Building Information Infrastructure in Rural Areas

This feature discusses major problems of the extension of advanced telecommunication services to communities in remote and rural areas.

Written by Ryszard Struzak[1]

Global Communications #3 Asia '97 (ISBN 0946-393-869)
Released at Telecom Asia 97, Singapore 9-14 June 1997, pages 227-233

The global society is undergoing dramatic changes. Modern telecommunication and information technologies are moving us fast toward the Global Information Society, do we like it or not. That process started formally in 1993, when the Clinton / Gore Administration launched the US National Information Infrastructure (NII) initiative, a vision of "a seamless web of communication networks, computers, data bases, and consumer electronics that will put vast amount of information at users' fingertips" leading to "an information revolution that will change forever the way people live, work, and interact with each other."

The information revolution accomplishing before our very eyes is, perhaps, even more significant than the great industrial revolution of the past. It opens new opportunities to reduce inequities due to geographic remoteness and affects everyone, from the urban businessman to the farmer and tourist far away from the city, to our families at home and our kids in the school. Although we do not fully understand all its consequences, it is generally accepted that the development of information infrastructure is necessary for both, the economic growth and improved quality of life. It generates unprecedented social pressure in remote and rural communities to create access to telecommunication services comparable to that available in the cities.

Ambitious programs to achieve higher standards of life and to reduce the existing imbalance between less developed and more developed regions depend critically on telecommunications that influence the cooperation on the local, regional, national, and international scales. The benefits derived from telecommunications services are several times the cost of supply. These benefits are potentially much larger in rural and remote areas than in cities because of greater distances involved and the higher cost of alternative forms of communications such as travel.

The stimulating and supportive role of telecommunications in the economic and social transformations is known, but there is still a long way to achieve in rural areas the goals established for cities. Serious concerns are being expressed that the information revolution may enlarge further the existing gap. The main barriers to overcome are the cost, organization, technology, and time.

In many countries, the existing telecommunications network is unsatisfactory. Not only it is underdeveloped, but it is also unequally distributed and there is an enormous disparity between regions. The information infrastructure has been concentrated

[1] The opinions expressed in the paper are the author's personal views, and do not necessarily reflect those of ITU or any other entity.

in large cities, whereas rural areas, with often more than 80% of the country population, suffer from restricted access even to basic telecommunication services. In spite of tremendous development over the last years, telephone is still a luxury in many regions, especially in developing countries.

Table 1. Information infrastructure services

Service	**Example**
Interactive speech	Telephony Audio conferencing
Image transfer	Facsimile
Electronic mail (store and forward)	Text mail Voice mail Fax mail
Multimedia document retrieval	World-Wide Web Image database
Video on demand	Movies on demand News on demand Music on demand
Interactive video services	Videotelephony Video conferencing Interactive games Tele-shopping Tele-medicine Distance learning
Computer-supported cooperative working	Tele-working Cooperative editing Cooperative engineering
Broadcast TV/radio/data - Contribution	Program production
Broadcast TV/radio/data - Distribution	Broadcast TV Pay per view Pay-per-channel
Distributed processing	Distributed manufacturing Real-time inventory Electronic Funds Trans-fer at Point of Sale Telecontrol Telecommand Tele-alarm Network and service management
Real-time multipoint retrieval	Video surveillance News gathering Telemetry Real market research Audience survey Tele-voting

INFORMATION INFRASTRUCTURE

Probably the most powerful aspect of the information revolution will be the opportunities offered by new processing techniques to put the user in a pro-active role with regard to telecommunication services. Tables 1 and 2 reflect the scope of generic current, near-term and target services that will develop in the near- to mid-term, according to ETSI [ETSI 1995].

STRATEGIC ISSUES

Substantial reforms have been introduced in many countries to extend the information infrastructure over the remote and rural areas. Expanding it at the pace required by global competition is a formidable task. But it is necessary to assist remote and rural communities to overcome disadvantages due to distance from industrial, cultural, and educational centers.

Rural Applications

Telecommunication services offered to remote and rural communities have been based on simple extension of the traditional urban and office-oriented technologies and services. But the needs of urban and rural populations are not necessarily identical and the technologies proved to be efficient in urban environment not necessary are the most appropriate in remote areas and rural environment. Because of remoteness, many issues of relatively low value in cities become vital in remote and rural areas. Examples are: emergency communications, alarm and local weather forecasts, voice mail, safety, security, medical and veterinary aid, tele-education, distant access to libraries, teleshopping, tele-banking, access to market information, etc.

What is valued is a practical approach addressing directly the specific needs of the local communities. This involves much more than simply the telecommunications equipment, rather its operational use and information contents in such a way as to facilitate the evolution and integration within the whole society. Some years ago, the telephone and computer served as a sign of high social status. Today they are essential tools. A farmer, to be competitive, has to make a better use of his resources and his time. He needs now a fax to order goods and services and personal computer to manage his farm and to access, via computer network, data he needs. He may also need a mobile phone for urgent business and family contacts while he is working in the field. His kids need to be familiar with computers to be competitive in the information society of tomorrow.

Cost Factors

The delivery of telecommunications services in rural and remote areas has been unsatisfactory mainly due to the high cost of traditional wire-line infrastructure. Unless they are directly subsidized, these services carry high market risks. For basic telephone services, the unit cost of $1,000 per line has been identified by the World Bank and ITU as achievable in favorable conditions but, in remote areas, costs ten times higher can be found, too. These numbers concern the existing technologies and may change significantly with the new generation of systems using satellites or stratospheric balloons. Anyway, subscriber growth implies substantial investments. The level of governmental investment may be insufficient for that purpose and non-governmental investments may be needed, but non-governmental partners follow the market rules.

To minimize market risk, the operator/investor must adopt a strategy which focuses on the following:

- Minimize the *First cost* that is the total expenditure required to provide plant ready for use.
- Minimize the *Return period* that is the time necessary to recover the first cost.
- Minimize the *Marginal cost* that is the cost of increasing, by a unit quantity, the amount of plant installed at a given time.
- Maximize the *Fill* that is the ratio of the number of units of plant in service to the total number of units installed.
- Minimize the *maintenance* costs.
- *Integrate* local applications, services and users to share the first costs and the maintenance costs.

Non-Governmental Investment

One of the main challenges for policy makers is to incorporate commercial realities into a coherent framework of national goals as only commercially viable operations are able to attract private capital. However, not all potential service areas or network segments are equally attractive. Some rural areas may therefore remain under-invested unless supportive policy instruments, which recognize the limits of commercial viability, are devised. This requires the regulator to be able to monitor the true costs and revenues attributable to operations in remote and rural areas, and to facilitate interconnect agreements or other financial inducements which provide an enhanced revenue flow.

The World Bank and ITU studies indicate that, when planned and managed correctly, and supported by sound tariff and administration structures, services in remote and rural regions can be economically viable. They can generate sufficient revenue to enable the operator to offer services and to sustain ongoing expansions on a commercial basis. However, some key policy instruments related to interconnection and the regulation of inter-company revenue sharing and/or financial assistance are required in many situations.

Potential Financement Source

One of substantial activities of ITU consists in the notification of assignments of frequencies and orbital positions in the ITU Master Frequency Register with the aim to facilitate the coordination and development of wireless systems. It resembles an airline seat reservation system. The notification and maintenance of the Master Register does not involve any extra fees. This leads to so called "warehousing of frequencies", "dead wood", "paper transmitters", or more recently - "paper satellites" and abuse of spectrum/ orbit resources. The issue was raised at various occasions, among others at the ITU Plenipotentiary Conference Kyoto 1994 that invited proposals to solve the problem. This author proposed that spectrum/ orbit reservation fees should be introduced. It would resemble the fees collected for keeping the register of patents, but would allow differentiating fees and implementing a simple policy mechanism. Everybody placing a satellite or a transmitting station in the Master Register would pay a fee. The income would be used to maintain the system and the surplus could be used to extend the Global Information Infrastructure to rural/ remote regions and developing countries. A few similar proposals were submitted independently for consideration at the WRC 97, but did not find required support. The issue will probably be discussed again at the 1998 Plenipotentiary Conference.

Development Strategy

The rural telecommunications policy must incorporate a reasonable strategy for initiating telecommunication services and then facilitating migration from the initial situation of relatively low telephone penetration, where many people are still waiting for network access, to higher penetration levels value-added and information services. The development model should be technology neutral and evolutionary. It should start from the first critical step - making basic telephone service available where it does not yet exist. Then it should concentrate further efforts toward making more telephones and more diversified services available to those who need them. The development and investment decisions should be based on the actual demand, in an environment that permits competition among technologies and providers.

When the population live below the income threshold necessary to afford a private telephone line (or does not recognize benefits from telecommunications), special strategies are required, such as providing public payphones. These strategies improve access to the network and generate future demand. The strategy of rural telecommunications development should therefore focus initially on government agencies, business and other entities which derive the highest economic benefits and generate the highest revenue, and then on payphones. Public payphones (with fax and other facilities as demand is identified) can capture the wide demand for infrequent use of the network from small business and the general public. Other services can be offered when the increased demand, or reduced marginal costs, allow the required profitability.

Local integration

A natural extension of public payphones is the concept of public telecentres or teleaccess businesses. These can offer a range of local and long distance telecommunication and office technology services such as photocopying, printing and computer-based services. This concept, which began in Scandinavia, offers to rural and remote communities, at an affordable price, services such as: telephone, facsimile, electronic mail and other data communications facilities, electronic data processing, Internet access, etc. It has been transformed in the Eurovillage project in Länna, Sweden. A Eurovillage is defined as an intelligent village that establishes a platform for continuous learning and development of multi-media communication and cooperation in a local and European context. It constitutes a virtual meeting and market place for local multi-media culture, multilingual communication, education and electronic commerce [Soete].

Possible business areas served by such centers include health and on-line medical & veterinary assistance, education, teacher support & updating material, access to remote data basses, libraries, public authorities, professional information, etc. In addition, special information services for farmers and small enterprises, computer-based education and training, etc., tele-shopping, and tele-banking services can be offered. Information on government programs, such as social security, agriculture & stock breeding, markets, the labor market, public press services, political programs, emergency readiness and tele-voting could also, of course, be delivered at such tele-service centers.

The most effective commercial arrangements for public payphones, call offices or telecenters is to be operated as franchises or “phone shops”. They may be operated by an existing business, since the income from commissions may not at first offer sufficient revenue for a stand-alone business. This usually ensures a level of responsibility, accountability and incentive which will maximize service availability. In addition it limits vandalism.

Appropriate technology

To provide telecommunication services in a competitive environment, operators and investors need an environment which offers low or manageable risk, a reasonably quick capital recovery and an attractive level of profitability.

- *Low risk* involves a transparent, favorable and stable legal, regulatory and financial environment as well as an appropriate technology which can meet demand without excessive cost.
- *Quick capital recovery*. To satisfy that requirement, the applied technological solution should assure a rapid system deployment and service delivery.
- *Profitability* translates into the application of technology that, in addition to low initial investment, has high reliability, easy and inexpensive system modification, and low operating and maintenance costs. Such features are inherent to wireless systems, whose maintenance costs (about 2.5%) are about one fourth those of wired solutions.

In selecting the appropriate technological solution, all factors listed above have to be taken into account. Often, there is no single technology able to satisfy all these requirements, and a combination of various technologies has to be optimally adapted to the local environment to address all operating company concerns, namely:

- *Business & Finance:* Minimize costs, maximize revenues.
- *Planning & Engineering:* Allow rapid deployment, meet goals, provide network flexibility, allow modular growth, reduce the need to negotiate land access.
- *Operation & Administration:* Minimize operational costs, utilize minimum skilled staff, improve resistance to theft and vandalism, operate a future-proof solution.

There are many new technological solutions that address all these requirements. Most of them are described elsewhere. A real break-through is expected from the global systems using low-orbiting satellite constellations or stations on balloons in the stratosphere, planned to be operational about the year 2000.

The significance of these new communication applications cannot be overestimated. Information exchange and computer applications become increasingly essential to economic development, education, health care, public services, and many other activities. However, most of the world does not have access even to the most basic telephone service. Even where this basic service is available, most of the networks over which it is provided are inappropriate for computer communications. They are antiquated and in need of modernization. The cost and the time required to upgrade these facilities through conventional lines would be prohibitive for much of the world. The new satellite systems are capable of providing the needed services at a lower cost, indifferent to distance or location. Because satellites in polar orbits move in relation to the Earth, the cost of continuous coverage of any one point on Earth is the same as the cost of covering of all points on the Earth. It radically transforms the economics of telecommunications infrastructure and enables leapfrogging earlier stages of telecommunication development to gain immediate access to the most advanced information infrastructure. The value of such systems lies in the number of people getting access to advanced communication services and who otherwise will never have such access at all.

REGULATIONS

National Regulations

The attitude towards telecommunications in remote and rural regions is changing. Several years ago they were seen as an extravagant luxury. Today they are considered as necessary to normal life, such as water or electric power installations. It is thus time now to adapt the national strategy to that environment. The telecommunication infrastructure should be treated as an inherent part of the country's general infrastructure, and a part of a comprehensive plan for regional disaster preparedness and relief.

It may be necessary to define a separate category of rural telecommunication areas and rural operators; to encourage introduction of new technological, organizational, and financial solutions; to establish a rural telecommunication development grant, or no-interest or low-interest loan finance to encourage take-up and promote additional investment in rural areas.

Usually, the majority of calls from rural areas are long-distance, to a district center, provincial or national capital. World experience indicates that usage patterns are initially not affected significantly by tariff levels, hence the most practical pricing policy is to ensure that tariffs are as close to cost recovery as much a practical.

Liberalization

Liberalization wave is opening the way to new solutions and commercially viable provision of telecommunications in remote and rural areas. The rural market is now different from that which existed only a few years ago. However, many operators and investors still neglect remote and rural areas because they receive little incentive to commit sufficient resources. They invest according to their risk and rate of return, and these areas are perceived as high risk and low return.

Many countries, have introduced competition between alternate suppliers as a means of lowering costs and increasing incentive. However, there may be good reason to license *specialized rural operators* who will focus specifically on the needs of rural communities. In cases where the calling patterns and tariff structure does not allow profitability on an isolated and strictly rural basis, operators which have within their territory both urban and rural markets could be viable, so long as the terms of their interconnect agreement with the national carrier are favorable. The operators should be offered interconnect agreements and incentives which facilitate commercial viability and provide acceptable financial returns. If this could be achieved, the remote/rural telecommunication investments could accelerate significantly.

Interconnection Arrangements

Fair interconnection agreements are a key instrument which policy makers and regulators can use to bring about equity in the market place, and to create incentive for investment in small regional or rural networks. In a multi-operator environment, rural operators should be compensated for their higher cost structures and higher financial risk by means of *asymmetric interconnection agreements* which establish differential cost-based network access fees between urban-based and rural operators. The rural operator should receive a higher share for traffic than the urban or national carrier receives. The justification for this is as follows:

- Urban/rural costs-causality is not equal. The call traffic generated between urban and new rural subscribers is usually only a small increment on the top of a relatively

large inter-urban traffic volume. The incremental cost of originating urban-to-rural calls or terminating rural-to-urban calls is therefore considerably smaller than the rural network's corresponding cost. This inequality should be taken into account in income sharing arrangements.

- Many rural regions experience higher incoming traffic than outgoing. This is due to urban subscribers having greater financial resources and "modern" customs. In rural areas which have import/export trade or a significant overseas migrant worker population, there is often much heavier incoming international call traffic which generates a positive net foreign exchange revenue settlement.

Because this revenue redistribution is cost-based, it is well suited to a liberalized environment. It has been used historically, in one form or other, in the USA, Canada, and other multi-operator environment. It is estimated that such an arrangement could yield 30%-40% additional revenues to the rural operator, compared to the usual form of equal revenue sharing agreement or simple *sender-keep-all* arrangement [Dymond]. In many cases, this would be sufficient to extend the commercial viability zone by a wide margin, providing higher returns for potential investors.

SOME INITIATIVES

After the US National Information Infrastructure initiative has been launched in 1993, a number of other countries have decided to follow that example. Some have joined efforts and resources to facilitate their transition to global information society. For instance, the West-European Ministers responsible for telecommunications agreed at the Luxembourg meeting in June 1995, that all citizens in Europe should have access to minimum telecommunications services, the same in rural areas as in cities. In addition to voice and facsimile, these minimum services should embrace electronic mail, file transfer and video services, according to the recommendations of the High-Level Group on the Information Society. The Group recommended also that the first step should include the universal availability of Integrated Services Digital Networks (ISDN).

Table 3 summarizes the objectives of these initiatives in the USA, Europe and Japan. Some details on the initiatives undertaken in the framework of ITU and European Community are given in the following sections.

ITU Programs

The Buenos Aires Action Plan of the International Telecommunication Union (ITU) foresees, among others, programs on Integrated Rural Development (#9), on Information Services (#11) and on Development of Telematics and Computer Networks (#12). The concept of integrated rural development covers all human activities in the rural environment and is based on the concerted development of all sectors such as agriculture, education, transportation, health care, etc. It is believed that efficient telecommunication infrastructure will, among others, foster some degree of rural entrepreneurship.

Rather that attempting to provide telephone lines to individuals, the programs aim at providing access to telecommunication and information technology for whole communities at strategic locations. The ITU programs focus therefore on community telecommunication service centers mentioned earlier and are integrated within a wider program of sustainable community development.. Such a center could serve a population of some 10'000. Following the decisions of the ITU Members, the pilot program aims at the community telecenters in some least developed 20 countries before the year 2000.

Table 3. Overall goals of some national and regional information initiatives

USA	Europe	Japan
• improve national competitiveness • regulatory reform • stimulate private investment • provide cross-industry focus • promote extend universal service concept • access to government information • BB infrastructure • initiate and encourage Global Information Infrastructure	• growth, competitiveness and employment • European-wide harmonized and stable regulatory and legal framework • open competitive markets • stimulate private investment • provide pan-European cross industry focus • NB and BB trans-European information networks	• build an intellectually creative society for the 21st century • economic growth and creation of new business and job opportunities • social development of the country (medical care, education, government services) • solutions for ageing society and global environment problems • international networks

BB: Broad Band; NB: Narrow Band
Source: European Information Infrastructure, ETSI 1995.

European Programs

In its report, the High-Level Group on the Information Society identified a number of specific application areas that need to be developed more rapidly. Some of them are listed below [Bandemann].

Distance Learning

Distance learning, that is providing courseware, training and tuition services, extending advance distance learning techniques into schools and colleges is one of major tasks. We list it first as the education is at the hearth of every society. The International Commission on Education for the 21st Century has emphasized that the education and training are the major challenges the humanity confronts in designing and building its future. The number of young people under the age of 15 has grown from 700 million in 1950 to 1.700 million in 1990. This accounts for the unprecedented pressure on existing education systems and the demands on them which stretch to the limit, and sometimes outstrip their capacity to deliver [Delors]. The benefits of distance learning include cost reductions and optimal use of scarce training and education resources. Employees needing to upgrade their skills, people tied to the home and in remote locations, and students accessing higher quality teaching will gain.

Teleworking

Teleworking in homes and satellite offices is seen as a means to create more jobs and as a remedy against the migration and transportation problems. Commuters will no longer need to travel long distances to work as they can connect electronically to whatever professional environment they need. For companies it will offer productivity gains, increased flexibility and cost savings. For the general public, pollution levels, traffic congestion and energy consumption will be reduced. For employees, more flexible working arrangements will be particularly beneficial for all those tied to home. The aim is 10 million teleworking jobs by the year 2000.

Telematic services

Telematic services for small and medium enterprises are the E-mail, file transfer, video conferencing, etc. with links to public authorities, trade associations, customers and suppliers. Small companies will be able to compete on a more equal basis with larger companies. They will be more competitive, will grow faster and create more jobs. The target was to have 40% of firms with more than 50 employees using telematic services by 1996.

Electronic tendering

Electronic tendering means the introduction of electronic procedures for public procurement and creation of a European Electronic Tendering Network. Public administrations will benefit from cost savings in replacing paper handling with electronic handling and from the more competitive environment between suppliers drawn from the wider market. Small and medium sized enterprises will benefit from participating in trans-European public procurement and from the diffusion of telematic services. A critical mass of 10% of awarding authorities using electronic procedures for their procurement needs should be reached by 1997.

Healthcare networks

Healthcare networks will be created, linking general practitioners, hospitals and social centers on a continental scale. Patients will benefit from a substantial improvement in healthcare, such as tele-diagnostics, or transplant matching. Taxpayers will benefit from tighter cost control and cost savings. First level implementation of networks at a regional and national level was targeted at the end of 1995.

Public administration networks

Public administration networks means more effective and cheaper government through electronic information exchange. The unification process for the single market will benefit from lower cost and better relations with citizens. Implementation of interconnected networks allowing interchange in the tax, custom, statistical, social security etc. domains, was targeted at 1996.

Information highways

Information highways mean providing households with on-line multimedia services on a local, regional, national and international basis. Consumers will enjoy transaction oriented services such as home-banking, or home-shopping, and access to a variety of information services. The target for 1997 is 200,000 households in five cities.

Continental Information Network

Trans-European Information Network means the access to libraries of universities and research centers around the world.

CONCLUSIONS

In our discussions about the Information Society, we have to realize that more than half of the world's population has still no access even to the basic telephone service. Despite the exponential growth of the Internet, only 3% of its users are in the low- to middle-income countries which account for 85% of the world's population. The gap between the "information rich" and "information poor" is here more sharply visible than elsewhere. However, without providing effective telecommunications service to communities in remote and rural areas, it is unrealistic to expect that any nation can join the Global Information Society in a foreseeable future.

New technologies create new hopes for these communities but technology alone is insufficient to make real progress. The successful development of information infrastructure outside the urban boundaries requires a complementary strategic package of policy, regulatory, financial, and operational innovations in addition to the appropriate technology. It requires commitment and collaboration between regulators, operators, and suppliers of technology and capital. The ingredients to the successful extension of information infrastructure over rural areas include:

- Creation of an appropriate national policy and program for rural telecommunication development.
- Removal of non-commercial burdens and regulatory and budgetary constraints imposed on rural telecommunication operators.
- Exemption of rural operators from fees and taxes during the initial period of investment until they reach a sufficient level of profitability.
- Cross-subsidization - e.g. contribution to a development fund or revenue pool - by operators who enjoy a level of profitability above a certain level .
- Provision of incentive to use or lease existing infrastructure.
- Training and education of independent operators to adapt them to a new environment.

The common target is to offer universal access to ISDN and global information superhighways everywhere. However, available technologies, limited resources and the enormous scale of the task may impose, in the first phase, the target of providing access to basic telephone service only. However, the technology applied should assure an easy and inexpensive migration to full ISDN services in the future.

As Martin Bangemann, Chairman of the High-Level Group on the Information Society has pointed out: "All revolutions generate uncertainty, discontinuity and opportunity. How we respond, how we turn current opportunities into real benefits, will depend on how quickly we can enter the [...] information society."

Table 3. Examples of key applications areas of information infrastructure

Main area	Main actors	Main drivers	Main applications
Education, research Training Research	Universities Research institutes Schools and educational institutions Students Employers	Cost, Efficiency Life long education Competition Specialization Seeking new products and services	Tele-education Learning-on-demand Electronic education information
Health care Consultancy Diagnostic Surgery Nursing Assistance	Hospitals Practitioners Pharmacies Insurance companies Patients	Graying population Cost reduction Quality of service Health advice	Tele-diagnosis Tele-presence Tele-consultation Patient records handling & processing Alarm & emergency services
Retail, shopping Advertising Direct marketing	Retailers Customers	Competition Efficiency: 24-hour shopping Customer information Fast product turnover	Tele-shopping Tele-advice Tele-marketing Interactive advertising
Financial services Payments Transactions Loans Information/Advice	Banks Insurance companies Investors Stock markets Customers	Competition Efficiency Customer service Globalization	Tele-payments Electronic transactions Electronic banking Electronic information services
Travel Reservations Booking Information Advice	Hotels, motels Travel agencies Tourist associations Restaurants Travelers	Competition Efficiency Customization	Tele-reservation Tele-information
Audio-visual Broadcasting	Program makers Studios Broadcasters Advertisers Consumers	Competition Efficiency Deregulation	Programs on demand Pay-per-view services Assistance to program access (navigation services)
Transport Fleet management Document handling Traffic information & control Navigation	Road, railway, airline and shipping companies Transshipment companies Customers	Competition Efficiency Safety	Fleet tracking Electronic document handling Electronic traffic information & control Electronic navigation
Administration Emergency services Security & defense Law enforcement Collecting taxes Information Issuing documents	Local, regional, and national state agencies Companies & institutions Citizens	Efficiency Cost Quality of services	Electronic information services Tele-voting Electronic mail with MPs & civil servants
Publishing News gathering & processing Advertising	News agencies Publishing houses Advertisers Customers, readers	Competition Efficiency Concentration	Distributed processing, editing, printing etc. Image and file transfer

FOR FURTHER READING

Bangemann M., (1944) Europe and the global information society. Recommendations to the European Council, Brussels.

Calhoun G. (1992) Wireless access and the local telephone network, Artech House.

Commission of the European Communities (1966): Official documents Community - Telecommunications Policy.

Delors J., (1996) Learning: the treasure within, Report to UNESCO of the International Commission on Education for the 21 century, UNESCO Publishing

Dymond A., (1995) Analyzing the long-term economic viability of providing rural and remote communications, Pan-Asian Rural Communications Summit, Hong Kong, 11-13 September.

ETSI (1995) European Information Infrastructure

Intelecon (1995) Options for Rural Telecommunications development. Report for the World Bank, July.

ITU (1994) Restructuring of telecommunications for development: evolution, policies and trends

ITU (1994) Rural Telecommunications, Vol. I through IV.

ITU (1994) World Telecommunication Development Conference, Buenos Aires.

ITU (1995) World Telecommunication Development Report

Soete L. (1996) Building the European Information Society for us all. Interim Report of the High Level Expert Group on the Social and Societal Aspects of the Information Society.

Stanley D., (1996) The information age and its effect on the future of New Zealand and New Zealanders, Pacific Telecommunications Review, September, pp. 26-35.