ACCESS TO THE DIGITAL ECONOMY:

ISSUES FOR RURAL AND DEVELOPING REGIONS

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1. Introduction

The convergence of telecommunications, information technologies, and electronic media have made possible new forms of economic interaction that are becoming characterized as the "digital economy". This paper examines ways of conceptualizing access to this emerging digital economy, and identifies research questions that need to be addressed to formulate policies and strategies to extend access, both to rural and disadvantaged populations in industrialized countries and to people in the developing world.

2. Information Gaps

2.1. The U.S. and Other Industrialized Countries

In industrialized countries, there is growing concern that a "digital divide" separates those with access to information technologies and the skills and resources to use them from the rest of the society. In general, electronic access in the U.S. has increased, with 93.8 percent of households having telephone service, 36.6 percent equipped with personal computers, and 26.3 percent with modems in 1997. The growth in ownership of personal computers and modems contributed to an increase in households with access to e-mail of nearly 400 percent between 1994 and 1997.[1] However, despite growth in access overall, there is a widening gap between high and low income households, while Blacks, Hispanics and apparently native American populations now lag further behind Whites in computer ownership and online access.

In rural areas, there has been significant progress in access to basic telecommunications; distance no longer accounts for difference in household access to a telephone; income levels are now a better predictor. The gap in connectivity to the Internet persists in rural areas. At every income level, households in rural areas are significantly less likely -- sometimes half as likely -- to have home Internet access than those in urban or central city areas.[2] Those who are connected typically pay more than their urban counterparts for Internet access.

2.2. Developing Countries

Access to information and communications technologies (ICTs) remains much more limited in the developing world. In its Statement on Universal Access to Basic Communication and Information Services, the United Nations noted:

> ... "The information and technology gap and related inequities between industrialized and developing nations are widening: a new type of poverty - information poverty - looms. Most developing countries, especially the Least Developed Countries (LDCs) are not sharing in the communications revolution, since they lack:
>
> - ✓ affordable access to core information resources, cutting-edge technology and to sophisticated telecommunications systems and infrastructure;
> - ✓ the capacity to build, operate, manage, and service the technologies involved;
> - ✓ policies that promote equitable public participation in the information society as both producers and consumers of information and knowledge; and
> - ✓ a work force trained to develop, maintain and provide the value-added products and services required by the information economy." [3]

Table 1: Internet Access by Region, June 1999[4]

	People Connected (millions)	**Global Percentage**	**Percentage of Global Population**
Canada and U.S.	97.0	56.6%	5.1%
Europe	40.1	23.4	13.7
Asia / Pacific	27.0	15.8	56.2
Latin America	5.3	3.1	8.4
Africa	1.1	0.6	12.9
Middle East	0.9	0.5	3.6

Table 1 shows the gap in Internet access between the industrialized and developing worlds. More than 85 percent of the world's Internet users are in developed countries, which account for only about 22 percent of the world's population.[5] Of course, Internet access requires both communications links and information technologies, particularly personal computers or networked computer terminals. While there is still much less access to telecommunications in developing countries than in industrialized countries, at present, the gap in access to computers is much greater than the gap in access to telephone lines or telephones. High-income countries had 22 times as

many telephone lines per 100 population as low-income countries, but 96 times as many computers. However, as prices for computers continue to decline, access may become more related to perceived value than to price. See Table 2.

Table 2: Access Indicators[6]

Country Classification	Tel Lines /100	PCs /100	Internet Hosts/10,000	Internet Users/10,000
High Income	54.1	22.3	28.1	92.0
Upper Middle	13.4	2.9	8.4	55.9
Lower Middle	9.7	1.3	1.9	19.0
Low Income	2.5	0.2	0.1	0.9

Typically, a high percentage of developing country residents live in rural areas (as much as 80 percent of the population in the least developed countries), where access to communication networks is much more limited than in urban areas. See Table 3. It should be noted that this table overestimates rural access because the "rest of country" includes everything except the largest city. Also, facilities are not likely to be evenly distributed throughout the country, so that in poorer nations there may be many rural settlements without any communications infrastructure.

Table 3: Access to Telecommunications[7]

Country Classification	Teledensity (Tel Lines/100)		
	National	Urban	Rest of Country
High Income	46.0	52.9	43.8
Upper Middle	13.7	25.7	11.5
Lower Middle	9.7	22.1	7.2
Low Income	2.5	6.5	2.3

3. The Importance of Access

Having identified gaps in access to the digital economy, it is important to consider the significance of these "digital divides". The theoretical underpinning of research on the impact of information and communications technologies in general is that information is critical to the social and economic activities that comprise the development process. Information is obviously central to activities that have come to be known as the

"information sector" including education and research, media and publishing, information equipment and software, and information-intensive services such as financial services, consulting, and trade. But information is also critical to other economic activities ranging from manufacturing to agriculture and resource extraction, for management, logistics, marketing, and other functions. Information is also important to the delivery of health care and public services. If information is critical to development, then information and communications technologies, as means of accessing, processing, and sharing information, are links in the chain of the development process itself.

In general, the ability to access and share information can contribute to the development process by improving:

- ✓ *efficiency*, or the ratio of output to cost;
- ✓ *effectiveness,* or the quality of products and services;
- ✓ *equity*, or the distribution of development benefits throughout the society.[8]

Much of the research to date on socio-economic effects of new communication technologies has examined the role of information networking through telecommunications. The extended impact of the combination of networks and information technologies is just beginning to be understood. The U.S. and OECD are in the early stages of collecting data on the growth of electronic commerce, and analyzing its impact. The Department of Commerce states that the output of IT industries has contributed more than one third to the growth of real output to the overall US economy between 1995 and 1998[9].

While we are in the early stages of understanding the effects of the emerging digital economy, it is important to note that more than access will likely be necessary; simply increasing teledensity or placing computers in schools is likely not to make significant impact. A workforce with sufficient general education and specialized training as well as an institutional environment that fosters innovation and productivity are likely to be critical factors.

4. Access Parameters

4.1. Access vs. Service

The terms "universal access" and "universal service" are sometimes used interchangeably, and typically refer to telecommunications networks. However, it is also necessary to consider access to the technologies connected to these networks that make possible information access and processing necessary to participate in the digital economy. Typically, end user equipment would include personal computers with

sufficient speed and capacity to process data from the worldwide web (or networked terminals with central access to sufficient capacity), and access to value-added services such as Internet service providers (ISPs). Access is thus a broader concept than service that involves the following components:

- ✓ *Infrastructure*: reach of networks and services, for example, to rural areas, low income populations in inner cities; available bandwidth (e.g. broadband capacity for highspeed Internet access);
- ✓ *Range of Services:* e.g. basic voice service (plain old telephone service, or "POTS"), value-added services such as ISPs;
- ✓ *Affordability:* pricing of installation, monthly service, usage by time or volume, etc;.
- ✓ *Reliability:* quality of service, as shown by extent of outages, breakdowns, circuit blockage, circuits degraded by noise or echoes, etc.

Another important component of access is specifying to whom telecommunications services should be accessible. Users may be considered in several categories:

- ✓ *Public:*
  - geographical: urban / rural, regional;
  - demographic: disadvantaged groups: low income, disabled, ethnic or other minorities, etc.
- ✓ *Commercial Enterprises:*
  - large and small businesses, entrepreneurs;
  - critical sectors: agriculture, transportation, manufacturing, tourism, etc.
- ✓ *Public services*:
  - health care, education, other government / public services, etc.
  - nonprofit and nongovernmental organizations (NGOs)

4.2. Universal Access: A Moving Target

Universal access must be considered a dynamic concept with a set of moving targets. The unit of analysis for accessibility may be the household, the municipality, or even institutions such as schools and health centers. Also, the definition of basic service must be revised periodically to take into consideration change in technology and user needs. Thus, goals should not be stated in terms of a specific technology or service provider (such as wireline or wireless service provided by a telephone company) but in terms of functions and capabilities, such as ability to transmit voice and data. Because of the importance of information access for socio-economic development as outlined above, the units of analysis for access should include not only the individual, but the

community and institutions such as schools, clinics, libraries, and community centers.

Economic and demographic diversity in inner cities, impoverished rural areas, and developing countries will require a variety of goals for information infrastructure. Rapid technological change also dictates that the definitions of basic and "advanced" or "enhanced" services will change over time. Thus, for example we could propose a multi-tiered definition of access, identifying requirements within households, within communities and for education and social service providers. For example:

- ✓ **Level One**: community access (e.g. through kiosks, libraries, post offices, community centers, telecenters, etc.)
- ✓ **Level Two**: institutional access (schools, hospitals, clinics, etc)
- ✓ **Level Three**: household access.

Universality has been defined differently in various countries. In North America and Europe, the goal has been to provide basic telephone service to every household, with the assumption that businesses and organizations would all have access to at least this grade of service. The ITU's Maitland Commission called for a telephone within an hour's walk throughout the developing world. Some developing countries set targets of public telephones within a radius of a few kilometers in rural areas.[10] Others such as China, India, Mexico, Nepal, Thailand aim for at least one telephone per village or settlement.

It is interesting to note that for Internet access, the U.S. is applying the community and institutional access models more commonly found in developing countries. The U.S. Telecommunications Act of 1996 specifies that "advanced services" should be provided at a discount to schools, libraries, and rural health centers.[11] "Advanced services" are currently interpreted as Internet access. In the future, it is likely that "advanced services" will be redefined, perhaps to include access to new generations of services available through the Internet or its successors. It should also be noted that industrialized countries such as the U.S. and Canada have extended the concept of basic service beyond quality adequate for voice to include single party service, and circuits capable of supporting the capacity of current modems, with the assumption that people will want to communicate electronically from their homes.[12] These criteria are also likely to be revised over time to keep pace with demands of the digital economy.

5. Understanding Demand for Information Services

As noted above, income may be the best underlying predictor of access to the tools of the digital economy. Typically, higher income populations are better educated; they thus have not only the money but the skills to use new technologies and services,

and are more likely than poorer people to use these tools in their work. Also, higher income populations tend to live in urban and suburban areas where communication networks are more available in developing countries and more affordable almost everywhere.

Yet income may not fully explain demand for information technologies and services, nor can lack of access to telephone lines necessarily be attributed to lack of demand or purchasing power. For example, in many developing countries, television sets are much more prevalent than telephones. In industrialized countries, both TV sets and telephone lines are almost universally available. However, in middle income countries there are twice as many TV sets as telephone lines, while in low income countries, there are more than 5 times as many TV sets as telephone lines (see Table 4). It appears that where television is available, a significant percentage of families will find the money to buy TV sets. Thus, even in the poorest countries, there may be much more disposable income available than per capita GDP data would indicate, and there may be significant demand for other information services. (The growth of cellphone subscribers in Uganda noted above is another example of unanticipated demand for information services in a low income country.) Another conclusion that can be drawn from the above analysis is that changing the policy environment to create incentives to serve previously ignored populations may significantly increase access among these groups (see below).

Table 4: Teledensity vs. TV Density[13]

	Tel Lines/100	TV Sets/100	TV Sets/Tel Lines Ratio
High Income Countries	54.1	61.9	1.1
Upper Middle Income Countries	13.4	26.3	2.0
Lower Middle Income Countries	9.7	22.7	2.3
Low Income Countries	2.5	13.1	5.2

Indicators other than population and household income may be better predictors of demand for communication services. One study estimates that rural users in developing countries are able collectively to pay 1 to 1.5 percent of their gross *community* income for telecommunications services.[14] The ITU uses an estimate of 5 percent of *household* income as an affordability threshold. To generate revenues to cover capital and operating costs of the network, the average household income required would be $2060; for a more efficiently run network, it would be $1340.[15] Using the higher estimate, 20 percent of households in low income countries could afford a telephone; in lower middle income countries the range could be from 40 percent to 80 percent, while in upper middle income countries such as Eastern Europe, more than 80 percent of households could afford telephone service.[16] It should be possible to extend apply

similar analysis to forecast affordability of access to the Internet in developing regions.

Other approaches may also be used to gauge demand for information services. For example, the presence of video shops indicates significant disposable income to afford television sets, video cassette players, and cassette rentals. Telephone service resellers (such as in Indonesia, Senegal and Bangladesh), local cable television operators (common in India) and small satellite dishes on rural homesteads and urban flats (common in Eastern Europe and many Asian countries) also signal demand and ability to pay for information services. The existence of video rental outlets, phone shops, and storefront copy centers is also evidence of entrepreneurs who could possibly operate other information service businesses.

Collectively, expenditures on rural and regional telecommunications in developing countries are between 1 and 2 percent of national GDP. Revenue forecasts are often based on the traffic generated from the rural area. However, revenues should also include urban to rural traffic For example, workers in the Arabian Gulf call family members in rural communities in Egypt, Yemen, India, and Pakistan. In South Africa, mine workers call their families in rural townships as well as in neighboring countries. As more rural communities have e-mail and Internet access, we could expect urban to rural traffic to increase, as urban businesses are able to place orders from rural suppliers, individuals and travel agencies can make reservations for rural tourist facilities, and urban relatives can more easily contact rural family members. Of course, rural to urban traffic to send messages and access websites is also likely to increase.

6. Technological Trends

From the service providers' perspective, there have traditionally been few incentives to provide access to low income customers such as disadvantaged minorities and inner city residents who are presumed to have limited demand for new services, and rural and remote regions where the cost of extending or upgrading facilities and services is assumed to be higher than expected revenues. However, technological innovations, many of which were initially designed for other applications, are now creating opportunities to reduce costs and/or increase revenues among these populations.

The tremendous capacity of fiber optic backbone networks and the increased capacity available to end users through enhancements of the wireline local loop such as ISDN (Integrated Services Digital Network) and DSL (Digital Subscriber Line) as well as coaxial cable and hybrid fiber coax (HFC) make it possible to provide increased bandwidth for accessing the Web to households and small businesses. Also, the capacity of these technologies to carry voice and video as well as data can provide a wider range

of services at potentially lower cost to customers than separately delivered services. Of course, these technologies are being targeted initially at larger businesses or more affluent residential customers, but the widespread availability of wireline in telephone networks, coaxial cable television networks and fiber backbones should make increased bandwidth affordable for residents of inner cities and small businesses and nonprofit organizations. In rural areas, both terrestrial wireless and satellites offer greater capacity without the cost of building out fiber and cable networks. More information on these technologies can be found in Appendix A.

6.1. Implications for Access Policy

There are significant implications of these technological trends, particularly for rural and developing regions:

- ✓ *Distance is no longer a barrier* to accessing information. Technologies are available that can provide interactive voice, data and multimedia services virtually anywhere.

- ✓ *Costs of providing services are declining.* Satellite transmission costs are independent of distance; transmission costs using other technologies have also declined dramatically. Thus communications services can be priced not according to distance, which penalizes rural and remote users, but per unit of information (message, bit) or unit of time.

- ✓ *The potential for competition is increasing.* Lower costs make rural/remote areas more attractive. New competitors can offer multiple technological solutions, including wireless, satellite, copper, cable, etc.

In addition, it is no longer technically or economically necessary to set rural benchmarks lower than urban benchmarks for access both to basic telecommunications and to the Internet. The U.S. Telecommunications Act of 1996 requires that rural services and prices are to be *reasonably comparable* to those in urban areas. This standard rejects the assumption that "something is better than nothing" in rural areas because minimal service was all that was either technically feasible or economically justifiable. However, as noted above, advances in technologies such as terrestrial wireless and satellite systems can now provide higher quality at lower cost in rural areas. The implications of these changes in policy and technology are particularly critical in enabling rural residents to participate in the digital economy.

While the US and other industrialized countries must upgrade outdated wireline networks and analog exchanges in rural areas, developing countries can leapfrog old technologies and install fully digital wireless networks. Thus developing country

regulators can also adopt rural comparability standards to avoid penalizing rural services and businesses in access to information services. For example, in the Philippines, after extensive discussion, both government and industry representatives agreed on rural benchmarks including digital switching, single party service, and line quality sufficient for facsimile and data communications.[17]

7. Policies and Strategies for Increasing Access

7.1.. Innovative Private Sector Strategies

A variety of innovative strategies have been adopted to provide community access to telecommunications, and more recently to the Internet. Some countries such as Chile and Mexico have mandated requirements for operators to install payphones in rural communities; South Africa has also required its wireless operators to install fixed rural payphones. Franchised payphones have been introduced in Indonesia, India, Bangladesh, and other countries in order to involve entrepreneurs where the operator is still government-owned. Indonesia's franchised call offices known as Wartels (Warung Telekomunikasi), operated by small entrepreneurs, generate more than $9,000 per line, about 10 times more than Telkom's average revenue per line.[18] Franchised telephone booths operate in several francophone African countries; in Senegal, phone shops known locally as telecenters, average four times the revenue of those operated by the national carrier.[19] In Bangladesh, Grameen Phone has rented cellphones to rural women who provide portable payphone service to their communities. Such examples of simple resale can create incentives to meet pent-up demand even if network competition has not yet been introduced.

Innovative operators are also using information technology to extend access to previously unserved customers. Prepaid phone cards, widely available in Europe and Japan, have been introduced in developing countries to eliminate the need for coin phones (which require coin collection and may be subject to pilferage and vandalism). Cellular operators have now extended this concept to offer prepaid cellular service using rechargeable smart cards, so that telephone service is now available to customers without credit histories or even bank accounts. In South Africa, the cellular carrier Vodacom has introduced prepaid calling cards: Vodacom sold more than 300,000 prepaid starter packs and one million recharge vouchers for cellular use in 1997.[20] In Uganda, within one year of licensing a second cellular operator, its prepayment strategy coupled with aggressive marketing and attractive pricing has resulted in there being more cellular customers than fixed lines in the country. For most of the new subscribers, their cellphone is their first and only telephone.[21]

Innovative approaches are also helping to extend access to the Internet. Virtually every major city in the developing world now has cybercafes or privately operated telecenters equipped with personal computers linked to the Internet. The African Communications Group plans wireless kiosks for Internet access, with web pages enabling artisans, farmers and other small entrepreneurs to set up shop in the global marketplace.[22] Initiatives to support public Internet access through community telecenters are being supported by several development agencies including the International Telecommunication Union (ITU), Unesco, United Nations Development Program (UNDP), Canada's International Development Research Centre (IDRC), and the US Agency for International Development (USAID). South Africa is also supporting the installation of telecenters equipped with phone lines, facsimile, and computers with Internet access through a Universal Service Fund; South Africa now plans to provide Internet access to government information and electronic commerce services through post offices. Many other countries are extending public access to the Internet through telecenters, libraries, post offices, and kiosks.

Access to telephones through booths, kiosks, and telecenters can be coupled with electronic messaging to provide "virtual telephone service". TeleBahia in northeastern Brazil offers a virtual service for small businesses without individual telephones. These customers rent a voice mail box for a monthly fee and check their messages from a payphone, providing a means for clients to contact them. African Communications Group is setting up wireless public payphones and providing voice mail accounts and pagers that announce incoming messages. The recipient calls back or leaves a voice mail message using a phone card; the service is priced for people making $200 per month.[23] (Similar systems are used for migrant farm workers in California to enable them to stay in touch with their families, and in homeless shelters to enable job seekers to be contacted by employers.)

Telecenters and other public facilities can provide access to e-mail, which is much faster than the postal service and cheaper than facsimile transmission. For example, a message of 2,000 words takes 10 minutes to read over a telephone; two minutes to send by fax, and about 4 seconds to transmit via 28.8 kbps modem.[24] Such services can be valuable even for illiterates. For example, a Member of Parliament from Uganda stated that his father sent many telegrams during his lifetime, but could neither read nor write. Local scribes wrote down his messages. Similarly, "information brokers" ranging from librarians to cybercafe staff can help people with limited education to send and access electronic information.

7.2. Service Obligations

Many countries include a universal service obligation (USO) as a condition of the

license. The cost of USOs may vary depending on geography and population density. British Telecom's universal service obligation costs just 1 percent of its total revenue base[25] Latin American countries with USOs include Argentina, Chile, Mexico, Peru, and Venezuela. In Mexico, the privatized monopoly operator, TelMex, must provide service to all communities with at least 500 population by the year 2000. In the Philippines, local exchange obligations are bundled with cellular and international gateway licenses; licensees were required to install up to 300,000 access lines in previously unserved areas within three years.[26]

Some countries use a "carrier of last resort" model which has the obligation to provide service if no other carrier has done so. Typically, the dominant carrier bears this obligation and is entitled to a subsidy to provide the service. However, this approach can be flawed if it provides no incentive for the carrier with the USO to use the most appropriate and inexpensive technology and to operate efficiently. It can also serve as a justification for the dominant carrier to be protected from competition because it has additional costs and obligations not required of new competitors.

7.2. Subsidies

A variety of schemes can be used to subsidize operators that serve regions where revenues would apparently not cover costs. Subsidies may be paired with USOs to compensate the carrier with the obligation to serve.

- ✓ **Internal Cross Subsidies:** The traditional means of ensuring provision of service to unprofitable areas or customers has been through cross subsidies, such as from international or interexchange to local services. However, technological changes and the liberalization of the telecommunications sector now make it impracticable to rely on internal cross subsidies. For example, customers may bypass high priced services using callback, VSATs or Internet telephony.

- ✓ **Targeted Subsidies:** In a competitive environment, cross subsidies cannot be maintained. Carriers that have relied on revenues from one service to subsidize another now face competitors that can underprice them on individual services. Also, new entrants cannot survive if their competitors are subsidized. Therefore, if subsidies are required, they must be made explicit and targeted at specific classes of customers or locations such as:

    - **High cost areas:** Carriers may be subsidized to serve locations that are isolated and/or have very low population density so that they are significantly more expensive to serve than other locations. This

approach is used in the U.S. and has recently been mandated in Canada.

- **Disadvantaged areas or customers:** Subsidies may target economically disadvantaged areas or groups that could not afford typical prices for installation and usage, or where demand for service is significantly lower than average. Some operators may offer interest free loans or extended payment periods to assist new subscribers to connect to the network. In the U.S., the Lifeline program subsidizes basic monthly services charges for low income subscribers. The subsidy funds come from a combination of carrier contributions and surcharges on subscriber bills. Some 4.4 million households receive Lifeline assistance. Also in the U.S., the Linkup program subsidizes connection to the network for low income households.

✓ **Route Averaging:** Some countries including Australia, Canada, the United Kingdom and the United States require that rates be averaged so that all customers pay uniform distance charges, regardless of location. Thus, for example, the rate per minute Sydney and Melbourne would be the same as the rate over an equal distance in the Australian Outback, where costs are much higher. Such policies can bridge the digital divide by reducing rural access costs.

7.3. Rural Telecommunications Funds

Funds for subsidies may be generated from several sources such as contributions required from all carriers: e.g. a percentage of revenues or tax on revenues; a surcharge on customer bills; and government subsidies: i.e. from general tax revenues or other government sources.

✓ **Transfers among Operators:** Some countries with many carriers rely on settlement and repayment pooling schemes among operators to transfer payments to carriers with high operating costs. For example, the U.S. Universal Service Fund is mandated by the Federal Communications Commission (FCC) but administered by the carriers through the National Exchange Carriers Association (NECA), and transfers funds to subsidize access lines to carriers whose costs are above 115 percent of the national average.[27]

✓ **Government-Financed Funds:** In Poland, over 7,885 localities were connected between 1992 and 1996 with funding of US $20 million from the state budget.[28]

In 1994, Peru established a rural telecommunications investment fund, FITEL (Fondo de Inversion de Telecomunicaciones), which is financed by a one percent tax on revenues of all telecommunications providers, ranging from the country's newly privatized monopoly operator, Telefonica/ENTEL to cable TV operators. Since established, it has generated an average of US$450,000 per month; growing by US$12 million annually.[29] Private sector operators may apply to FITEL for financing.[30]

7.4. Bidding for Subsidies

Rather than designating a single carrier of last resort, some countries are introducing bidding schemes for rural subsidies. In Chile, a development fund was established in 1994 to increase access for the approximately 10 percent of the population in communities without telephone access. The regulator estimated the required subsidies, distinguishing between commercially viable and commercially unviable, and put them out to competitive tender. There were 62 bids for 42 of the 46 projects. Surprisingly, 16 projects were awarded to bids of zero subsidy; as a result of preparing for the bidding process, operators were able to document demand and willingness to pay in many communities. Once completed, these projects will provide service to about 460,000 people, about one-third of the Chilean population without access.[31] Peru is introducing a similar program.

7.5. Licensing Rural Operators

Some countries grant monopoly franchises to rural operators. For example, Bangladesh has licensed two rural monopoly operators; they are allowed to prioritize the most financially attractive customers and charge an substantial up-front subscriber connection fee. The Bangladesh Rural Telecommunications Authority (BRTA) is profitable, even though it has to provide at least one public call office (PCO) in each village that requests one.[32]

However, other countries are opening up rural areas to competition as part of national liberalization policies. Argentina allows rural operators to compete with the two privatized monopolies, Telecom and Telefonica. Some 135 rural cooperatives have been formed to provide telecommunications services in communities with fewer than 300 people.[33] Finland's association of telephone companies has created several jointly-owned entities that provide a range of rural, local and long distance services in their concession areas, in competition with the national operator.[34] In Alaska, a second carrier, GCI, competes with AT&T Alascom to provide long distance services in rural and remote areas. This competition has benefited Alaskan schools in gaining access to the Internet. GCI has assisted school districts in applying for E-rate subsidies for Internet

access, apparently viewing this initiative as a win-win opportunity for both schools and the telephone company.

Although in most countries a single carrier provides both local and long distance services, it is also possible to delineate territories that can be served by local entities. In the U.S., the model of rural cooperatives fostered through the Rural Utilities Service (formerly Rural Electrification Administration) has been used to bring telephone service to areas ignored by the large carriers. As noted above, wireless technologies could change the economics of providing rural services, making rural franchises much more attractive to investors. As a result of availability of funds from the RUS for upgrading networks, rural cooperatives in the US typically offer higher quality networks and better Internet access than provided by large telephone companies serving rural areas.

Third parties may also be permitted to lease capacity in bulk and resell it in units of bandwidth and/or time appropriate for business customers and other major users. This approach may be suitable where some excess network capacity exists (e.g. between major cities or on domestic or regional satellites). Resale is one of the simplest ways to introduce some competition and lower rates for users, but is not legal in many developing countries, even where some excess capacity exists in backbone networks

8. Topics for Research

8.1. Tracking Information Gaps

It will be important to design ongoing measures to track disparities in access to the technical components of the digital economy, such as connectivity (via telecommunications infrastructure) and information processing and storage (at present, primarily provided in personal computers). Data such as those available through NTIA s Digital Divide[35] studies will provide a valuable resource for monitoring such trends. Other countries should develop similar sets of indicators, based on their own demographics and definitions of disadvantaged groups. At the international level, it would be useful to propose a common set of indicators that could be tracked through inclusion of census data. (For example, South Africa included questions on telephone access for the first time in its 1996 census.) Such steps would then provide a means for monitoring access on a global basis, while enabling each country to track progress toward its own goals.

There is also a need for research to determine which underlying factors are the best explanations of variations in access. For example, in the U.S., attention is frequently focused on ethnicity and rurality; e.g. access by blacks, Hispanics, native Americans;

disparities between urban and rural residents. However, other factors such as income and education (often highly correlated) may influence access. Similar analysis in other countries may reveal underlying factors that form barriers to access. It would be useful to conduct more detailed statistical analyses on census data such as those reported in NTIA's "Falling through the Net" studies to determine whether one or more underlying factors such as income and/or education, best explain the growing gaps.[36] As definitions of access change to include computers and Internet connectivity as well as telephone service, we could expect that education would be an increasingly important predictor of access, since better educated people would tend to have better technical skills and greater perceived need for use of computers and online services.

Other industrialized countries show trends in access broadly similar to those in the U.S. Typically, access is greater among those with higher incomes and more education, and somewhat greater in urban than in rural areas. However, the percentage of the population with Internet access at home or at work is more than twice as high in the U.S., Canada, the Nordic countries and Australia as in the United Kingdom, and more than three times higher than in Germany, Japan, and France.[37] It would be interesting to determine what enabling or inhibiting factors are contributing to these disparities.

Beyond access, research will be needed to understand what factors influence use of ICTs once they are accessible, either through individual ownership and connectivity or public sites such as schools and libraries. Among youth, are there specific factors such as exposure at an early age, that appear preconditions for later use? Among adults, are there information-seeking behaviors or social norms that may influence use of ICTs? For example, in some cultures, women may be discouraged from using technology; also, older or less educated people may feel more comfortable using an "information broker" such as a librarian, social worker or extension agent to find information they need or contact others electronically.[38]

Data from various sources such as the census, government reports, statistics compiled by regulators and others such as consulting firms and Internet-tracking websites can be very useful in measuring change in access and seeking explanations for trends utilization of information technologies. Sharing data sets through web sites can enable researchers around the world to undertake comparative studies.[39]

8.2. Beyond Correlation

Since the 1960s, researchers have documented a close correlation between access to infrastructure (typically measured by teledensity) and economic growth (typically measured by per capita GDP). Of course, correlations do not indicate causality, so that in

general, the question has remained unanswered as to whether general economic growth led (or in research terms "caused") growth in infrastructure investment, or vice versa. A landmark study by Andrew Hardy (1980)[40] showed causality working in both directions, i.e. that investment increased as economies grew, but also that there was a small but significant contribution of telecommunications investment to economic growth. As the cost of investing in infrastructure (e.g. cost per line) has dropped, this finding has become more significant, as it suggests that early investment in infrastructure can contribute to economic growth.

Studies of outliers and anomalies could also improve our understanding of correlational trends. For example, why are the Scandinavian countries (Finland, Sweden, Norway, Denmark) in the top ten countries in Internet hosts per 1,000 population, and what impact is this high level of Internet access likely to have on their economies? Does the fact that Israel, Ireland and Taiwan have more Internet hosts per 1,000 population than France and Japan indicate future trends in economic growth, or is it a short term artefact of national policies? Are middle income countries such as Egypt and Jordan that have better Internet access than other economically similar countries likely to reap greater economic benefits than countries with below average access such as Tunisia and Algeria? Among the "Asian Tigers" does the greater Internet access of Singapore, Hong Kong and Taiwan give them an advantage over South Korea, Malaysia and Thailand? [41]

It will be important to continue these lines of research on transition to a digital economy, including access not only to infrastructure, but also other indicators such as density of personal computers and Internet hosts, and economic indicators not only of per capita GDP, but of information-related work and creation of new enterprises. Findings from such studies could be helpful in ascertaining whether policies such as incentives to upgrade or extend infrastructure and to foster innovative applications of information technologies can contribute to economic growth.

8.3. Usage of Information Technologies

In addition to analyzing trends and effects of national access to the global digital economy, it will be important to understand what factors influence actual usage of these facilities. Since computer use requires literacy and more skill than using a telephone, we could expect that education rather than income would be a better predictor of demand for information services in developing countries. U.S. data appears to indicate that education is critical to adoption; people with more education are not only more likely to use networked computers at work but to have access to the Internet at home. Are there other factors such as households with children who have used computers at school that are likely to encourage access? Or are there strategies such as community access or training that could increase utilization? To what extent is the "information broker" such

as a librarian, telecenter trainer, or extension agent important in encouraging access?

Anecdotal evidence from projects among senior citizens such as Seniornet in the U.S. and telecenters in developing countries indicates that such resource people can be very important as facilitators, especially at early stages in using the Internet among some populations such as senior citizens and women. For example, at telecenters in Mali, Uganda, and Mozambique, from 30 to 45 percent of the users are women, despite the fact that women typically have less education and exposure to technology than men in these societies.[42]

8.4. Institutional and Community Access

The Telecommunications Act of 1996 mandated policies designed to foster access to "advanced services" for schools, libraries, and rural health care facilities. At present, access to the Internet is considered to be an "advanced service", with subsidy programs implemented to increase access. An evaluation of the so-called E-rate Program should include demographic data on users, purposes and frequency of use, and impact of access on education and health care delivery. A primary research question is to what extent these subsidy programs have increased Internet access to these three target institutions. Secondly, what factors explain disparities among participation in these programs? Are some states or organizations more effective in encouraging participation than others? Is the role of the telecommunications carriers significant? The third, and most important set of research questions may be summarized as: "What difference does it make?" In other words, does improved access to the Internet improve education or rural health care? Does library access to the Internet increase Internet usage by people in the community without other access, and if so, with what effect?

The subsidies mandated by the Telecommunications Act and community access policies in several other countries are based on the assumption that publicly accessible Internet facilities will increase the number of Internet users, and will provide access to otherwise disadvantaged groups. Research is needed to determine success factors for various models of community access such as libraries, publicly supported telecenters, and privately owned kiosks or cybercafes. Again, demographic information on users, applications, and volume of usage should be collected, for example, for a sample of libraries participating in the E-rate Program and in case studies of public access models in other countries.

Research is also needed on sustainability of various community access models. For example, beyond individual access, what entrepreneurial and technical skills are most important in establishing and operating businesses that provide access to information technologies and services or are intensive users of such services? Where

such skills are lacking or in short supply, how can they be developed? What approaches are most successful in sustaining noncommercial forms of access such as school networks, libraries, and nonprofit telecenters?

8.5. Rural Access

As noted above, technological innovations, particularly in terrestrial wireless and satellite technologies, have reduced the cost of providing reliable telecommunications facilities and increased bandwidth in rural areas. However, policies in many countries are still based on the assumption that prices for access will necessarily be higher and services will be more limited in rural areas. Little publicized sections of the Telecommunications Act of 1996 state that rural prices and services should be "reasonably comparable" to urban prices and services. To understand factors contributing to rural access to the digital economy, it would be useful to examine how rural comparability to urban services and prices, as stipulated in the Act been operationalized as a standard. For example, are there still significant disparities between urban and rural prices and / or service availability or quality in rural regions of the US?[43] Has there been any change in such disparities since the passage of the Act? Has any other country adopted a specific rural comparability benchmark or goal, and if so, with what effect?

This set of research questions could be expanded to include other issues related to availability and affordability of facilities and services. For example, to what extent is poor or nonexistent telecommunications infrastructure inhibiting growth of Internet use in the developing world? Once reliable networks are in place, will disparities in Internet access decrease dramatically, or are there other factors such as pricing that will influence usage? Are there lessons from the analysis of anomalies proposed above that could be useful in developing policies to foster Internet access?

8. 6. Impact of New Technologies

In addition to studies on economic impact of telecommunications access noted above, there is an extensive body of literature on the impact of so-called "new technologies" beginning with the diffusion of radio and television.[44] These studies showed that among individuals, there is a continuum in the adoption of new technologies from innovators through early adopters to laggards, and that various institutional factors can be important in the adoption of information technologies, such as educational television. In the 1970s, evaluations of experimental satellite projects showed both that information technologies could improve some elements of education, training and health care delivery, but that other factors such as perceived benefits by decision makers and sustainability were critical for institutional commitment to the

technologies and services past the pilot phase.[45] This literature should be reviewed to ascertain whether it provides insights and methodologies that can be applied to the study of the diffusion of the digital economy and its associated innovations.

9. Conclusion

This paper has shown how innovative technologies, strategies, and policies can help to increase access to the facilities and services of the emerging digital economy. However, effective applications of these facilities may require training, mentoring, and in certain cases facilitation through intermediaries. Many research questions remain to be answered, ranging from how access should be defined and measured, to what factors influence diffusion of these new technologies and services, and how electronic access to information services can benefit rural and disadvantaged populations.

Appendix A: Technologies and Services for Extending Access

Technological innovations that can help to achieve universal access to telecommunications in rural and developing countries include:

Wireline:

- ✓ **Digital Subscriber Line (DSL):** This technology could be appropriate for urban settings where copper wire is already installed, as its range is limited. However, it should be noted that copper wire is prone to theft in some countries: Telkom South Africa reported more than 4,000 incidents of cable theft in 1996, at an estimated cost of R 230 million (about US$ 50 million).[46]

- ✓ **Hybrid Fiber/Coax (HFC):** A combination of optical fiber and coaxial cable can provide broadband services such as TV and high speed Internet access as well as telephony; this combination is cheaper than installing fiber all the way to the customer premises. Unlike most cable systems, HFC allows two-way communication. The fiber runs from a central switch to a neighborhood node; coax links the node to the end user such as the subscriber's home or business. Developing countries with HFC projects include Chile, China, India, South Korea, and Malaysia.[47]

Terrestrial Wireless:

- ✓ **Wireless Local Loop (WLL):** Wireless local loop systems can be used to extend local telephone services to rural customers without laying cable or stringing copper wire. WLL costs have declined, making it competitive with copper; wireless allows faster rollout to customers than extending wire or cable, so that revenue can be generated more quickly; it also has a lower ratio of fixed to incremental costs than copper, making it easy to add more customers and serve transient populations. Wireless is also less vulnerable than copper wire or cable to accidental damage or vandalism. Examples of countries with WLL projects include: Bolivia, Czech Republic, Hungary, Indonesia, Sri Lanka.[48]

- ✓ **Cellular:** Cellular technology, originally designed for mobile services (such as communication from vehicles), is now being introduced for personal communications using small portable handsets. In developing countries without sufficient wireline infrastructure, wireless personal technology can be provided as a primary service, substituting for traditional wireline service. In China, there are more than 10 million wireless customers; other developing countries where wireless is used as a primary service include Colombia, Lebanon, Malaysia, the Philippines, Sri Lanka, South Africa, Venezuela, and Thailand.[49]

- ✓ **Wireless Payphones:** Cellular installations can be used to provide fixed public payphones. For example, new cellular operators in South Africa were required to install 30,000 wireless payphones within five years as a condition of the license. By March 1997, almost 15,000 wireless payphones had been installed.[50] Alternatively, a cellular subscriber may resell access. Entrepreneurs in Bangladesh offer payphone service using cell phones leased from Grameen Phone, which they carry by bicycle to various neighborhoods.

- ✓ **Multi-Access Radio:** Time division multiple access (TDMA) radio systems are a means of providing wireless rural telephony. They typically have 30 to 60 trunks and can accommodate 500 to 1,000 subscribers. Their range can be extended using multiple repeaters.[51]

- ✓ **Cordless:** Short range cordless extensions can provide the link from wireless outstations to subscriber premises; the DECT (Digital European Cordless Telephone) technology standard will also allow the base station to act as a wireless PBX and further reduce cost[52]. For example, DECT has been used in South Africa for the link to rural subscribers.[1]

Satellite Technologies:

- ✓ **Very Small Aperture Terminals (VSATS:** Small satellite earth stations operating with geosynchronous (GEO) satellites can be used for interactive voice and data, for data broadcasting, and for broadcasting. For example, banks in remote areas of Brazil are linked via VSATs; the National Stock Exchange in India links brokers with rooftop VSATs; China s Xinhua News Agency uses VSATs for broadcasting news feeds to subscribers. VSATs for television reception (known as TVROs for television receive only) deliver broadcasting signals to viewers in many developing regions of Asia and Latin America.

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[1] It should be noted that a disadvantage of all of these wireless technologies is limited bandwidth. While they can be used for email, they do not provide sufficient capacity for accessing the worldwide web at present. However, a new protocol known as WAP (wireless application protocol) being developed to enable cell phone users to access the web may also make it possible to access text on the web using very limited bandwidth.

- ✓ **Demand Assignment Multiple Access (DAMA):** In geostationary satellite systems, instead of assigning dedicated circuits to each location, DAMA allows the terminal to access the satellite only on demand and eliminates double hops between rural locations served by the same system. The system is very cost effective because satellite transponder expense is reduced to a fraction of that associated with a fixed-assigned system for the same amount of traffic. Also, digital DAMA systems provide higher bandwidth capabilities at much lower cost than analog. Both AT&T Alascom and GCI are introducing DAMA for their satellite networks in Alaska.

- ✓ **Global Mobile Personal Communications Systems (GMPCS):** Using low earth orbiting (LEO) satellites, these systems (e.g. Iridium, Globalstar and ICO) will be able to provide voice and low-speed (typically 2400 to 9600 kbps) data virtually anywhere, using handheld transceivers. However, the price per minute for these services may be much higher than national terrestrial services, and the first generation of LEOs has very limited bandwidth.

- ✓ **Internet via Satellite:** Internet gateways can be accessed via geostationary satellites. For example, MagicNet in Mongolia and some African ISPs access the Internet in the U.S. via PanAmSat, and residents of the Canadian Arctic use the Anik satellite system, while Alaskan villagers use U.S. domestic satellites. However, these systems are not optimized for Internet use, and may therefore be quite expensive. Several improvements in using GEOs are becoming available:

    - **DirecPC:** This system designed by Hughes use a VSAT as a downlink from the ISP, but provide upstream connectivity over existing telephone lines. Some rural schools in the U.S. are using DirecPC for Internet access.

    - **Interactive Access via VSAT:** Several companies are developing protocols for fully interactive Internet access via satellite.[53]

    - **High Bandwidth LEOs:** Future LEO systems are being planned to provide bandwidth on demand. Constellations of LEO satellites such as Teledesic, Cyberstar, or Skybridge may provide another means of Internet access via satellite.[54]

    - **Data Broadcasting:** Satellites designed for digital audio broadcasting (such as Worldspace) can also be used to broadcast web pages to small receivers. Users would not have fully interactive service, but could receive regular downloads of specified pages addressed to their

receivers.

Digital Services:

- ✓ **Compressed Voice**: Compression algorithms can be used to "compress" digital voice signals, so that 8 or more conversations can be carried on a single 64 kbps voice channel, thus reducing transmission costs.

- ✓ **Compressed Video:** Compressed digital video can be used to transmit motion video over as few as 2 telephone lines (128 kbps), offering the possibility of low cost videoconferencing for distance education and training.

- ✓ **Internet Telephony: (Voice over IP):** Some carriers are beginning to offer dial-up access to Internet telephony. The advantage of using Internet protocols for voice as well as data is much lower transmission cost than over circuit-switched telephony networks. IP telephony may eventually operate on separate data networks.

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2. Fact Sheet: Rural Areas Magnify 'Digital Divide'
(www.ntia.doc.gov / ntiahome / digitaldivide / factsheets / rural.htm)
Ibid.

3. United Nations Administrative Committee on Coordination (ACC), "Statement on Universal Access to Basic Communication and Information Services." April 1997. Quoted in ITU: *World Telecommunication Development Report*, 1998, p. 10.

4. Derived from Henry, David et al. *The Emerging Digital Economy II.* Washington, DC. U.S. Department of Commerce, June 1999.

5. It should be noted that Japan and Australia are included in the Asia / Pacific in this chart; the estimate in the text includes them with industrialized countries of Europe and North America.

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12. See CRTC Decision ------- (www.crtc.gc.ca)

13. Derived from ITU, *World Telecommunication Development Report,* 1998.

14. Kayani, Rogati and Andrew Dymond. *Options for Rural Telecommunications Development.* Washington, DC: World Bank, 1997, p. xviii.

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16. ITU, *World Telecommunication Development Report,* 1998, p. 37. It should be noted that this calculation appears to assume even distribution of income throughout the society at higher income levels, which is not necessarily true.

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29. ITU, *World Telecommunication Development Report*, 1998, p. 79.

30. Kayani and Dymond, pp. 63-4.

31. ITU, *World Telecommunication Development Report*, 1998, p. 79.

32. Kayani and Dymond, p. 18.

33. Kayani and Dymond, p. 18.

34. Kayani and Dymond, p. 19.

35. See www.ntia.doc.gov/ntiahome/digitaldivide.

36. Unfortunately, while the above study analyzes census data to show access by race, location, and education as well as income, it does not include statistical analysis which would indicate whether income is the underlying variable which accounts for much of the disparity across these other variables.

37. International Telecommunication Union, *Challenges to the Network: Internet for Development*. ITU: Geneva, October 1999, p.22.

38. For example, peasant farmers in Ecuador found out how to eliminate a pest that was destroying their potato crop through the assistance of a field worker who posted their question on several Internet news groups (personal communication, October 1999).

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