start, picked up momentum with massive growth in India and China and has now made CDMA 800 and 1900 frequencies highly valuable as well. As these popular frequencies become occupied and/or become expensive, other frequency ranges such as CDMA 450 are likely to attract the attention of manufacturers and service providers.

Governments and regulatory agencies are not the best judges of technology trends and the success of standards; however, piecemeal responses to individual requests for frequencies is not the most transparent or efficient method of spectrum management/market entry. Governments and regulatory agencies will have to maintain some form of technology-horizon scanning and market assessment capabilities, based upon which ranges of frequencies can be cleared of lower-value uses and auctioned off. The auctions need not be designed with the sole objective of maximizing proceeds, but can be designed to achieve the paramount objective of transparency along with other policy objectives. Indeed, the Hong Kong and Denmark 3G auctions showed that auctions can be designed to discourage excessive bids.[16]

The International Telecommunication Union (ITU) oversees the allocation of spectrum to various services based on three regions, yet equipment is manufactured by companies that see the world as their market and, especially with mobile services, handsets do not necessarily stay in one region. Partly because of the rapid pace of technology and market development and partly because of the inconsistency of the allocations and different national spectrum policies and priorities, frequency ranges are not uniformly available for new services. For example, the most common GSM handsets that use the 900-

15. Telecom Regulatory Authority of India (TRAI) Consultation Paper on Efficient Utilisation, Spectrum Allocation, and Spectrum Pricing, May 31 2004. Available at: http://www.trai.gov.in/trai/upload/ConsultationPapers/74/consultation%20paper%20on%20spectrum%20released.pdf (consulted 12 July 2006).

16. Ure. J. (2002) 3G Auctions: A Change of Course, in Robin Mansell, Rohan Samarajiva and Amy Mahan eds. Networking Knowledge for Information Societies: Institutions & Intervention, Delft University Press: a festschrift *for Professor William Melody, pp. 127–131. At: http://lirne.net/2003/resources/netknowledge/ure.pdf (consulted 30 December 2005).*

Table 1. Sequence of a hypothetical refarming process for GSM and CDMA

	Main policy actions	Parallel policy actions
Step 1	Government sets overall policy and authorizes negotiations with seven operators (O_1–O_7)	
Step 2	System and frequency license modifications negotiated. Modifications include removal of technology restrictions from O_1, O_2, etc. and may include extending license term of O_4 (which will gain no benefits but has to yield frequencies)	
Steps 3 and 3A in parallel	O_4 and O_5 release GSM 900 frequencies; O_1, O_2, and O_3 will also be requested to agree to phased release of frequencies to enable overall ordering of the bands	1800-MHz tender board releases funds for band clearing (some 1800-MHz frequencies have been auctioned to GSM operators)
Steps 4 and 4A in parallel	O_6 assigned GSM 900 frequencies and releases CDMA 800 frequencies	1800 GSM and 1900 CDMA bands fully cleared
Step 5 and 5A in parallel	O_1, O_2, and O_3 assigned CDMA 800 frequencies	Auction frequency slots that may be used for CDMA 1900 or GSM 1800 to current operators but possibly also to newcomers

MHz and 1800-MHz frequency ranges in ITU regions 1 (Europe) and 3 (Asia Pacific), cannot be used in ITU region 2 (Americas), where those frequencies have been assigned for different services. An example of technology and market development causing difficulties was the use of CDMA 800 frequencies for AMPS, an obsolete mobile telephony standard, in Sri Lanka.

Therefore, the efficient use of wireless requires government action in the form of spectrum refarming, the clearing of frequencies from low-value (by economic and/or social criteria) and reassignment to high-value applications. This is a complex and difficult task in that the occupants of the frequencies to be reassigned are unlikely to be pleased by the change because of disruptions to their activities. In addition, refarming will make the equipment previously used in those frequencies completely unusable, at least in that country. This means that they must be compensated on a replacement-cost basis. The funds for compensation must be raised from the beneficiaries of refarming, ideally as part of auction proceeds. The complexity of the refarming process is illustrated by the hypothetical flowchart in Table 1.

The desired end state in this process is for three operators to be assigned a base allotment of 2.5 MHz each in the CDMA 800 band and for four operators to be assigned 7.5 MHz each in the GSM 900 band, with additional requirements being met through auctions in the GSM 1800 and CDMA 1900 bands. The auctions would also be the source of funds for compensating the displaced users.

Refarming frequencies for use by IEEE 802.11–type technologies poses additional challenges. In the old model of exclusive assignments, there is a clearly identifiable entity that benefits from the refarming exercise and can therefore be used as the source of compensation payments. In the case of unlicensed frequency bands such as 2.4 GHz, there is no identifiable beneficiary. Thus, the government has to find an alternative source of funding for refarming in these instances. In addition, the new unlicensed technologies require a range of frequencies that can be used by many in common, rather than the old discrete frequencies. This also poses a challenge to the spectrum manager.

Management of Scarce Resources

Supply of telecom services in a rapidly growing market requires both the ability to obtain additional

scarce resources needed for increasing supply and the assurance that the assigned resources can be used effectively. These expectations apply to rights of way and towers as well as for spectrum. In view of the present focus on wireless, emphasis will be placed on spectrum and towers.[17]

As subscribers and coverage areas expand, operators require access to additional frequencies. As explained above, the frequencies must be from particular bands that satisfy the technical requirements of operators. The spectrum manager must manage the resource efficiently, anticipating the operators' requirements as best as possible and refarming the expansion bands. In light of the importance and value of these incremental frequencies, it is generally better to assign them through transparent mechanisms such as auctions.

Because most extant technology standards, with the exception of IEEE 802.11 and similar unlicensed applications, require interference-free, exclusive, or shared use of frequencies, it is important that the spectrum be efficiently monitored and that unauthorized use in whatever form (e.g., out of band, excess power) be policed. The requirements are generally automated frequency monitoring and management systems, competent staff, and appropriate legislation.

Adequate geographical coverage requires the placement of base stations in areas with significant populations. This requires significant investment and the surmounting of a number of bureaucratic barriers. The building of antenna towers or the placement of antenna on existing structures is one that usually involves multiple authorities, resulting in delay, expense, and, in many cases, bribery.

Towers capable of supporting multiple antennae will ideally be constructed with transparent, cost-based charging systems that would enable more than one operator to use it. This reduces environmental impact and costs. In most developing countries where the governance structures are not strong enough to efficiently regulate common facilities such as towers, however, it may be advisable to leave open a "build" option as an incentive for reasonable negotiation by tower operators.

Tower construction requires multiple layers of approval. If the laws governing this activity could be simplified, the extension of wireless coverage would be easier. Simplification does not mean that local authorities should be stripped of their powers over the placement of visible structures because that is an intrinsic element of managing the living space of a community. Better is the provision of time-bound procedures for resolving disputes with regard to antenna towers and placement. These provisions should extend to street rights of way because the operators may find it necessary to connect base stations with cables rather than using wireless. In cases where an incumbent has laid underground cables or conduits, it would be necessary for the regulatory body to ensure cost-based, nondiscriminatory access. Again, the proviso regarding the utility of a "build" option in countries with weak governance applies.

Interconnection and Access

Interconnection and access are critical problems in all competitive telecom environments, regardless of whether services are provided wirelessly. Therefore, they will not be discussed in detail here; however, the importance of ensuring cost-oriented and nondiscriminatory interconnection and access to essential facilities including backbone and undersea cable stations cannot be overemphasized. The effects of unsatisfactory interconnection and access regimes can undo much of the benefits of good regulation in other areas. The best spectrum management in the world will not make an operator offer services in a remote area if the costs of backhaul are too high.

Effective Enforcement of Competition and Regulatory Rules

The markets within which suppliers of wireless-based services operate are highly imperfect and pervaded by market power and government discretion. Therefore, successful operation is not simply about picking the right technologies, keeping the costs down and making the customer happy. In many countries, skills in negotiating with the incumbent and with the regulator overshadow the skills involved in running a telecom business.

If regulatory risk and the consequently higher costs are to be minimized and operators' energies

17. Telecommunications Regulatory Authority of India, "Recommendations on Growth of Telecom Services in Rural India: The Way Forward," 3 October 2005, At: http://www.trai.gov.in/Recommendations_content.asp?id=6 (consulted 12 July 2006)

refocused on the provision of services and away from influencing the regulator and negotiating with the incumbent, it is essential that the regulatory agency be effective. A necessary condition for effective regulation is modern, promarket, discretion-minimizing legislation that also includes provisions for the independence and accountability of the regulatory agency. Requirements for broad consultation and transparency will also contribute.

The sufficient conditions for effective regulation are trained and committed people. There tends to be a dearth of such people in sectors of government in developing countries. Part of the reason why the problem exists is the lack of resources to pay for skilled personnel and, in many cases, the requirement to recruit from the local labor market or from within the administrative service. To a greater or lesser extent these causes may be remedied, but the intangibles of leadership and commitment cannot be administratively ensured.[18]

It is generally accepted that spectrum is so integrally connected to the core tasks of regulation in a competitive marketplace that its management should be given to the regulatory agency, unlike, for example, in India, where the executive still controls it. Government must create the necessary structures to ensure smooth coordination with the noncommercial users of spectrum, primarily the military, and also to build in mechanisms to counterbalance the tendencies of such parties to hoard frequencies and be inefficient in frequency use.[19]

In many developing countries, competition law and effective competition enforcement are absent. Even if legislation and an authority exist, there may be merit in assigning most, if not all competition powers to the specialized ex-ante regulatory agency because parallel jurisdiction can create opportunities for delay and gaming and result in increasing regulatory risk. There is also the problem of adequately staffing both a regulatory agency and a competition authority.

In cases where competition law is not yet enacted, it is still possible to enforce competition rules through license conditions and the general provisions of telecom regulatory legislation.

Examples of wireless-related anticompetitive practices that can be addressed under formal competition legislation or under the specific provision in licenses are the preferential treatment of a mobile affiliate by an incumbent in terms of interconnection and access to essential facilities, including sharing of antenna towers. Refusal to deal with Internet service providers that use wireless in the access network (in terms of not providing leased lines) or discriminatory pricing are very common, though rarely challenged. As the momentum builds toward convergence, anticompetitive practices such as tied sales are likely to increase.

Concluding Comments

Wireless matters in the Asia-Pacific; it matters throughout the world. The extraordinary expansion of connectivity that is being witnessed across the world, especially across Asia, would not have happened if not for wireless. The most powerful illustration is Afghanistan. A country devastated by 23 years of war, it had no mobile service and the number of fixed phones was decreasing every year. If not for wireless, Afghanistan's two private mobile operators could not have added in excess of 200,000 new mobile customers in two years, almost catching up with Bangladesh, which had mobile service for more than 10 years, on a per capita basis.[20]

The Indian and Chinese booms are far from over. New entry and investments in Bangladesh and Pakistan, two countries with large populations and enormous unmet demand, will drive Asia-Pacific growth even faster in the coming years, unless there is active obstruction by regulators. Throughout the Asia-Pacific, operators are learning not only how to live with hitherto unthinkably low ARPUs (average revenue per user) but to keep their investors happy with good returns. The popularity of prepaid mobile, in many Asia-Pacific countries accounting for as much as 80% of customers, has lowered the barriers to telecom use by the financially constrained. The pre-

18. Samarajiva, R. (2001). Regulating in an imperfect world: Building independence through legitimacy. Info, 3(5), 363–68.

19. For an example of the kind of high-level initiative that is required, see The Hindu Businessline (2006, March 21), "Telecom operators may get additional spectrum," at: http://www.blonnet.com/2006/03/21/stories/2006032102210900.htm (consulted 12 July 2006).

20. Zita, Ken (2004). Afghanistan telecom brief (prepared for US Trade Development Administration). http://www.export.gov/afghanistan/pdf/telecom_market_overview.pdf (consulted 12 July 2006).

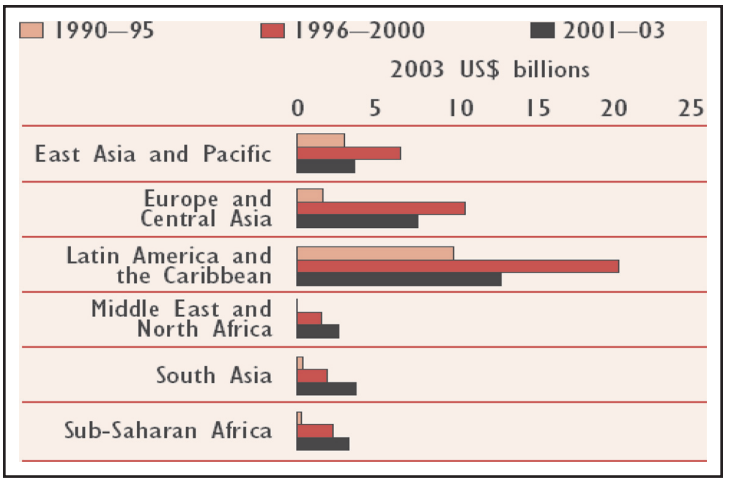


Figure 8 Private investment in telecom 1990–2003

Source: Izaguirre, Ada Karina (2005) Private Telecom Projects, Public Policy for the Private Sector, World Bank. At: http://rru.worldbank.org/Documents/PublicPolicyJournal/288izaguirre.pdf (consulted 12 July 2006)

paid mode of service delivery is now moving over to the fixed sector as well. The driving down of per-line costs of networks and the growing availability of low-cost handsets[21] will bring additional millions into the ranks of telecom users. Almost all of them will conduct at least a part of their communications over wireless; many of them will do so entirely over wireless.

But wireless is not the only thing that matters. The technological and business innovations that make possible the current levels of participation and that will enable millions more to participate are not new. What has held back their deployment has been the lack of investment; what has held back investment for the most part has been the unsatisfactory policy and regulatory environment.

As Figure 8 shows, both the richer East Asian and Pacific region, as well as the poorer South Asian region, have attracted far less private investment than have other regions, barring Africa and the Middle East. The figure does not distinguish between wired and wireless, but, as discussed above, wireless now plays a key role in all telecom. The good sign, in this somewhat dated figure, is that investment has increased in South Asia, even after the collapse of the bubble. Impressionistic evidence suggests that investment increased substantially in South Asia after 2003, with the entry of Etisalat, Orascom, Telenor, Singtel, and others to large South Asian markets, the refocusing of Telekom Malaysia's investments in South Asia following withdrawal from Africa, and the raising of the foreign direct investment cap in India.

The core question then is why the technology and business innovations centered on wireless were not effectively and fully applied to meet the unmet demands of the people of the Asia Pacific. The answer is poor policy and regulatory environments that have not only driven up the costs of supplying telecom services by wireless or otherwise by increasing regulatory risk and through rent seeking, but have, in some cases, actually barred the deployment of wireless technologies.

Unless the policy and regulatory environment is right, investment will not flow in, or, where it does flow in, will be skewed in various ways (quick returns, urban, tied to rent-seeking opportunities, etc.). Policy and regulatory reforms that cover market entry, management of scarce resources, interconnection, and the effective enforcement of regulatory and competition rules are essential. In all cases, paper reforms must be followed by credible implementation.

A glance back over the past decades is instructive as we assess the potential of another technology to advance development. In the 1960s and 1970s, satellites were supposed to deliver development; telehealth and tele-education were all the rage; village phones, multipurpose telecenters, the Internet, the list goes on. Satellites have made certain things possible as have all the other technologies, but there was no silver bullet. In all cases, the application of the technology was mediated by industry structures, primarily the incumbent monopolies. The results were less than optimal. The satellites are commercial; most telecenters have closed down. Now with a

21. GSM Association press release: GSM Association Forges Sub-$30 Mobile Phone Segment for Developing Countries. September 27 2005, Singapore. At http://www.gsmworld.com/news/press_2005/press05_23.shtml (consulted 12 July 2006).

majority of the world's countries abandoning the monopoly supply model, the conditions are better for greater participation, innovation and contribution to development, but there remain many policy and regulatory barriers. Their removal, in parallel with wireless innovation, is necessary if wireless is truly to contribute to development. ■

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