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PROVIDING LOW-COST INFORMATION TECHNOLOGY ACCESS TO RURAL COMMUNITIES IN DEVELOPING COUNTRIES: WHAT WORKS? WHAT PAYS?

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RÉSUMÉ

Les zones rurales des pays en développement sont les dernières à attendre encore la révolution des technologies de l'information. Le taux de pénétration du téléphone et d'Internet reste encore minime par rapport à celui des pays développés. Les moyens limités de communication électronique avec le reste du monde sont une source d'isolement parmi d'autres — mais importante — des communautés et des économies rurales par rapport aux dynamiques de l'intégration nationale et mondiale. En l'absence de routes et d'électricité, améliorer l'accès aux TIC n'a qu'un intérêt limité. A l'inverse, dès que ces éléments d'infrastructures existent, les avantages se cumulent.

Fournir des TIC dans les zones rurales est généralement plus coûteux que dans des zones urbaines plus peuplées ; les moyens des abonnés potentiels semblent aussi plus limités. Ces dernières années, un certain nombre d'expériences intéressantes ont été entreprises pour développer le téléphone à bas prix et, dans certains cas, l'accès à Internet des communautés rurales à faible revenu. Ce document rend compte de quelques-unes de ces expériences, en s'intéressant notamment à leur pérennité financière.

Des enquêtes auprès des ménages ruraux sur leur disposition à payer pour des services téléphoniques montrent qu'ils sont vraisemblablement viables sur le plan commercial. Les systèmes de concession pour un accès partagé semblent être les plus intéressants d'un point de vue économique. Grâce à l'uniformisation et à l'agrégation de la demande, ces systèmes permettent de tabler sur des économies d'échelle pour l'achat du matériel informatique et des logiciels mais aussi au niveau de l'assistance technique ; ils assurent également un meilleur pouvoir de négociation des frais d'interconnexion et du prix des lignes louées. Ces modèles ouvrent des perspectives aux petits entrepreneurs, tout en incitant à la réduction des dépenses et à l'adoption d'une gestion financière rigoureuse. Si l'on ne veut pas porter un coup d'arrêt à l'innovation cependant, les modèles de concession doivent s'accompagner dune certaine souplesse dans la mise en oeuvre au niveau local.

Alors que les économies rurales sont probablement moins complexes d'un point de vue technologique que les économies urbanisées des pays développés, la valeur de l'obtention en temps et en heure d'une information est tout aussi importante — voire même plus — en termes relatifs. Au-delà de bénéfices purement économiques, ce système peut avoir d'importantes retombées sociales, en permettant un contact longue distance avec des membres de la famille installés à l'étranger ou dans une grande ville. L'expérience des femmes bangladaises, qui constituent la majorité des opérateurs téléphoniques dans les villages du réseau Grameen, montre que le statut social peut sortir renforcé grâce au contrôle exercé sur une ressource précieuse — l'accès à l'information.

Les pouvoirs publics doivent opérer de délicats arbitrages entre les demandes concurrentes qui pèsent sur les rares recettes fiscales et les fonds empruntés. Heureusement, dans le cas des télécommunications et d'Internet, les besoins d'investissements publics sont moins lourds que pour la construction de routes et le raccordement à l'électricité dans les zones rurales. Un cadre réglementaire approprié et des processus d'appel d'offres bien conçus pour équiper les segments les moins profitables du marché devraient contribuer à attirer les investisseurs privés, y compris dans les zones mal desservies. En dernier ressort, c'est sans doute la voie la plus courte vers l'objectif ultime de « services universels ».

SUMMARY

Rural areas of the developing world are the last frontier of the information technology revolution. Telephone and internet penetration there remains a small fraction of what it is in the developed world. Limited means of electronic communication with the outside world are just one source of isolation of rural communities and economies from the forces of national and global integration, albeit an important one. Without roads and electricity, the benefits of extending ICT access would be greatly diminished. Conversely, where these other elements of infrastructure are in place, those benefits can be multiplied.

The costs of ICT provision to rural areas tend to be higher than to more densely populated urban areas, and the ability to pay of potential subscribers lower. In recent years, a number of interesting experiments has been initiated to extend low-cost telephone and, in some cases, internet access to low-income rural communities. This paper reviews some of these, with a particular emphasis on whether they are likely to prove financially sustainable.

Surveys of rural households' willingness to pay for telephone service point to its potential commercial viability. Franchise models of shared-access provision would appear to have the most favourable economics. Through standardisation and demand aggregation, they offer the prospect of reaping economies of scale in hardware and software procurement as well as in provision of technical support, and enhanced bargaining power in negotiating interconnection fees and leased line prices. Such models provide opportunities to small entrepreneurs, at the same time creating incentives to both cost containment and rigorous financial management. If innovation is not to be stymied, however, the franchise model needs to allow for flexible local variation in implementation.

While rural economies may be less complex technologically than the highly urbanised economies of the developed world, the value of timely information can be just as high — if not higher — in relative terms. Besides the strictly economic benefits, there can be important social benefits of maintaining long-distance contact with family members working abroad or in the city. The experience of Bangladeshi women who make up the majority of village phone operators for the Grameen network suggests that social status can be enhanced by virtue of control over a valuable resource — information access.

Governments need to consider the difficult tradeoffs among competing uses of scarce tax revenues and borrowed funds. Fortunately, in the case of telecoms and the internet, there is not the same need for substantial public investment that there is in rural roads and electricity. An adequate regulatory framework and well-designed contractual bidding process for supplying less profitable segments of the market should go a long way towards attracting private investment, including in underserved areas. In the end, this is likely to be the most direct path towards the ultimate goal of "universal service".

I. INTRODUCTION

Telecommunications access contributes positively and significantly to economic growth (cf. Canning and Pedroni, 1999). The internet is too new to permit comparable assessment of its long-run growth impact. This paper takes the potential economic benefits of ICT access as a given; the rapid growth in mobile telephone and internet use in many low-income countries suggests there is a sizeable pent-up demand for modern communications technologies. The fact remains, however, that there are enormous gaps in ICT access not only between developed and developing countries, but also between urban and rural areas of developing countries. To some degree these differences may reflect differences in the returns to technology use in different environments. There are, however, technical difficulties in providing ICT access to rural populations of the developing world that often raise the unsubsidised costs beyond what they are for typical urban users. The added supply costs on the one side confront the low incomes, hence ability to pay, on the other. How effectively is this dilemma been addressed? How do various organisational models of low-cost rural ICT provision compare in terms of both affordability and sustainability? What technical options are most promising in specific circumstances? These are the questions addressed here.

The private return to investing in rural telecommunications is not necessarily more attractive than that to investing in rural roads. Both face the same problem of a high fixed investment that is difficult to recover in an acceptable timeframe, given the low user densities of many rural areas. Of course, roads have the additional characteristic that, while access may be technically excludable, free access is the norm, making cost recovery by a private investor impossible. The government must generally provide rural roads if they are to be provided at all. As for rural telecommunications, with new transmission technologies, there is greater scope for involvement of private investors, since the up-front costs of network extension are not quite so prohibitive — e.g. with wireless networks there is no need for laying cable to remote areas — and because access to and payment for telecommunications can be managed more easily than for roads (e.g. by cutting off telecommunications users who do not pay). The economics of rural telecoms are changing, but the question remains whether market forces alone will suffice to extend rural ICT access at a sufficiently rapid rate to meet expectations.

The paper is organised as follows. The next section briefly enumerates the main channels through which ICTs are thought to benefit rural communities. The following section outlines the main challenges faced by would-be ICT infrastructure builders and service providers in low-income rural areas and describes the main organisational models of ICT access provision, with a particular focus on their financial sustainability. Section IV examines the technology options, both for transmission and for end-user devices. Section V suggests ways of addressing key demand- and supply-side constraints to broader rural ICT access, including the financing of “universal service”. Section VI discusses possible policy instruments to support more rapid ICT diffusion, with a strong emphasis on telecoms regulatory reform. Section VII summarises and concludes. Annex Tables summarise *i)* the main features of the contending technical options for low-cost rural telephony and internet access and *ii)* low-cost electricity supply options for rural telecentres.

II. THE ROLE OF ICTs IN DEVELOPMENT

Before turning to the "what works? what pays?", let us consider first the "what for?" of rural ICT access. What need do poor rural communities in the developing world have for telephones, computers and the internet (henceforth, ICT)? How important are these technologies to their social and economic well-being?

As Hardy (1980) argues, if telephones contribute at all to economic development, it is most probably through the expansion they make possible of social networks beyond the immediate neighbourhood, the better co-ordination of entrepreneurs over long distances, and the timely access they can provide to valuable information (particularly but not only price information)[1]. As for price information, take a typical Asian rice farmer, with an average landholding of one hectare, an average yield of 4 000 kg per hectare, and two crops a year. If the farmgate paddy price is $0.16 per kg., then a one-cent increase would raise the farmer's annual rice-crop income by roughly 6 per cent. The questions remain of whether the telephone or internet can enable the farmer consistently to obtain a higher price than otherwise and, if so, how much higher. There is substantial anecdotal evidence to suggest that timely price information can make a major difference to earning prospects, but more systematic statistical analysis would be helpful. The evidence suggests that the utility of ICT access extends beyond timely agricultural price information. In rural areas of Bangladesh, for example, where overseas remittances are a very important supplement to local incomes, arranging low-cost funds transfer and conversion to local currency at a favourable exchange rate can be important benefits of ICT access.

The internet is an enhanced means of acquiring and sharing useful information and of multilateral communication (as opposed to the bilateral sort characteristic of the telephone). Weak information infrastructure, just like weak transport infrastructure, can reduce attractiveness of merchandise trade with particular areas. Evidence from Botswana and Zimbabwe shows that areas lacking telephone access see significantly less entrepreneurial activity than those with access (Kenny, 2001). ICTs can diminish — though generally not completely overcome — the isolation of rural communities. For example, crop price information transmitted by telephone or internet from the nearest urban centre may permit a better timing of trips to markets, but the trips may still take an inordinate amount of time in the absence of quality roads, not to mention motorised transport. These two forms of infrastructure are thus strongly complementary. Fully exploiting the benefits of one depends on having access to the other.

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1. Leff (1984) argues that, by providing a broader information base for decision making, ICTs can make risk more calculable for entrepreneurs, including farmers.

With the internet boom of the late 1990s, much speculation surrounded the developmental potential of this global network. Anecdotes were rife in the popular press and in the grey literature about artisans in remote areas of developing countries being able to market their handicrafts, music, etc., directly to customers via the internet. While there have been occasional success stories, in general analyses have tended to exaggerate the potential benefits by failing to take fully into account that *i)* only a relatively small number of goods and services can be directly distributed via the internet, *viz.* those (like audio and video recordings, books, drawings, data) that can be digitised, *ii)* for other goods the rural artisans continue to have to rely on intermediary agents (at the very least shippers) to get their goods to market, and *iii)* developed country buyers are accustomed to paying for purchases with credit/debit cards, which developing country vendors must be able and willing to accept as means of payment while ensuring the security of customer financial information (Goldstein and O'Connor, 2000).

Above all, reaping the potential benefits of the internet presupposes that the problem of low-cost access in rural areas and other low-income communities has been resolved. In addition to the question of cost, the problem of the quality of access should not be underestimated: especially in remote areas of developing countries, cables tend to be in bad repair, and international access to the internet often very limited. The nearest server may well be farther than a local phone call away. The combination of these factors tends to make internet access very slow and costly.

While the internet may have been excessively hyped during the dotcom boom, there are certainly valuable uses for the technology. It is an important instrument for co-ordinating decisions and arranging procurement along global supply chains, to which developing country companies are increasingly linked. Also, local communities can reap advantages from ICTs inasmuch as they improve the speed, quality, and responsiveness of governments to their citizens, enhance accessibility to government services (UNDP, 2001), and facilitate civil society participation in public debates and influence on decision making processes. The Indian state of Andhra Pradesh has set up internet-based Integrated Citizen Service Centres. The services provided in these centres include bill payment; issuing certificates, permits and licenses; public information; and administration procedures. Moreover, ICTs can facilitate the effective provision of public services — e.g. in the case of education through distance learning, or in the health sector through providing fast and cheap access to specialists.

Finally, ICTs have proved to be a force for democratisation in some communities and countries. For example, the Bangladeshi women — most often poor — who make up the majority of phone operators for the Grameen Village Phone network have experienced an enhancement of their social status by virtue of their privileged access to a means of acquiring valuable information (Aminuzamman, 2002). The internet is more difficult for government authorities to control and censor than radio, TV or print media, and excessive control comes at an economic cost (e.g. by discouraging foreign investment). Its vital role as an up-to-date, independent, potentially life-saving information source has been demonstrated during the ongoing SARS (severe acute respiratory syndrome) epidemic in China, with the WHO website at first providing a more complete picture of the extent of the crisis than did official government information sources. The internet has tended to empower civil society organisations that can make effective use of the technology to share information, disseminate their views, and co-ordinate action.

III. ORGANISATIONAL MODELS FOR LOW-COST ICT ACCESS IN RURAL AREAS

This section asks whether there are prospects to supply ICT access to low-income communities at low cost and at the same time on a financially sustainable basis. The task of providing ICT access is subject to particular challenges in rural areas of developing countries. These challenges include:

– Remoteness, leading to high start-up and maintenance costs, as well as lack of electricity, so that computers in rural areas often require generators and voltage stabilisers;
– Low population density, which again negatively impacts upon costs;
– Lack of relevant human capital (in particular technicians for maintenance and repair). Consequently, costs are again raised since the equipment used must be extremely robust;
– Low earning capacity of rural population, such that considerations of commercial viability could lead to firms having to charge prices which at best a tiny minority could afford.

Given these problems, the aim of universal telecommunications — not to mention internet — access in developing countries would appear to be a remote one. Nonetheless, there are some promising new experiments that could potentially evolve into a commercially viable model for provision of rural access. Three broad institutional approaches to rural ICT provision are discussed here, the Grameen Village Phones in Bangladesh, the telecentre concept and variations on that theme, and the n-Logue multi-tier franchise model in India.

a) Grameen Village Phones

One of the best-known experiments in extending telephone access to the poor has been undertaken by Grameen Telecom (a member of the Grameen Group). Grameen Telecom (GT) uses two main methods of extending phone access: firstly, the provision of phones directly to potential subscribers (often businesses) and, secondly, the leasing of phones to Grameen Bank[2] members who then provide telephone services on a fee-for-service basis to the rest of their community (the "Village Pay Phone" — VPP — system).

2. Grameen Bank is best known for its successful microfinance programme targeted at poor rural women of Bangladesh, the model having been replicated throughout the world over the past decade.

Service provision to direct subscribers rests on the idea that there are many potential sources of demand for telephone service in the rural areas that are currently going unmet. These include health centres, secondary schools and colleges, large farmers, and local businessmen.

The VPP initiative of GT combines the Grameen Bank's (GB) expertise in village-based micro-enterprise and micro-credit with the latest GSM digital wireless technology of a sister company, Grameen Phone (GP), which primarily services the urban mobile phone market. Grameen Phone has become the country's dominant mobile carrier, providing services in urban areas and along the major railway routes via a network of cellular towers linked by fiber-optic cable. It has approximately 600 000 subscribers. GT and GB work together towards the dual objective: to help the latter's members shift from relatively low-yield traditional ventures (mostly animal husbandry and agricultural activities) into the technology sector, and to provide whole villages with connectivity.

One cause of reluctance on the part of commercial telecoms operators to extend access to low-income rural communities is the difficult logistics of bill collection. The GB network is already extensive, and the information the bank collects on creditworthiness of its customers provides a strong basis for judging the trustworthiness of prospective telephone operators. Among the criteria GT uses for selection of VPP operators are: at least two years as a GB member and a record of on-time loan repayments. GT provides the phones and related equipment (approx. value: $420), while GB provides a loan of about $300 to the prospective VPP operator. Repayment with interest (at 22 per cent) is made from the operator's cash flow, with a three-year grace period (Aminuzzaman, 2002).

The phones are made available to all users in the village, whether for outgoing or incoming calls, all on a fee-paying basis. The operator charges the market retail rate, while GT charges her half that rate, while buying bulk airtime from GP at a discounted rate. Each month, an average of 70 customers uses each phone. The "shared-access" business model concentrates demand and creates relatively high cash flow, even in poor villages, enabling operators to make regular loan payments and still turn a profit. Repayment rates to GB are 90-95 per cent (Cohen, 2001). From the perspective of GP, the VPP is a profit-making venture, despite the low wholesale charge, because of high airtime capacity utilisation and low operating costs (Torero *et al.*, 2002).

Recent research by the Telecommons Development Group (TDG) has shown that the VPP programme yields significant economic benefits. TDG estimates the full value of a single phone call for VPP users in terms of consumer surplus based on the estimated cost of travel between the village and Dhaka. The cost of the trip (including out-of-pocket expenses plus the opportunity cost of travel time evaluated at the average rural wage) ranges from 3.7 to 7.1 times the cost of the phone call, meaning real savings of between 51 and 91 Taka per call (see Table 1).

Table 1. **Estimates of Consumer Surplus Provided by Grameen Village Pay Phones**
(in Taka, except column 2)

Economic Status	Hours required by alternative methods	Transport costs entailed in alternative methods	Opportunity cost of time required for alternative methods	Total costs of alternative methods (3 + 4)	Total cost of Village Pay Phone call	Consumer Surplus (5 - 6)
1	2	3	4	5	6	7
All poor	3.67	60.89	34.32	95.21	17.35	77.86
Extremely poor	3.08	54.97	26.41	81.38	20.08	61.30
Moderately poor	4.15	65.82	40.89	106.71	15.07	91.64
Non-poor	2.54	45.80	21.71	67.51	16.73	50.78
Entire sample	2.70	48.02	23.57	71.58	16.82	54.77

Note: 49 Taka = $1 (at 1999 exchange rate)
Source: Bayes *et al*., 1999.

The same study compares prices received by farmers in VPP villages with those in control villages, finding that the former receive on average 70-75 per cent of the paddy price paid by the final consumers, discernibly more than the 65-70 per cent received by the latter. Moreover, a survey of perceptions of VPP users suggests the following benefits:

– lower cost of information;

– more stable supply of inputs (particularly fuels);

– quicker and more effective communication during disasters;

– reduced spoilage of perishable products;

– better access to health-care services.

Allowing for methodological deficiencies of such surveys (e.g. there was no attempt to isolate the “pure” Village Phone-effect), these findings point to considerable benefits to villagers from access to ICTs.

Aminuzzuman (2002) has conducted a more recent assessment, based on a sample of 350 VPP owner/operators and users. Most owner/operators found VPPs a profitable investment and ownership has substantially raised their average monthly incomes. The mostly female owner/operators have experienced some social and economic empowerment by virtue of the income the phones bring to their households. On the other hand, more often than not it is male household members who interface with users (in other words, the owner is not usually the operator), and only a small fraction of users (22 per cent) are women. So, the effect of VPPs on women’s social and economic status has been rather modest. Still, those women who do operate and use VPPs are convinced of their positive impact on their economic and social status.

Box 1. **Constraints on Grameen Rural Phone System**

Despite being widely heralded as a success in bringing ICT access to rural areas, the Grameen rural phone system still grapples with a number of problems that might either limit its future expansion or be solved by means unlikely to be available to other rural ICT providers in developing countries.

Infrastructure

Grameen Telecom's original goal was to have a phone in every one of Bangladesh's 65 000 villages by 2000, but only 4 543 village phones were in service as of March 2001. The primary constraint has been a distorted telecommunications market controlled by a monopolistic government provider, BTTB. Because BTTB has been unwilling to increase its interconnect capacity, despite Grameen Phone's offer to pay for the upgrading, GP and other mobile companies have been unable to connect additional phones to the national switched network and instead have had to offer primarily mobile-to-mobile phone services. This infrastructure barrier has also limited expansion of the rural phone network, and points to the central importance of interconnectivity to fixed line networks being resolved through appropriate regulatory policy if initiatives relying on wireless communications to extend ICTs to rural areas (such as the Grameen Telecoms system) are to be viable.

A second constraint is GT's use of cellular technology for its VPPs, a choice that is neither efficient nor probably competitive over the long run (at least in rural areas). GSM — used throughout much of Europe and Asia — is far more expensive than fixed wireless local loop (WLL) systems used by GT's competitors, Sheba and BRTA. While GSM towers can provide service within 5 kilometres, WLL towers provide coverage within 50 kilometres. Moreover, WLL provides better bandwidth for data transmission at a lower cost. This raises the possibility that GT may be put at a severe "first-mover" disadvantage due to technology lock-in effects.

Policy

Bangladesh's telecom regulatory regime is both antiquated and anti-competitive. One consequence has been BTTB's ability to maintain control over the switched network without expanding its capacity, even in the face of high demand. Scarcity forces Bangladeshis to pay large inducements to BTTB officials in order to obtain phone service. BTTB's control of the network is likely to become an even more significant market disadvantage to GP and other mobile operators once BTTB launches its own GSM mobile network, although the telecoms regulatory authority is supposed to ensure a level playing field.

Enterprise

Grameen Telecom's village phone venture would not be feasible without access to the credit and bill collection services provided by Grameen Bank and the infrastructure and urban network provided by Grameen Phone. Village phones would be far less successful if GP were not able to discount by 50 per cent the rate charged to GT for a phone call, an underlying subsidy made possible by the more profitable urban part of the business — and a significant advantage unavailable to rural-only competitors BRTA and Sheba.

Source: Cohen, 2001

b) Telecentres

Another model of ICT provision in rural areas of developing countries — one which attempts to combine phone access with access to other ICTs (in particular the internet) — is that of the telecentre. A telecentre is a common point of access for multiple users (often an entire community), providing a range of ICT services including internet, fax, word processing, and even specialised information retrieval or applications (e.g. distance education). Telecentres have been established widely in the developing world, and vary in their service provision and means of funding. In Peru, the establishment of numerous Cabinas Públicas has led to a relatively high rate of internet use for the developing world (1 150 per 10 000 inhabitants, on a par with New Zealand) and a significant reduction in prices (Girardet, 2001).

The experience with telecentres has so far been a mixed one (see, for example, Ernberg, 1998). In numerous cases, usage, particularly of PCs, has been lower than expected or commercial viability has not been attained. Many telecentres have failed to serve their particular target groups. Of the over 70 community telecentres established since 1997 by the South African Universal Services Agency, only 40 per cent remain open today, with only 3 per cent making enough money to cover costs (Girardet, 2001). This is surprising given that several studies estimate a relatively high absolute amount, or percentage of disposable income, that poor people in developing countries are willing to pay for ICT access (Ernberg, 1998 puts the percentage at 3 per cent). Torero *et al.* (2002), for example, report on a contingent valuation survey of Bangladeshi and Peruvian rural households to estimate their willingness to pay for public phone access. They find a willingness to pay for both local and long-distance calls generally above current tariff rates, suggesting significant welfare benefits of telephone access.

Several types of telecentre can be distinguished. Some models have proved more successful than others. They run the gamut from small internet cafes started by individual entrepreneurs through networks of telecentres set up on a franchise model (often initially by an NGO, as with Peru's Cabinas Públicas) to telecentres affiliated with educational and training institutions to government-sponsored (-subsidised) centres established with or without financial support from foreign aid donors. The Andhra Pradesh model is one of telecentres underwritten by a private company contracted by the state government also to provide a fibre optic backbone linking villages, with the government providing an "anchor application" in the form of web-accessed government services (Tschang *et al.*, 2002).

Small, family-run internet access centres have been successful in many countries. Given the relatively low start-up costs, the competition is intense. They tend to be concentrated in urban areas, since it is only there that they can currently expect to be commercially viable. They generally offer little more than an internet access device and refreshments. They are not in the business of generating local content, as is the case for example with some of the NGO, government and donor-supported centres.

Few large telecentres are financially sustainable without ongoing external support. The more realistic projects, such as in Mozambique, have business plans that show that the centres will take at least four years to become self-sustaining — and only then with the capital written off. At best, these centres cover operating costs, while no major funded telecentre has been able to set aside money for depreciation of equipment, let alone generate money to repay the initial capital. Many telecentres are offering useful services in their communities, though most are so young that evidence of their impact is mostly anecdotal (Benjamin, *n.d.*).

The establishment of a network of franchised telecentres under the auspices of a national telecoms and/or internet provider has some attractive features. It can offer economies of scale in equipment procurement and start-up support to franchise owners — e.g. in the form of a start-up package, an operating manual, recruitment and training guidelines, and standard payment vehicles (e.g. pre-paid cards). The latter can increase turnover, as for example when urban dwellers purchase pre-paid cards for rural relatives to facilitate two-way communications. This model can also ensure common quality-of-service standards.

In El Salvador, the franchise model of telecentre creation has been taken a step further. Infocentros, a non-profit organisation established to promote the information society, borrowed $10 million interest-free from the government to build 100 telecentres within a two-year period. These for-profit telecentres were to be run as franchises-cum-business-incubators (Khelladi, 2001). For technical assistance, Infocentros turned to José Soriano, founder of the Peruvian Scientific Network, which pioneered the establishment of the public internet access centres mentioned above (*cabinas públicas*). In an initial phase, each telecentre is established and operated directly under Infocentros' management. Only when the centre achieves profitability is it sold to a franchisee. Eventually, 90 telecentres will be run as private franchises, while 10 will remain under Infocentros' control, acting as nodes, providing assistance and services to the franchisees, e.g. training, technical support, maintenance. Infocentros' ability to negotiate interconnection contracts with the telecoms operator on behalf of its nationwide network has substantially reduced costs. For instance, whereas a 128K line normally costs $600 per month, Infocentros has been able to negotiate a price of $400 per month for that bandwidth.

A key market for the telecentres is the large number of micro enterprises in El Salvador, whose owners often have little formal education but have need of accounting, banking, invoicing, and stock management support. The plan is to develop applications and services that meet these enterprises' needs. Free web-page hosting is also offered. Unfortunately, the analysis of Khelladi covers a period during which only 5 telecentres were established and, while the initial results are encouraging (with four of the five having reached their Infocentros-defined profit target), it is not known how the experiment has fared in the more recent past.

Telecentres are also sometimes established in schools and universities, where the physical infrastructure can be extended at modest cost to accommodate the telecentre and some of the ICT-relevant training can be integrated into the mainstream curriculum of the educational institution. At the same time, telecentres in universities have little direct impact on those with little formal education, and hence on the mass of the rural poor. In any case, almost all universities in developing countries are in urban areas. At a minimum, these telecentres could be connected with the rest of the community by, e.g. opening their doors to the public at the end of the school day.

c) The n-Logue Multi-Tiered Franchise Business Model[3]

Although it has one of the 10 largest telephone networks in the world and the third largest among developing countries, India currently has a teledensity of only 3.4 per 100 persons compared to China's 13.8 (ITU, 2002). The Indian startup n-Logue has created a for-profit business model to tap into what it believes to be a latent rural demand for connectivity. N-Logue was incubated by the Telecommunications and Computer Network (TeNet) Group of the Indian Institute of Technology in Madras (now Chennai) as part of the group's strategy of disseminating low-cost communications technologies to the rural poor (Prahalad and Hammond, n.d.).

Unlike the Grameen Village Pay Phone Model or the majority of telecentres, n-Logue takes the franchise concept above the level of the retailer to other levels of the network. N-Logue has fashioned a franchise-based business model that consists of three levels of interdependent networks (Howard *et al.*, 2001):

– At the foundation-level, n-Logue forges and facilitates relationships among a range of institutions — hardware and equipment providers, non-governmental organisations, content providers, and government — that support the businesses of franchise owners.

– At the intermediary level, n-Logue maintains regional networks of franchised Local Service Partners (LSP). These cooperate with n-Logue to establish Access Centres or nodes to which individual kiosk operators are connected, using Wireless Local Loop technology.

– Finally, at the highest level, local entrepreneurs are recruited by the LSPs (who are usually established businesspeople or district governments) to establish village-level kiosk franchises to provide Internet and telephone access to the local population. The LSPs provide training, business advisory services, and collect revenues from the kiosk operators, which are then passed on to n-Logue. Through the LSP, n-Logue offers low-priced "kiosk packages" consisting of a subscriber wall set (that connects the kiosk to the Access Centre), a computer, printer and backup battery. Local franchise owners are themselves responsible for developing additional product and service offerings (e.g. computer courses) as well as marketing strategies.

N-Logue employs a unique fixed wireless local loop (WLL) technology designed by TeNet for its village-level communications package. As with other WLL technologies, voice and data are transmitted over radio frequency rather than wires, in this case with a fixed unit emitting the signal. The subscriber wall set can communicate both voice and data simultaneously to an Access Centre that must be located within a 25 km line-of-sight distance. Because the central base station handles traffic from 200-1 000 subscribers, it works well in small, dispersed markets and does not require the large subscriber base that traditional landline or cellular systems do to be profitable (Prahalad and Hammond, n.d.).

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3. This section is based largely on Howard *et al.*, 2001; N-Logue Homepage: http://www.tenet.res.in/nlogue.html.

To date, use of the internet in many regions of India is inhibited, *inter alia*, by the dearth of internet content in any of the 15 national languages. N-Logue has responded to this challenge by setting up strategic alliances for local language software and content, commodity market price information, school education augmentation, agri-services, animal husbandry, money transfer, sales of financial products, and e-governance applications. In pilot projects, LSPs have taken an extremely active role in generating content. In some pilot projects, kiosks are connected only to the LSP intranet, but these have nevertheless managed to generate strong returns, suggesting the particular attractiveness of local content to villagers (Howard *et al.*, 2001).

While there is so far little empirical evidence on the comparative financial sustainability of the three access models discussed here, the n-Logue and Grameen Village Pay Phone models seem to have one considerable cost advantage over most telecentres: by not only providing shared access at the point of the end user, but also shared resources (including bandwidth) at the nodes further up in the “system”, they are able to offer lower prices. Moreover, n-Logue’s work at the foundation level is likely to contribute further to lowering end-user prices by enabling it to organise equipment bulk-buying for village kiosks as well as by lowering maintenance and repair costs through harmonisation of equipment and software throughout the kiosk network. Finally, n-Logue uses the headquarters staff expertise to choose high-quality hard- and software and certify its reliability to the kiosk owners. In this way, the risk of kiosk owners’ buying low-quality, or even faulty, equipment and thus jeopardising their own ability to repay loans is minimised.

d) Other Options

Virtual Telephones: A further idea, possibly to be used in combination with the above access models, is that of so-called “virtual telephones” or village voice mail systems, as have been set up in Brazil. These can provide individuals with their own telephone number and access to a voice mailbox. In other words, the individual need not possess a telephone but can receive calls to a voice mailbox using his/her personal PIN. Extending this idea to text e-mail access, a South African company assigns e-mail addresses to every Post Office box address in the country, thereby providing electronic mail indirectly to around eight million South African households. Public Internet Terminals — similar to a bank’s automated teller machines — will be located in every Post Office. Through an encoded card with a personal identification number, users will be able to send, retrieve and print e-mail messages.

Internet Kiosks: The Foundation of Occupational Development (FOOD) has helped to establish kiosks in India that are fitted with phone lines. Individuals can visit a kiosk and dictate an e-mail message over the phone to the closest telecentre against a fee payable to the kiosk owner (who in turn pays the telecentre). Some telecentres also provide a service in which incoming e-mail messages are dictated back over the phone to the kiosk owner, to be delivered to the appropriate customer. E-mail is therefore available to anyone with access to an internet kiosk, and small operators can enter the telecentre business with a minimum investment. When the scheme began, around 50 telephone booth operators enrolled in it. The users, however, seemed to find it difficult to adapt to voicing an e-mail message on a telephone. Traffic volumes did not achieve expectations, and of the 50 original operators, few remain in the scheme, servicing only a handful of messages weekly (IDRC, 1999).

These two options are ones that mix and match technology solutions, e.g. wedding the internet and telephone, or e-mail and snail mail. Another example is the use of conventional AM radio to broadcast information downloaded from the worldwide web at a single access node.

The question of what works is answered to an extent by this review of organisational models. The VPP model would appear to be most effective in reducing the information asymmetry problem that plagues credit markets in developing countries, limiting entrepreneurial access to the investment capital to start up an internet kiosk or village pay phone service. Reliance on the Grameen Bank network also facilitates payment collection. Bulk purchase of airtime from a sister company holds down costs and charges to VPP operators. The n-Logue model and the Infocentros model have the advantage of offering economies of scale — in negotiating interconnection fees, in equipment and software purchase, in training and maintenance — that stand-alone village kiosks or telecentres cannot hope to realise. The franchise model also provides performance incentives to the owner/operator to the extent that s/he must risk some of her/his own capital or, in the case of VPP, her creditworthiness, hence future access to capital.

IV. TECHNOLOGY OPTIONS FOR RURAL ICT ACCESS

The preferred technology, or technology mix, for providing low-cost ICT access will vary with local conditions. In any case, even using the lowest-cost technology available, cost of access provision is certain to vary across locations depending on the degree of remoteness from the backbone network and central node, user density and clustering, and the type of service and traffic. The major transmission technologies are discussed, along with their strengths and weaknesses in specific contexts. Then, access devices are briefly discussed. The purpose here is simply to provide some guideposts that may assist decision makers in weighing the relative attractiveness of different technology solutions in specific circumstances, not to offer a "one-size-fits-all" solution, which does not exist. In this area, technologies are evolving rapidly, so what looks attractive technically and financially today may appear less so in a few years' time.

Transmission Technologies

There are several options for signal transmission. There are at least two segments of transmission that need to be considered separately: long-haul transmission from a central exchange, usually located in a city (serving roughly between 100 and 10 000 subscribers) — the "last 100 miles" — to an access distribution point node (serving roughly between 10 and 100 subscribers); and the local-loop transmission from that distribution point to the end-users — the "last mile". A major investment component in rural networks is for the former, and the most important alternatives for these "backbones" are:

– Terrestrial access, usually via copper cable; a faster, higher capacity but also more expensive option is fibre optic cable.

– Satellite access via VSAT ("Very Small Aperture Terminals", which can be used for one-way or interactive communications via satellite). This involves either leasing capacity on other countries' satellites or launching one's own. Banks in remote areas of Brazil are currently linked via VSATs; the National Stock Exchange in India links brokers via rooftop VSATs. Using satellite access then involves a choice between Geostationary Earth Orbit Satellites (GEOS) and Low Earth Orbit Satellites (LEOS). Whereas GEOS are strategically placed in the geostationary orbit, at an altitude of 22 300 miles above the equator, LEOS travel in a lower orbit, allowing for faster signal transmission but also requiring multiple satellites to cover the same "footprint" as a single GEOS.

– Microwave systems, which cut down on the cost of material compared to cable over longer distances, while limiting theft and maintenance problems. These are generally used as key components of wireless networks and require line-of-sight signal relay.

The relative costs and user advantages of these options are summarised in Annex Table I.1. However, they should not be seen as mutually exclusive, with long-haul network sometimes including “mix-and-match” approaches. For instance, Bhutan has chosen such an approach, combining international connections via satellite with microwave connections between cities and “last mile” connections that are often established via cable.

At the local level, these backbones can then be linked either to land-line-based local loops (which can be costly in low-density rural areas, though single-pair overhead cables have only a fraction of the installation cost of underground copper cables) or wireless systems — whether wireless local loop (WLL) or mobile cellular. Unlike the latter, the former do not generally allow roaming, though they may at a cost in terms of bandwidth or signal attenuation. The use of CDMA technology permits fixed-WLL systems to accommodate a much larger number of subscribers in a given bandwidth than can most other wireless transmission technologies. WLL systems connect subscribers to the network using radio signals rather than wire to complete the “last mile”; they are often implemented as network extenders by the main fixed-line service provider (still in many cases a state or quasi-state monopoly). WLL has some major advantages over “wired” end-user access, but also some significant drawbacks (summarised in Box 2). WLL is considered a highly promising technical option for low-cost telephone access in the rural areas of developing countries. WLL projects have been set up *inter alia* in Bolivia, the Czech Republic, Hungary, Indonesia, South Africa and Sri Lanka (ITU, 1998).

The advantages of WLL over landline “last mile” connections apply to mobile cellular as well. The cellular technology standard so far used in the main rural ICT access schemes, in particular the Grameen Village Phone system, is the Global System of Mobile Telecommunications, or GSM. Whereas three to five years ago, GSM was not very economical, its costs have fallen significantly in many countries as a widening installed base has given rise to economies of scale. Unlike WLL, mobile systems require no installation in premises. GSM can offer low-speed data applications like WAP, and GPRS is available at higher cost for higher-speed applications (it is a migration step to third-generation, or 3G, mobile phones). While more advanced “standards” such as UMTS (a full-fledged 3G technology) could provide greater bandwidth; they are very unlikely to replace GSM in developing countries in the near future since the cost of mobile phones would be prohibitive, transmission technologies would need to be adjusted or replaced, and micro- or picocells would be needed to provide greater bandwidth.

Box 2. **Summary of Advantages and Remaining Challenges of Wireless Local Loop (WLL)**

Advantages:

- Cost: In rural areas, the segment connecting the subscriber to the exchange often accounts for more than 50 per cent of initial investment. The cost advantage of WLL is based on three factors:

  i) Quick deployment compared to copper wire, meaning that revenue streams begin sooner and investment is recouped more quickly.

  ii) Cost structure: WLL typically tends to have a low ratio of fixed to incremental costs. Once base stations and the link to the telephone exchange have been installed, new subscribers can be added quickly and at relatively low cost.

  iii) WLL tends to be less prone to failure than copper wire and is less likely to be stolen or damaged, lowering maintenance costs. Furthermore, it is much easier to locate the point of failure in WLL networks than in hard-wired ones.

- Flexibility: new customers can be added easily (i.e. without the need to lay new sets of cables). Moreover, WLL systems are redeployable, which is particularly useful in the case of fast-growing areas or areas where subscribers switch providers or cancel contracts frequently.
- Speed: In order to lay cable, permission has to be obtained from municipal authorities or landowners which delays implementation. WLL systems can be implemented more quickly and less obtrusively than copper wires. Furthermore, obstacles of various kinds (hills, forests, rivers) can increase the cost of installing copper wire.
- WLL systems can be used in the mobile mode: WLL users can theoretically roam freely with their handsets within the coverage area of their base station, which can range up to 50 kilometres.

Remaining challenges:

- No global standard: Most WLL systems are based on existing technologies.
- WLL systems tend to suffer attenuation where there is heavy rainfall or extensive foliage.
- The need to have frequency allocated for WLL imposes constraints on operators planning to use this technology. The price to be paid for this will raise costs.
- Concerning the possibility for “roaming”, incumbent mobile cellular operators may complain, arguing that the WLL service provider infringes on the exclusivity of their existing licenses (as has happened in India and Poland). The problem is more serious where spectrum is allocated at low cost for a WLL system which then competes with mobile cellular operators who have paid in some cases high spectrum fees in competitive auctions.
- Some WLL technologies have relatively low bandwidth, restricting ability for broadband applications and some of the most advanced services (one has to bear in mind, however, that provision of these most advanced technical solutions is probably not required for low-cost rural telecommunications).

Source: ITU, 1998.

To reiterate, the choice of technology for rural access provision needs to be made taking into account the specific circumstances of the project in question, with the main criteria including the type of service required, the likely amount of traffic, user density, and the average distance of users from the central node. While generally a cable backbone–WLL combination seems attractive, this might be less appropriate in larger countries with considerable distances (where establishing the cable backbone would hence incur high costs). Assuming government covers the fixed costs, particularly remote locations might call for a VSAT–WLL combination. The same holds for locations that are not necessarily remote but where the geographic givens (e.g. mountainous or archipelagic terrain) make the establishment of cable or microwave connections difficult. Finally, the wireless option can be attractive for the local loop in developing countries, given the ease of expansion of the network. For medium-density rural areas, mobile cellular systems are likely to be cost-competitive, since the existing GSM network infrastructure can be expanded relatively easily. The same could be said for fixed-WLL, *viz*. where extension of the landline network via WLL should be possible at relatively low cost in medium-density rural areas. Still, most poor people in rural areas of the developing world cannot afford to become individual subscribers to telephone services, whatever the technology — assuming access is available — and will continue to rely on shared access models like those described in the previous section. For these, especially in low density rural areas, it may well be that fixed-WLL is an attractive solution, depending on remoteness. While the VPP programme demonstrates that GSM can be made profitable in low-income areas, the rural areas served until now could be characterised as medium- to high-density ones not far removed from urban centres, so extension of an existing GSM network has been possible.

Relying on the existing cable TV infrastructure may be an option where this is already extensive, as in India. This could significantly lower the up-front costs of establishing connectivity. It is possible to use cable TV connections to provide internet as well as phone access, a service that is currently already offered in several OECD countries. Cable TV provides considerably higher data transfer speed than standard telephone lines. Presently, roughly 30 million Indian households (about 15 per cent) have cable TV access, a much higher penetration rate than for telephones. According to Digitalpartners.org, a non-profit organisation aiming at developing market-based technology solutions for the poor, this expansion can be attributed to very low monthly subscription fees of Rs. 60-150 ($1.28-3.20), an active second-hand market for low-cost televisions, and an explosive growth in the number of small-scale entrepreneurs providing cable service, whose costs are far lower than those of the corporate sector. Indeed, in India, cable services are among the cheapest in the world, cheaper than telephone service. To provide internet access via cable TV, however, requires the operate to make a substantial investment (in the range of $45 000 to $100 000 in India) in a cable modem terminator system (CMTS), which the small entrepreneurs cannot easily afford, while the cable modem installed at customer premises ranges in price from $275 to $330 and monthly charges for households are around $20 — far beyond the means of a poor household.

Besides combining cable TV and internet access, it is also possible to deliver telephony over the internet, which could eventually do away with the need for "phone only" connections in all locations where the internet is available. Where the equipment for internet access is not available, however, its installation cost still poses a barrier, especially to low-income households. This alternative is particularly attractive for long-distance phone calls, as the cost of an "internet phone call" is determined by the time spent connected to the local internet service independently of the distance between the two communicating parties. Again, this assumes that the user can establish access an internet service provider via a local phone call, which is not always the case in rural areas of the developing world. (The reasons for the dramatically lower cost of internet telephony include greater economies of scale through the shared and decentralised administration of the global internet infrastructure, as well as internet telephony's better ability to maximise the use of available bandwidth.)

Phone access alone remains considerably cheaper than access to the internet, so that for poor households internet phone access will probably not be an attractive option in the near term. Central to the decision of whether to establish phone access alone or internet-plus-phone access is a calculation of the net costs after the higher up-front costs of establishing internet connectivity and the monthly charges for maintaining it are compared to the lower recurring costs of the phone calls. It should, however, be borne in mind that the internet may make phone calls cheaper even where neither the calling nor the receiving party has access to the internet — simply through a network of gateways between the internet and the telecoms network, with the internet thus functioning as a low-cost connection between two, possibly remote, high-cost local telephone networks.

End User Equipment Choices for Internet Access

A key question concerning internet access in rural areas is what sort of user interface offers the best technical solution at an affordable price. Are personal computers (PCs) or some other type of device preferred? Here again, different circumstances may dictate different choices. The case for PCs is that they can simultaneously be used for a variety of other "non-communication" purposes (word processing, spreadsheets, etc.). The case against them rests on *i)* their cost and *ii)* their power and maintenance requirements relative to alternatives. The installation of multimedia user terminals (in a price range of $300-500 per terminal) can be an effective way of providing access to internet and multimedia services. E-mail, voice and video communications are becoming available through such non-traditional devices. Another such device is the personal digital assistant (PDA), whose technology is being merged inexorably with that of the mobile phone. These new devices, while still very expensive compared to a simple mobile phone, are cheaper than most PCs — and certainly than the laptop variety. Moreover, there is no reason not to expect prices to experience the same steep declines as with earlier generations of mobile telephone and computer technology. The main constraint in using such devices in rural areas of the developing world is likely to be bandwidth limitations of mobile telecoms networks. The same constraint makes accessing the internet via a PC and a dial-up modem connection extremely slow and potentially costly for anything more than simple applications like e-mail.

E-mail-only appliances allow users to send and receive e-mail (albeit normally without attachments). In order to have e-mail access via a standard PC, the user requires a hard disk drive; needs to install e-mail software; has to configure connectivity options such as the dial-up access number; must boot up the hard drive every time he wants to establish access; needs to connect to a phone line (for the case of dial-up access, which is still widespread in developing countries) and disconnect once the e-mail has been sent. E-mail-only appliances are frequently much less complicated. They often dial up the e-mail provider at the touch of a button and automatically disconnect once an e-mail has been downloaded. Hence, e-mail-only appliances could be used in rural areas where low cost and minimal bandwidth usage are paramount concerns.

The Indian "simputer" is somewhere between a PDA and a PC, though closer to the former than the latter. Like a Palm Pilot®, the Simputer® includes a touch screen interface that does away with input devices like a mouse or keyboard. It uses a standardised interface language called IML (Information Markup Language). Thanks to these and an icon-driven interface, a high level of computer literacy is not essential for using the device. At a minimum, all it takes is the ability to point and touch an icon on screen with a stylus. The simputer is also designed to withstand the harsh environmental conditions found in rural areas of the developing world. Initial target markets are government offices and private companies. It is still too early to know how it will fare in the marketplace, especially in the face of competition from low-cost PDAs.

An additional advantage of such simple solutions is that they might make it easier for rural inhabitants to learn how to use the internet (if only limited features) by doing away with the need for PC management skills. Another expected advantage would be lower lifetime maintenance costs and slightly lower power requirements per unit (see Annex II for details of energy options to power rural ICT). This should be weighed against the fact that in many locations — especially in many telecentres — there is also demand for "traditional" use of PCs, e.g. for word processing or work with spreadsheets. In this case, PCs are likely to be the preferred option. Generally, however, there is nothing to be said against mixing e-mail-only appliances with PCs. The installation of several e-mail appliances for less than the cost of an additional PC can help meet the demand for e-mail access while freeing up the limited number of PCs for "PC-only" tasks.

V. ADDRESSING DEMAND- AND SUPPLY-SIDE CONSTRAINTS TO WIDER ICT DIFFUSION

The hallmark of successful ICT provision in low-income communities is that the venture *i)* provides services that users genuinely need and demand at a price they can afford, and *ii)* has a pricing model that ensures long-term financial sustainability. Certain conditions — like the broader telecoms and ISP regulatory environment, unique geography, etc. — may be outside the control of individual ICT ventures (though collectively such ventures may be effective in lobbying for a more favourable environment).

A Demand-Driven Approach

Making the content accessible. Projects need to use innovative models to extend service provision in a form that is widely accessible. This may involve mix-and-match technological approaches, for instance using AM radio to broadcast information downloaded from the internet to the rural population, some of whom may be illiterate but most of whom own a radio (see Box 3). It also means the use of local languages when providing information over the internet.

Box 3. **Kothmale Community Radio, Sri Lanka**

The Kothmale Community Radio (KCR) in Sri Lanka combines community radio and internet access. Generally, community radio is a good starting point for the dissemination of ICTs since it is inexpensive, easy to operate, and reaches all segments of local communities through local languages to offer information, education and entertainment, as well as being a platform for debate and cultural expression. KCR was set up as a mini-ISP with leased line connection to the internet and a number of computers: broadcasters use the internet in research/production, while local people come to the KCR premises and other access points to use the internet.

Furthermore, on a “radio browsing” programme, presenters browse the Web on behalf of listeners (who provide requests/input through phone or post). Relevant “experts” from the community (lawyers, doctors, etc.) then interpret the information for listeners. The radio station also adds value to the information by putting it into local context, also through development of a rural database that packages information of the most frequently-needed kind for off-line use.

Source: www.kothmale.net

Developing useful local content. Telecentres can be made significantly more useful if they provide relevant local network content. The problem with content provision is that it is much more difficult to recover costs of content development than of access provision. Most information available on the world-wide web is still provided for free, and many users have come to expect free content. Even assuming a willingness to pay, there is no readily available vehicle for the “micropayments” that would be needed to access small information bits or parcels. Such vehicles will undoubtedly be developed, but they are not yet readily available. Thus, the question arises of who is going to develop local content that cannot be sold. Presumably only NGOs and/or governments would undertake such a service.

One example of local content creation is provided by four “Infoshops” in Pondicherry, India, a rural area of around 20 000 inhabitants (Shore, 1999). After information requirements had been identified during a trial period, volunteers from the village created a local database comprising:

- Government programmes for low-income rural families;
- Cost and availability of farming inputs such as seeds and fertilisers, and grain prices in different local markets;
- A directory of insurance plans for crops and families;
- Pest management plans for rice and sugar cane;
- A directory of local hospitals, medical practitioners and their specialities;
- A directory of local veterinarians, cattle and animal husbandry programmes.

Naturally, creating such databases and keeping them up-to-date are two different things, and many projects come to grief for lack of commitment to ongoing maintenance. Ultimately, once a critical mass of local users has been achieved, most local content provision should be run as a commercial enterprise, just like internet service provision. The initial target market for such commercially-oriented content provision is likely to be those users willing and able to pay a premium for tailor-made information (to save on their own information search costs), brokering services, etc. Advertisers may also be willing to pay for access to target online communities.

*Linking ICT projects with microfinance programmes***.** The establishment of telecentres can be linked to microcredit programmes as well as the provision of other business incubator services. This makes sense, however, only if there are potential synergies between the two kinds of institutions. In the case of Grameen Telecoms, its sister Grameen Bank already possesses the relevant microcredit expertise. Microfinance can thus be extended easily to support ICT-using business ventures (Box 3 provides an example of a reverse synergy, i.e. using ICT to support microfinance operations.). Not all telecentre experiments are likely to have the same access to microcredit expertise. On the other hand, they should have the potential to make available small-business software applications to microenterprises, either providing software training to enterprise owners or performing outsourcing of basic business processes like accounting and bookkeeping on a fee-for-service basis.

Box 4. **PlaNet Finance and PRIDE Africa: Using the Internet to Support Microfinance Projects**

PlaNet Finance (www.planetfinance.org) offers technical support to microfinance organisations through a variety of services. PlaNet Ring is a microfinance webring giving access to the sites of organisations concerned with microfinance. PlaNet Systems offers support for the institutions that are members of the network in implementing and using IT. PlaNet University is the online training centre for microfinance and the use of information and communication technologies therein. PlaNet Rating offers appraisal and rating services to financial institutions, to microfinance institutions and to donors.

A related, grass-roots example is that of PRIDE Africa, a Nairobi-based organisation that extends micro-credit to small entrepreneurs in East Africa. Since 1996, the organisation has used the Internet to communicate cost-effectively, send and receive valuable information, and to market its services via its own web site. Pride Africa's mission is to create a sustainable financial and information services network for small-scale entrepreneurs to increase incomes and employment and to stimulate business growth in Africa. When the organisation decided to subscribe to an internet service, it was looking for fast and easy access to information available on the internet; it also wanted to bypass the high costs of communicating by telephone and the inefficiency and unreliability of sending information through the postal service

Once the decision was made to establish an internet account, Pride Africa identified a local ISP, Africa Online, who offered the services it was seeking. Since the organisation had previously acquired computers, its only additional investment was a modem. The ISP provided basic training to Pride Africa staff. As the staff gained experience in using e-mail, they began to explore other Internet features including web site development. In February 1997, Pride Africa launched its own web page, which is hosted through its ISP. The Pride Africa web page has emerged as a strong marketing tool for its products (http://www.usaid.gov/regions/afr/leland/micro.htm).

Participatory approaches. Local communities need to be involved in the design of universal access programmes by participating in decisions about particular information access outlets. Indeed, most studies find that the most effective way of ensuring the economic success of ICTs in rural areas is to encourage local participation and create social institutions in support of new technologies (Kenny, 2001). This means in particular helping communities define their needs in terms of *i)* communication (who wants to communicate with whom, why, and how); *ii)* information (what information is needed, by whom, when, where, for what purpose, etc.); and *iii)* education and training (who needs what, when, where, and how would they prefer to have it delivered to them) (Paisley *et al.,* 1999).

Training. Clearly, one of the keys to successful network development lies in training people to use as well as maintain the system. According to Roman and Colle (2002), training for telecentre staff has so far concentrated too heavily on how to operate computer hardware and software. Roman and Colle argue that training needs in the telecentre context ought to be understood more broadly to include reaching out to the community and "strategically building a clientele that can make a telecentre demand-driven". One example of an ICT access project that contains a substantial training component is the MS Swaminathan Research Foundation (MSSRF). Here, work in village telecentres includes the training of villagers, especially young people and women, in how to operate the telecentres and training in the production of locally relevant materials from generic information.

Financing Rural ICT Infrastructure

Clearly, ventures providing rural ICT access should aim to become commercially sustainable over the medium term. Yet, where commercial funding is not adequate initially, policymakers may consider that the developmental benefits of a functioning national network of telecentres warrant an infrastructure subsidy. At the same time, it is clear that a publicly provided or highly subsidised telecommunications network can stifle private sector initiative and that, if the public sector decides to provide rural telecommunications services, it needs to commit the relevant funds on a continuing basis (Bastistas-Buch *et al.*, 2001).

The classic public policy tool to finance ICT access in underserved areas is to encourage private, competing network operators, with incentives and/or obligations to extend their networks and services on an affordable basis to geographic areas and socio-demographic groups deemed to be marginally profitable or unprofitable (see Box 5 for the South African case). Often governments have used "service requirements" as a bid evaluation criterion and written these into operating licenses. These may go beyond teledensity or rollout target for public and private lines, to include conditions on the quality and speed of service. In Mexico, Telmex's 1990 licence required it to install at least one telephone with long-distance service in all towns with a population greater than 500 prior to the end of 1994 (ITU, 1998). PT Telkom Wartels in Indonesia is a similar case. This approach effectively amounts to cross-subsidisation of the least viable parts of a network by the profitable ones (a practice which, incidentally, is widely applied in the OECD countries). The "service requirements" approach also necessitates enforcement procedures on the attainment of targets and sanctions for failure to do so. At the same time, public policy makers need to bear commercial feasibility needs in mind when designing service requirements (this dictates in particular an analysis of the target users' ability to pay). Requirements that are overly ambitious can threaten the financial performance of the operators and thus, ultimately, the goal of extending network coverage. Finally, provisions such as free choice of technology (subject to certain performance standards) may make service requirements less onerous for firms.

As an alternative to service requirements being imposed on operators, governments may use taxes on telecommunication revenues to fund service extension to unserved areas. In Peru, a universal service fund along with a least-subsidy auction is being used to supply rural telephone services. The fund, established in 1994, is financed by a 1 per cent tax on the gross annual billings of all telecommunications providers (including cable television providers). Since its inception, the tax has generated an average of $450 000 per month. The fund administrator can identify and target rural areas considered to be of preferential social interest. Although the initial focus of these types of universal access funds was to support the provision of public telephones, some countries are using this approach to support the establishment of public internet access points, notably through telecentres. This has been the approach followed in South Africa, where the Universal Service Agency has used the funds to franchise telecentres around the country. Peru has recently started using a similar mechanism to support the public provision of telecentres and internet terminals in poor city neighbourhoods. One should bear in mind, however, that funds only work in countries with sufficient telecom revenues and are unlikely to be effective in smaller developing countries.

In the case of service requirements incorporated in competitive contract bid conditions, there is an implicit government subsidy insofar as the regulatory environment is normally such as to make possible above-normal profits in one segment of the market to cross-subsidise services in another. As for telecommunications funds, their *raison d'être* is to provide a public subsidy for extending access to underserved communities. Through a system of competitive bidding, the funds can be awarded to the operator with the lowest required subsidy or the highest service roll-out commitment, or a combination of both. In Chile, for example, just over $2 million in public funds leveraged $40 million in private investment to install telephones in 1 000 localities, at about 10 per cent of the costs of direct public provision (Wellenius, 1997*b*). In the end, one-third of the unwired rural population acquired telephone access through this means. Interestingly, the bidding process resulted in 16 project contracts being awarded on the basis of zero subsidy — in other words, a substantial number of projects were commercially viable in terms of existing demand and willingness to pay but only found private sector investment after the public sector had taken initial steps in project evaluation and viability calculation (ITU, 1998).

Box 5. **Cellular Licenses and Universal Service**

South Africa provides an interesting case of how cellular licensees have been required to satisfy both the geographic and affordability components of universal service. The 1993 invitation to tender issued by the South African government advised applicants for its two GSM licenses that fulfilment of community service obligations would be a key criterion in the selection process, given in particular the imbalance between black and white communities in ICT access. Both licensees, Vodacom and Mobile Telephone Networks, had community service obligations incorporated in their license terms

Vodacom devised a system by which it provides a franchisee with the necessary equipment in return for a monthly rental, while the franchisee commits to provide the public with cellular phone and voice mail service in accordance with standards contained in the franchise contract. The leased equipment consists of a phone shop (a mobile container that can be relocated when necessary); up to ten cubicles equipped with phones (including transceivers) and metering units housed in the container; and a central call charge management system for use of the centre operator. The franchisee purchases telephone services from Vodacom and resells them to the public with a margin of about 33 per cent.

Source: Schwartz, 1996.

VI. PUBLIC POLICY FOR RURAL ICT ACCESS

There are a number of steps that developing country policy makers can take to improve rural telephony and internet access.

A range of studies suggest that there can be dramatic increases in access to telephone and internet services through a telecommunications-sector reform programme. Such a programme, to be successful, ought to rest on four pillars: privatisation and liberalisation; legal and regulatory mechanisms to promote competition; complementary public investments; support for business planning.

a) *Privatisation and competition.* Table 2 indicates the benefits from privatisation and liberalisation of the telecoms market in Latin America between 1984 and 1994, measured by annual percentage growth in main telephone lines. There is a clear pattern of privatised open markets performing best, followed by privatised monopolies, with state monopolies coming last. This also feeds through in differential internet access costs, given that in many developing countries much of the cost of internet access is accounted for by the cost of basic phone access. A recent study of African ISPs suggests that countries with a highly liberalised telecommunications network have costs of internet access eight times lower than those with a completely closed market. Countries with more open telecommunications sectors also have more internet hosts, lower monthly internet charges, a greater number of providers, and higher rates of internet penetration (Kenny, 2001). Wallsten (2002) finds that regulations pertaining specifically to the ISP market also affect significantly internet user density and access costs.

Table 2. **Faster Growth in Open, Privatised Markets**
(Annual Percentage Growth in Main Telephone Lines)

	1984-89	1989-94
Brazil, Colombia, Ecuador, Peru, Uruguay	7.0*	7.8*
Argentina, Mexico, Venezuela	6.7*	11.3**
Chile	6.6*	20.5***

Notes:
* State Monopolies.
** Privatised Monopolies.
*** Privatised Open Markets.
Source: Wellenius, 1997*b*.

b) *Legal and regulatory mechanisms to promote competition*. Privatisation alone is not likely to ensure access for the rural poor. Even when telecommunications markets have been privatised and liberalised, there remains a need for legal and regulatory mechanisms to promote competition, especially fair interconnection charges and revenue-sharing arrangements between telecommunications operators (especially between former monopolists and new entrants to the market). The overall objective is to move towards cost-oriented tariffs, where costs are forced down through competition, with the exception of carefully designed subsidies to ensure basic access for the poor. One risk is that, in the interests of maximising its revenue take from the sale of the state share in the telecoms monopoly, the government may agree to restrict competition in the privatised market for an extended period. This can prolong high tariffs, undermining one of the principal objectives of privatisation. Another problem is that private operators (e.g. of mobile networks) need to be able to interconnect to the fixed-line network to increase system coverage (notably for long-distance calls), and in the absence of strong regulation the incumbent fixed-line monopolist can charge exorbitant interconnection fees, often to protect its own mobile phone service. Finally, private ISPs can face similarly steep costs for leased lines from a telephone monopolist eager to protect its own captive ISP. Thus, effective liberalisation includes the imperative of establishing a strong and truly independent regulatory agency capable of enforcing rules aimed at establishing a level playing field.

c) *Complementary public investments.* The advent of the internet in developing countries often depends vitally on complementary investments in other infrastructure, namely electricity, but also copper or fibre optic cables. In some parts of the developing world, there is a need to build regional backbones. For instance, setting up regional telecommunication backbones in each of Africa’s sub-regions may help local companies to lower tariffs on both phone lines and internet access. Where such backbones traverse multiple countries, each with relatively low telephone density and low per capita incomes, financing constraints become binding. The private sector is unlikely to take a keen interest, but neither is the public sector in individual countries. International financial institutions can play a vital role in executing such regional infrastructure projects. In some cases, satellite may be the most economical means of ensuring broad network coverage.

d) *Support for business planning.* Finally, the government regulator may wish to provide support for business planning wherever this is thought to improve the prospects of the setting-up of rural internet access. Telecommunications investors, financial institutions that provide telecom loans, and urban telecom operators are generally reluctant to involve themselves in rural operations because they see telecom ventures in rural areas, especially those in developing countries and emerging markets, as high-risk, low-return propositions. Thus, the provision of Rapid Market Appraisals (RMAs, see Box 6) may help to entice prospective operators into the market, while helping in the planning for optimised financial performance and long-term commercial viability. For example, in the case of Grameen Telecom, it was the feasibility studies initiated by Gonophone Bangladesh Ltd. and Grameen Bank that attracted external investment from a qualified foreign operator.

Box 6. **Toolbox for Rural Telecoms Planning**

1) The goal of Rapid Market Appraisal (RMA) is to provide detailed assessment of line deployment requirements on a community-by-community basis. It employs two main techniques: *i)* conduct a willingness/ability-to-pay survey within a suitable sampling framework; *ii)* use a "basket" of measurable socio-economic indicators to determine the relative economic returns to communities of telecoms service. Good RMAs should also provide detailed assessment of revenue per line (based on willingness to pay and traffic scenarios).

2) "Community Mapping" is used to determine optimal allocation of access points within the community, combining the dual objectives of maximum revenue and maximum community access. The technique rests on participatory mapping exercises conducted with rural community members at key market points and meeting places.

3) "Stakeholder Communication Mapping" can help to determine existing communication patterns and mechanisms used by key potential users of rural telecom systems and desired improvements. It involves the identification and interview of key rural stakeholders (e.g. financial entities, suppliers of household products, agricultural input suppliers, commodity traders, major commercial enterprises, government agencies, schools, etc.).

4) Financial Modelling can be employed to determine the business case for rural telecoms investment. For this purpose, a combined analysis of RMA, stakeholder communication mapping, and community mapping can produce return on investment (ROI) scenarios for different levels of infrastructure investment.

5) "Multi-Stakeholder-Planning" can help to engage key stakeholders in supporting financially sustainable rural telecoms services. To this end, key stakeholders identified in Communication Mapping partake in structured workshops designed to solicit their input, support and interventions for value-added services that will enhance rural telecom revenues (e.g. health information services, or agricultural information services).

Source: Richardson, 2001.

VII. SUMMARY AND CONCLUSIONS

Telecommunications access is necessary if not sufficient to permit the rural poor in developing countries to extend the market for their goods and to ensure that they are as well-supplied as other market participants with price and other vital information. In most cases, shared access will be the dominant model for some time. Estimates of the willingness to pay of rural households for telecommunications services suggest that a rural telecoms service can in many instances be commercially viable. As the VPP experiment in Bangladesh shows, there is a pent-up demand for telephone service among small-scale entrepreneurs and more prosperous farmers that provide a reasonably large customer base, one that could justify network extension to underserved areas, including a franchise network of shared-access providers.

In poor, remote communities with very few potential individual subscribers, establishing network access is more difficult without an initial subsidy. Development NGOs working in such communities can often act as a catalyst to the introduction of information technology, but business models need to be introduced that make such ventures self-sustaining. Perhaps the most important contribution government can make is through establishing a conducive regulatory environment for telecoms and ISP competition, so that private providers do not pay crippling charges for network interconnection and leased lines. The Chilean example suggests innovative ways of targeting “universal service” subsidies to best effect, by getting private bidders to reveal their true willingness to pay for licenses to service specific underserved areas and communities.

Provision of ICT access in rural areas is likely to prove most beneficial where complementary infrastructure and services are also made available. Rural electricity and roads are the most obvious infrastructural complements. In terms of services, access to credit, micro or otherwise, is one of the most valuable accompaniments. Also, small entrepreneurs may benefit from IT-enabled business support services — e.g. outsourced accounting and bookkeeping, web-page design and management, etc. — as well as training in small business software applications. NGOs and local government agencies may also perform a useful public service in initial local content development, increasing the utility of ICT access to the point where a critical mass of users attracts private entrepreneurs into web-based (or web-enabled) services.

ANNEX I

Table I.1. **Transmission Options for Connecting Rural Areas: Key Cost Elements and Technical Features**

	Cable		Satellite			Microwave
	Copper	Fibre Optic	Leasing Capacity	Launching Satellites (GEOS)	Launching Satellites (LEOS)	
Cost	• Lower than fibre optic cable • Lower than satellite in less remote locations	• Higher than copper cable • Lower than satellite in less remote locations	• Higher than terrestrial access in densely populated locations, lower for remote/ inaccessible areas: hilly terrain, archipelagos. • So far, invariably too high to make system commercially viable	• Higher than terrestrial access in densely populated locations, lower for remote / inaccessible areas: hilly terrain, archipelagos. • Cost of increasing bandwidth is high (may require launching of new satellites). • Ongoing cost of space segment is high and difficult to determine in general terms. • Cost of launching a satellite into geostationary orbit up to 20 times higher than launching a LEOS. • Unlike LEOS, GEOS are continuously visible from any point within potential service area (ca. 40 per cent of Earth's surface). Hence fixed ground antennae need not be continually reoriented to track the satellite, thus avoiding computer-controlled tracking equipment.	• Higher than terrestrial access in densely populated locations, lower for remote / inaccessible areas: hilly terrains, archipelagos. • Cost of increasing bandwidth is high (may require launching of new satellites) • Ongoing cost of space segment is high and difficult to determine in general terms. • LEOS more expensive than GEOS, but cheaper to launch. LEOS receive antennae are comparatively cheap. • Unlike GEOS, LEOS are not continuously visible from any point within the potential service area. Hence, more satellites needed to guarantee that at least one satellite is always above a specific service area. • LEOS require more fuel in order to maintain altitude due to the stronger pull of the Earth's gravity.	• Lower than cable over longer distances; higher than satellite for the most remote distances.

Table I.1. **Transmission Options for Connecting Rural Areas: Key Cost Elements and Technical Features (continued)**

Technical Advantages & Drawbacks	• Can carry medium volume of data	• Can carry comparatively high volume of data. • Speedier access than through copper cables.	• Can carry comparatively low volume of data. • Flexibility: once installed, can support a variety of applications (internet, data, video, audio, voice and fax). Adding new applications or even sites is easy. • Reliability: reduced risk of poor-quality phone lines or outages, which are widespread in developing countries. • Able to broadcast applications to hundreds of sites in one transmission. This includes audio / video broadcast for training, distance learning, information databases and software updates.	• Flexibility: once installed, can support a variety of applications (internet, data, video, audio, voice and fax). Adding new applications or even sites is easy. • Reliability: reduced risk of poor-quality phone lines or outages, which are widespread in developing countries. • High orbit: hence delay in propagation of signals (for telephone conversations, this may cause problems through delays in voice transmission).	• Flexibility: once installed, can support a variety of applications (internet, data, video, audio, voice and fax). Adding new applications or even sites is easy. • Reliability: reduced risk of poor-quality phone lines or outages, which are widespread in developing countries. • No transmission delays.	• Reduced danger of theft and maintenance problems compared to cable. • The longer the distance, the greater the danger of outages due to microwave repeater failure. This requires considerable maintenance.

Sources: Schwartz, 1996; Intelecon, 2000.

ANNEX II

Energy Solutions for Rural ICT Access

An adequate and reliable energy supply is a prerequisite for the deployment of any modern telecommunications or other ICT system. This remains a fundamental problem with ICT access in the rural areas of developing countries, where there are currently 2 billion people without electricity. This is mostly due to the expense associated with extending the electricity grid into rural areas and the difficulty of recovering these costs due to the low purchasing power of local populations. Policy measures such as energy market liberalisation will not suffice on their own to remedy this problem [see World Bank report "Meeting the Challenge: Rural Energy and Development for 2 Billion People" (Word Bank, N.D.)]. Hence, one needs to investigate other ways to power telecentres and other institutions aiming to provide ICT access to remote localities.

Communities beyond the reach of the electricity grid in developing countries usually employ rudimentary electricity generation and distribution systems ("mini-grids") on the basis of diesel or gasoline fuelled generator sets or small solar energy systems, if they can afford to do so. A complete power system may include, in addition to a generator, a battery charge controller; a bank of batteries; an inverter; safety disconnects; a fuse; a grounding circuit; supporting structures; and wiring. Taken together, these balance-of-system (BOS) components may cost more than the generator. Electricity needed to power remote telecommunication infrastructure sites can range from less than 100 watts to tens of kilowatts, with power requirements depending on a host of factors including type of equipment used and local conditions (e.g. temperature). The power requirements of most end-user terminals are much lower. Cellular handsets and cordless telephones usually consume less than five watts of power, and can thus run on dry cell or lithium ion-type batteries. A team of Silicon Valley entrepreneurs has designed a low-power portable PC (based on 486 chip architecture) for use in rural Laos that can run on 12 watts as opposed to the typical PC's 90 watts. The computer's battery can be recharged using a generator that can in turn be charged using bicycle pedal power. The computer is designed to run in both the monsoon and the dry season, and it has a wireless card that permits it to connect to the internet via a radio signal transmitted 25 miles to the nearest large village with phone lines (see article by Kevin Fagan in *San Francisco Chronicle*, 17 January 2003).

Each of the energy-provision options has its own advantages and drawbacks. The following table summarises these:

Table II.1. **Energy Solutions for Rural ICT Applications**

	Nonrenewable Power Technologies	Renewable Power Technologies			Hybrid Power Systems
	Fuel-powered generator sets	Photovoltaics (PV, Solar Power)	Wind Energy	Micro-Hydropower Systems	(usually photovoltaics or wind generation with fuel-powered generator)
Costs	• For small systems, power requirements are far below the scale at which generator sets can be cost-effective. • Cost of running fuel-powered generator sets is directly related to hours of operation. Hence the longer the operating hours, the more costly (in comparative terms) this option becomes compared to Photovoltaics or Wind Energy.	• Small pre-assembled photovoltaics-based power systems providing 100 to 200 watt-hours per day (such as those used by Grameen Cybernet) are available for less than $1 000.	• May be higher than other alternative energy sources due to restrictions on turbines imposed by authorities (usually on hub height, as visibility tends to be the main issue).	• Cheaper to deploy than either solar or wind systems. • Long lifespan, hence reducing cost of running power-generation systems on this basis.	• Suitable for large power requirements in remote areas, where the size and costs of the renewable energy system and the battery bank can be significantly reduced if one incorporates modest use of an engine-driven generator.
Technical Advantages & Drawbacks	• Ensuring regular delivery of fuel to rural areas can be difficult in remote or inaccessible areas.	• Only some places suited for PV, and even then power production depends on weather conditions. Continuous energy provision requires storage devices (e.g. conventional lead accumulators). • Provide electricity without creating pollution at the point of energy production.	• Only some places suited for wind energy production, and even then power production depends on weather conditions. • May create noise pollution at the point of energy production.	• Only some places suited for hydro-energy production. Since most micro-hydro installations are of the “run-of-river”-type (i.e. they work without a reservoir stored behind a dam), they produce electricity only when water from river flow is available and cease to generate power when the river dries up. • Environmental impact usually small. • Simple to maintain; require only semi-skilled labour. • Flexibility in adapting to quick load variations.	

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