The Importance to Governments of Access to Distributed Knowledge

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Abstract[1]

The benefits to developing countries of international network links may differ from benefits perceived and realized from network utilization in the developed world. Individuals and organizations working toward international connectivity for their countries need to demonstrate how having such connectivity will address directly the needs of government ministries and will contribute to achieving the development objectives of the country. As an ally, government is in a strong position to accelerate the introduction and exploitation of network technology and services.

Background

Modern electronic data networks have evolved in developed countries during the last 30 years. This revolution in computing and communications has radically changed the developed world. Computing and information technology now pervade almost every area of life. Information, which used to be difficult to access, is now generally abundant. People living in developed countries are now more likely to suffer from information overload than the reverse.

Communications technology has revolutionized industries. Transportation and finance, for example, would not be the industries they are today without existing high speed communication and computing technology. All industries share in the benefits of having such information technologies available.

The diffusion and adoption of these technologies has been driven in large part by rapid cost and performance-price increases of microelectronics technology on the one hand and satellite technology, optical fiber and packet switching techniques on the other. The rate of performance-price increases in computing has been in the range of 25-30% for the last 35 years, with no major limiting factor seen for the next 10 years.

Performance-price improvements in long haul communication have been equally substantial. However, a major problem of communications systems, the local loop, will take a long time to improve substantially because of the major physical and capital investment required to approach universal connectivity. In developed countries, one of the driving forces is a well established market for products that can be delivered over high bandwidth end-to-end networks, such as combinations of video, interactive computer services, telephony, and print delivery, which is making investment in upgrading the local loop attractive to telecommunications suppliers. Markets for *content* are the primary motivating force toward expanding connectivity.

Computing and Communications Technology in Developing Countries

Any discussion of technology transfer to developing countries must recognize that developing countries as a group are quite heterogeneous. They differ substantially in the extent to which their infrastructure can adopt and support specific technologies. Different components of infrastructure have different degrees of robustness across countries. Thus, any general statement that one makes for developing countries as a class can be almost always be contradicted by specific examples.

What network development means to developing countries is primarily a function of their current state of development. For the lesser developed countries, the existence of a viable link from appropriate locations in the center of the capital city to foreign countries would provide major benefits; indeed, much more might not be supportable with the current physical infrastructure. For developing countries at a more advanced stage of development, international links are likely to be in place already (although probably not with the desired bandwidth), and the next stage of network development is to extend existing connections to other locations within the country. Both scenarios are important and need to be addressed. This paper concentrates more upon the former situation, reflecting the belief that it is important that every country in the world be aware of the benefits of internet connectivity and have incentives to achieve it.

Infrastructure issues

The state of the *physical communications infrastructure* is quite important for supporting data networking. The availability of adequate bandwidth on international links, the medium of transmission, and the quality of the local loops, if only in the capital city, are all important. Reliable electrical power is important to ensure that both telephony and data communications equipment function with a large mean time between failure. Redundant equipment stocks can help to compensate for remoteness from primary suppliers.

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The quality and coverage of the *human resource infrastructure* are important in establishing and operating a public data node. The skills required depend upon the type of connection, but include some mix of computing skills, including both hardware and software capability, and knowledge of some data communications hardware and protocols. Fortunately, the widespread dissemination of microcomputers throughout the developing world in the last decade has provided most countries with sufficient general skills to move into data communications, but this may not be true for all countries.

The *information infrastructure* in many developing countries is inadequate for robust support of networking activities. In contrast to the information overload threat within developed countries, developing countries are characterized by *information poverty*, both with respect to the stock available and with respect to the international and national flows. This condition is likely to retard the introduction of networking technology and use, but it is *the* condition that international network links, properly introduced and explained, can do the most to ameliorate.

Most but not all developing countries have a weak capital infrastructure, i.e. they suffer from financial poverty relative to developed countries, both in terms of assets and income, if not in natural resources also. After several decades of development activities, many have a level of external debt that is sizable relative to their national income. Further, the performance of their economies often depends to a large extent upon the performance of the economies of the developed countries, over which they have little control. Such a situation weakens planning for investment in any infrastructure component.

Many developing countries have a substantial surplus of unskilled labor. Basic wage rates are often quite low. From time to time, governments have regarded such a condition as a reason to assign low priority to the introduction of labor saving technologies. Unfortunately, such technologies include computing and communications.

The *size of the market* for such technology also affects the country's rate of absorption of technology. Small market size limits the presence of external suppliers, and does not provide good incentive for acquiring skills locally or establishing local businesses. Firms in small markets controlled by one or just a few suppliers behave like monopolists or oligopolists, often presenting information very selectively to prospective customers. A major advantage of investment in public data networking is that it is likely to weaken substantially any such restrictive control over information about products and technology

Importance of Identifying Benefits to Government

While the benefits of computing and communications technologies may be evident to people in developed countries who have woven them into the fabric of their everyday lives, they may not be so apparent to people in developing countries. How

is the value of e-mail communication with a distant correspondent perceived by a government official confronted daily with very real problems of hunger, health, poverty, or debt payment requirements? What is the value of on-line access to 200 library catalogues when the books are often neither attainable nor affordable? What is the value of access to 2000 Net News groups when the signal -to-noise ratio is generally quite low, and expensive bandwidth is consumed importing informal and often uninformed opinions on a variety of subjects often far removed from a government official's daily concerns?

Enthusiasm about networking, and about its related technologies, by itself is not a sufficient reason for the government of a developing country to be convinced of its usefulness. Alone, it is a risky platform on which to introduce networking; enthusiasm about content that is only marginally relevant, access to which competes for scarce investment funds, may be counterproductive in that its advocates may be regarded as not understanding or responding to the needs of the nation. Access to knowledge, even if efficient navigational tools existed, does not mean that the knowledge is relevant to the concerns of many people in developing countries.

The provision of network *transport* is important. Without an adequate transport mechanism, there is no way of delivering *content.* However, without sufficient guidance regarding the use of the internet, as well as effective navigational tools to adapt to the evolution of network services, the apparent signal to noise ratio of network information will be sufficiently low to seem irrelevant to most of the users in developing countries who can actually benefit substantially from what a network connection could deliver.

A key factor in the success of bringing international network links to developing countries and exploiting them effectively is obtaining the enthusiastic support of government ministries. If public data networking enjoys a high level of visibility in a country and government ministries are convinced that there are significant benefits to be gained from such connections, then the probability of success is dramatically enhanced. In a single statement of policy, or in a single allocation of financial resources, government can do more for or against the development of networking than can the efforts of hundreds of motivated and involved private individuals.

Content, therefore, and the ability to locate and obtain it is critical for networking success in developing countries. The current state of the internet, with its lack of good navigational tools and its low signal to noise ratio for specific usage may well be regarded by them as self-indulgent information overload by a bandwidth-rich developed world.

Electronic network connections have a potentially *higher* payoff for developing countries than for countries already developed because of the lack of alternatives. Developed countries already have reliable alternative methods of communication that have been developed and institutionalized over many years

and are widely available at moderate cost; they include mail and telephone service, telex, courier and other private delivery services, and intra-country public transport systems based upon physical road, rail and air transport networks. Developing countries have less of this infrastructure, and it is generally less reliable. On the cost side, the cost of developing a network infrastructure compares favorably with the cost of other physical infrastructures and rides on top of necessary investments in the overall communications infrastructure.

This higher payoff is also realized by the speedup in transaction time of communications between developing and developed countries. Alternative methods of communication in developed countries are relatively fast, but the alternatives for communication with developing countries are often much slower and of lesser quality and reliability. International mail and diplomatic pouch communication with developing countries can take a week or more; telephone is more reliable but not certain, and telex has low bandwidth and is not interactive in practice. An internet link can reduce the turnaround time in the search for information by a much greater factor in a developing country compared to within a developed country, helping to create a more equitable situation for development among all countries.

Benefits to Government

We might start by differentiating between access to specific individuals for the purposes of dialogue, and access to network services for the purpose of locating and extracting specific information. This distinction is not as sharp as might first appear, since exploiting one mode of access may lead to accesses and interactions of the other kind.

Access to individuals

Access to people is characterized by a high degree of interactivity and a relative lack of structure. In contrast to accessing computer based network services, human correspondents are flexible, can respond to what the questioner really wanted to know as opposed to what may have been asked, are capable of making intelligent side inquiries or referrals, and can reopen a conversation when additional relevant material becomes available. Difficulties in dealing with human sources of information include locating reliable information sources, making a successful claim on the time of these individuals to address the problem to be solved, and — for novice network users — understanding the culture and customs of the community of people who currently live in the highly networked culture of the internet.

A powerful example of the value of international network connectivity for developing countries is provided by the potential of simple, general network tools — electronic mail and file transfer — to increase substantially the payoff from external technical assistance.

Technical assistance to developing countries is provided by a variety of sources: multilateral development agencies such as UNDP, bilateral sources, selected NGOs, interorganizational arrangements such as twinning between universities, and private philanthropic sources. Most such assistance is in the form of projects that attempt to achieve a specific development objective. Resources brought to bear include expert services, equipment and supplies, and education and training of local staff. Each of these inputs can take a wide variety of forms.

Foreign expertise can be short or long term. Regardless of its length, in the past when an expert has resided in the country, his or her access to colleagues and reference materials at home is limited. More serious, after the expert has left the country the link between the expert, who now has experience with the problems of the country and the ongoing work within it, is generally weakened very substantially. Past forms of communication, including cables (telex), telephone, mail, and diplomatic pouch, have either high money or time costs, or long turnaround times, or both. The rapport that existed on site in the country, with its meaningful interactive discussions regarding how to solve real problems, has been dissipated.

Electronic mail connections can provide a major improvement this communication. If a foreign expert and a developing country ministry are connected via the internet, then the basis for continuing consultation after the end of the assignment are in place. Each transaction becomes easy to initiate, and response can be asynchronous based upon availability of the expert and the advice needed. Referrals to interested colleagues become trivial to initiate. The knowledge gained by the expert during his or her time in the country continues to work for the country well after his or her residence in the country ends.

Training and education of developing country nationals is a large part of many technical assistance projects. While basic training is generally done in the country, advanced training and education programs are generally done abroad. Students sent abroad for such training and education not only learn specific subject matter, but begin to create their individual web of technical and professional contacts that characterizes most effective professionals in developed countries. When those students return to their country, the ability to exercise or even maintain those contacts is radically diminished.

The Nobel Prize winner Herbert Simon, when once asked how he could know about so many different subjects, replied, "It's simple. I store my knowledge in my friends." What he was referring to was the notion that the talent of knowing where *and in whom* to look for information may be more important than any specific stock of information assimilated. This trait is most keenly developed by librarians, who are stewards of such large quantities of information that the option of knowing it all instead of knowing how to find it is dismissed without thought.

Electronic connectivity offers the strong hope that the benefits of such personal and professional networking can be extended to students returning to developing countries. In an information-rich environment, people find it convenient and rela-

tively easy to establish such connections as they are needed. In the information-poor environments of many developing countries, maintaining and using any set of existing contacts with points of expertise abroad becomes a meaningful achievement, especially if those contacts are with professional mentors with whom the student has worked closely while abroad. An internet connection provides a major first step in this direction.

Developing countries should not underestimate the very large reservoir of good will that exists toward them in many countries and institutions in the developed world. In the past, a major obstacle to tapping that good will has been the lack of an efficient way to make contact with it and exploit it. Electronic communication increases substantially the viability of not only maintaining contacts with people in developed countries once they have been made, it also makes possible referrals of questions to others who are connected in a very time and cost efficient manner. People are often willing to give their time and knowledge to the cause of developing countries if it can be done efficiently. Internet interconnectivity has the potential to provide such an appealing combination of efficiency and effectiveness.

Access to automated network services and resources

While access to individuals at network speeds can be a very powerful tool for development, the quantity, complexity, and preservation of knowledge has led to the establishment of institutions for collecting, organizing, and making access available to it. Libraries of all kinds have had this role in developed countries for centuries.

Libraries have responded aggressively to opportunities presented by information technology by making information about their collections available in automated form. Many libraries have made their card catalogs, containing *metainformation*, i.e. information describing the information in their holdings, available in machine readable form on computers that can search the catalogs in a variety of different ways. This service can be provided locally or via a larger network such as the internet; at the time of this writing, catalog information from over 200 libraries is available via the internet.

Such data may be useful by developing countries, but its usefulness often depends upon access to the content of the book itself. Such full text retrieval is not now common, although specialized information sources are looking toward offering full text information retrieval over the network in the future.

In addition to libraries, a variety of network services have sprung up, offering to potential users direct access over the network to specialized information. Such services will generally be of more immediate use to developing countries than library metainformation. However, the state of network services on the internet is currently relatively primitive, with inadequate navigational tools for finding items of significant interest efficiently. While the number and value of such services is sure to grow substantially, their growth is tied to issues relating to appropriate use of certain national internets, together with concerns about how commercial services should be introduced and allowed to coexist with those parts of the internet structure that are funded only for research and education.

Network services and applications by sector

Government acceptance of and enthusiasm for networking depends upon the ability of specific ministries and sectors to identify specific advantages for them in connecting to or using the network. Some suggestions by sector follow. These suggestions are illustrative of what is possible, and are not meant to be an exhaustive compilation. Furthermore, they do not include examples of potential benefits to those ministries that could result from a robust internal networking structure connecting their offices and their constituencies within the country.

Education

- access to colleagues' research in other countries, directly and through services such as the Physics Information Network.[2]
- ability to participate on basis of substance (rather than being distance limited) in joint research work with international colleagues.
- dialogues with teachers in other countries, all levels, both on an individual basis and through specialized list servers.
- international cultural exchanges between students in different countries, e.g. KIDSLINK.[3]
- language instruction through language structured communication with similar students in other countries.
- access to collections of teaching materials.

Health

- access to knowledge bases regarding health and disease, e.g. the National Institutes of Health Medline system.
- access to international information resources concerning health and disease, such as WHO and PAHO.
- ability to confer with physicians, epidemiologists, etc. regarding immediate health concerns.
- access to and participation in active Net News groups in the health sciences, e.g. bio.*.
- automatic and immediate delivery of special health alerts.
- participation in specialized health related logical subnets such as HealthNet.[4]

Statistics

- ability to report statistics to international organizations in more timely manner, and to obtain international statistical comparisons in computer form as they becomes available.

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[2] *NYSERNet: New User's Guide to Useful and Unique Resources on the Internet,* p. 106.
[3] *ibid,* pp. 65-67.
[4] *Internet Society News,* Vol. 1, No. 1, January 1992, p. 21.

Agriculture and Natural Resources

- access to agricultural libraries, e.g. the National Agricultural Library in Washington.
- access to economic information pertaining to agricultural markets, such as PENpages.[5]
- access to oceanographic and related marine data on a world-wide basis, from the Ocean Information Center.[6]

Development and Planning

- TCDC (Technical Co-operation among Developing Countries) direct information interchange or through international intermediaries, e.g. the PADIS model.

Telecommunications

- ability to learn new technology and participate in introduction of new networking technology in country infrastructure.
- closer linkage with counterparts in other countries as well as international agencies: ITU, CCITT, WMO.

Foreign Affairs

- additional links to embassies and consulates capable of transmitting computer-to-computer text.
- ability to work with multilateral and bilateral development agencies in the more rapid formulation and approval of development projects.
- disaster assistance efforts, in co-ordination with UNIENET and other UNDRO activities.[7]

The above suggestions are by no means exhaustive, and a more complete list would be more persuasive to governments in developing countries. While even a comprehensive list might not convince all countries to invest in network connections, it must be stressed that international networking is now only in its infancy. The data network transport infrastructure now being created will almost certainly generate rapid and vigorous growth in network services in many areas of human endeavor, and the benefits for those who have access to these services could be very substantial. It is imperative that countries serious about significant economic and social development learn about and understand the benefits and implications of this new major activity within the information society.

Conclusion

The public networking culture is growing exceedingly rapidly in developed countries and is facilitating a revolution in our thinking about and use of information resources. The benefits are already major, but the revolution really has yet to begin.

Developing countries have somewhat different priorities and less infrastructure with which to understand, absorb, or support this new culture. What seems exciting and productive in a developed country context may well seem of lesser importance than other more basic or urgent requirements to government officials in a developing country.

The new public networking culture has enormous relevance and power for developing countries as well as developed. However, the relevance is different and is in addition likely to be differently perceived. In many such countries, government involvement, enthusiasm, and support are essential in order for the process of introducing and exploiting the potential of international network links (as well as intra-country network development) to succeed. Government must be convinced that the content of services available through the international network will have direct payoff in terms of national development objectives.

Such payoff takes several forms. The amplification of contact with and value derived from foreign experts may in itself be sufficient to justify network connections. The specialized sectoral information resources available as network resources can be very useful, provided that they are accompanied with personal navigational assistance beyond what would be required in an information rich environment. Furthermore, it is increasingly likely that the idea of developing countries helping themselves can be realized in a time-efficient manner.

All of these modalities of network service exploitation are important. Government officials in developing countries need to understand specifically how network connectivity can help them directly. This understanding is likely to lead to commitment and prioritization of national objectives that will maximize the rate of appropriate network penetration and effective use of network services. Network enthusiasts should understand this process and use it in their efforts to bring international public networking to developing countries.

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[5] *NYSERNet: New User's Guide to Useful and Unique Resources on the Internet,* pp. 35-38.
[6] *ibid*, 32-34.
[7] *Internet Society News,* Vol. 1, No. 1, January 1992, pp. 25-26.