

Electronic Architectures for Bridging the Global Digital Divide: A Comparative Assessment of E-Business Systems Designed to Reach the Global Poor

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Abstract

This chapter presents a comparative view of e-business systems designed to extend the benefits of e-business to the poor demographic segments of the developing world and to reach populations that are on the “wrong side of the digital divide.” Some of the systems, such as the United Nations Trade Points program, are already operational in many countries while others are in the planning stage. In this chapter, we present case studies of a few such systems and provide a comparative technological, economic, and social assessment of the effectiveness of these systems in terms of meeting the overall goal of narrowing the global digital divide.

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INTRODUCTION

It is argued that Internet access and e-commerce are more valuable to the people in developing countries than in developed countries (World Bank 2000). There is, however, a wide gap between rich and poor nations in terms of their capabilities of accessing, delivering, and exchanging information in digital forms (Carter and Grieco 2000). Developing countries, comprising more than 80% of the world population, account for a tiny fraction of global e-commerce. An estimate suggests that 99.9 percent of business-to-consumer e-commerce in 2003 will take place in North America, Europe and Asia Pacific (Computer Economics 2000). This “global digital divide” is the outcome of the complex interactions between information and communication technologies (ICT) and various factors in the environment.

If larger numbers of firms and individuals from developing countries are connected to the Internet, it will increase the utility value of the network because of the well-known network externality effects (Katz and Shapiro 1985, 1986). Apart from economic benefits such as more choices and the convenience of shopping at home, Internet can facilitate progress on educational and scientific development, mutual aid, and world peace. It can also foster democracy and offer exposure to and knowledge of other cultures (Fink 1997). The benefits of widening and deepening of Internet access in the poorer countries thus accrue not only to the developing countries but also to the developed countries.

The global digital disparity is attracting the attention of academicians and policymakers (Petrazzini and Kibati 1999, UNDP 2001). In recent years, to exploit fully

the potential of the Internet and e-commerce and to bridge the existing digital divide, several initiatives are being taken at different levels. Some of the initiatives are purely philanthropic; some are commercial, while others are a combination of the two. The extent to which individuals and organizations from developing countries will be able to enjoy the benefits of the Internet is a function of the characteristics of the network architectures designed to reach them. This chapter provides a comparative assessment of the architecture of four of such networks – Global Trade Point Network (GTPN) of the United Nations, Little Intelligent Communities (LINCOS), Alcatel Telemedicine Network in Senegal (and proposed E-government Network in Mali), and the Johns Hopkins Global Access System.

BACKGROUND: RAPID EMERGENCE OF THE DIGITAL DIVIDE

All individuals and organizations are not equally likely to adopt a new technology. The adoption rate is influenced by economic variables such as profitability or relative advantage and social variables such as compatibility (Rogers 1983). A technology is not likely to offer the same level of profitability to all potential adopters and/or is not equally compatible with all social systems and hence adoption rates vary across individuals and organizations. Consequently, different types of “divide” emerge. In the case of the Internet and e-commerce, for instance, there are more male than female users. Likewise, more educated and higher income people are more likely to adopt the Internet than less educated and low income ones and large enterprises have higher e-commerce adoption rate than small and mid-sized enterprises (SMEs). There are also “digital divides” across different races, age groups, etc. The global digital divide between the rich and poor nations is thus embedded in and enmeshed with these other types of “digital divides.”

GLOBAL DIGITAL DIVIDE: PATTERNS AND CAUSES

Whereas high-income countries have income 63 times that of low-income countries, the respective ratios are 97 for PCs, 133 for mobile phones, and 2100 for Internet hosts (Table 1). While reliable data on e-commerce transactions are not available, the ratio is likely to be even higher for e-commerce transactions since e-commerce is virtually non-existent in many developing countries. The pattern indicates that the gap between developed and developing countries is wider for more recent technologies such as PC, mobile phone, and the Internet than for technologies which were introduced earlier. Policy measures at different levels determine whether the gap will widen or become narrower in the future.

Table 1: A comparison of countries in different income groups according to the penetration of several ICT products

Income group of Country	GNP per capita (1999)	TV per 1,000 (1998)	Telephone per 1,000 (1998)	PC per 1,000 (1998)	Mobile phones per 1,000 (1998)	Internet hosts per 10,000 (2000)
Low	410	76	23	3.2	2	0.3
Lower middle	1200	250	90	13.6	18	2.8
Upper middle	4900	285	176	53.1	76	35.5
High	25730	661	567	311.2	265	777.7
Ratio of High to Low income	62.8	8.7	24.7	97.3	132.5	2100

Source: Calculated from the World Bank (2001)

There are several causes of the digital divide. First, a large majority of potential users in developing countries cannot afford a telephone line, a personal computer, and the telephone and Internet services provider (ISP) access charges. Whereas the cost of a PC is 5 per cent of per capita GDP in high-income countries, it is as high as 289 percent in low-income countries (ITU 2001). For example, in January 2001, the cheapest Pentium

III computer cost US\$ 700 (UNDP 2001), which is much higher than the average per capita GDP of most developing countries (Table 1). Likewise monthly Internet access charge as a proportion of per capita GDP in the world varies from 1.2 percent in the U.S. to 118 per cent in Sierra Leone (ITU 2001).

Second, even if consumers are willing to pay for a telephone line, there is a big gap between demand and supply in many developing countries. High import taxes on ICT products, monopoly in the telecommunications sector, and unfavorable geographical conditions are partly responsible for the low availability and higher prices of ICT in these countries.

A third problem is lack of skills. A majority of potential users in developing countries lack English language and computer skills – prerequisites to the use of Internet. For instance, in 1998 about 85 percent of the text in 2.5 million Web pages that were surveyed was in English (Nunberg 2000). This proportion decreased to about 80 percent in 1999 and is estimated to plummet to 50 percent by 2003 (Nua 1999b). Although a shift of Internet content to non-English languages is under way (Nua 1999a), some knowledge of English is still necessary to use the Internet as the bulk of software used in the Internet is in English (Hedley 1999) and most of the human-computer interfaces favor English language users (Goodman 1994).

A fourth problem is the lack of relevant content. Although there are an estimated 4 billion Web pages in existence with a daily addition of about 7 million new pages (Nua 1999b) and an annual growth rate of about 100 percent (Nielsen 2001), the content remains largely geared to the needs of advanced nations.

In the case of e-commerce, Avinash Persaud of State Street Bank points out at least three forces that are likely to widen the global divide (Economist.com 2000). First, the “network” is likely to help first movers to establish a dominant position, giving firms

from developed countries an edge. Second, e-commerce has shifted power from sellers to buyers. Since most of the firms from developing countries are commodity producers that come low down in the supply chain, buyer firms from developed countries will squeeze the profit margins of supplier firms from developing countries. Third, developing countries will get low investment inflows in the high-tech sector since the combination of risks and returns in these countries is less attractive than in developed countries.

Thus in the absence of appropriate policy measures, it is likely that the global digital divide will become wider rather than narrower. Appropriate policy measures could bridge the gap or at least decrease the rate at which it widens.

APPROACHES TO BRIDGING THE DIGITAL DIVIDE

The Internet is a versatile technology that can be used for a variety of purposes including education (such as distance learning to provide access to rural areas), civic participation (online government information to increase efficiency, disseminating information, community networking, etc.), urban and rural development, transportation (such as advanced transport telematics to improve road conditions and traffic flows), health (for example, improved, efficient communications and health education on the Web), access to information (library, language translation for multilingual nations, etc.), and e-commerce (to change/enhance buyer-seller relationships, business information online, etc.). The relative importance of a function for firms and individuals in the developing countries is likely to be different from that in the developed ones. The effectiveness of a network in bridging the digital divide is, thus, a function of: (1) the network's ability to identify priorities of digitally excluded populations, and (2) the network's ability to attack the major barriers to Internet and e-commerce adoption.

In the following section, we discuss the network architectures of four e-business system designed to reach the global poor – the Global Trade Point Network (GTPN) of the United Nations Conference on Trade and Development (UNCTAD) (Figure 1), Alcatel Telemedicine Network (Figure 2), Little Intelligent Communities (LINCOS) (Figure 3) and Johns Hopkins International’s (JHI) Telemedicine Network (Figure 4). A comparison of the functioning of the four networks is provided in table 2.

NETWORKS FOR BRIDGING THE DIGITAL DIVIDE

United Nations Trade Point Program

UNCTAD launched the Global Trade Point Program in 1992 to facilitate the access to international markets for small and medium-sized enterprises (SMEs). There are more than 140 trade points in different parts of the world. In a trade point, participants in foreign trade transactions (e.g. customs authorities, foreign trade institutes, banks, chambers of commerce, freight forwarders, transport and insurance companies) are grouped together under a single physical or virtual roof to provide all required services at a reasonable cost¹. It is a source of trade-related information providing actual and potential traders with data about business and market opportunities, potential clients and suppliers, trade regulations and requirements, etc.

The Secure Electronic Authentication Link (SEAL) project and concept were developed by the United Nations Trade Point Development Center. Its smart card project is facilitating the payment flow in international trade. The first level smart card allows users to automatically authenticate their user profile to the SEAL and secure electronic trading opportunity (ETO) on the GTPN. The second level smart card allows confidentiality of information, payment information integrity, Cardholder account

¹ See <http://www.unctad.org>

authentication, merchant authentication, and interoperability with the ETO system on the Internet and the GTPN.

LINCOS: Little Intelligent Communities

The initiative for LINCOS was developed jointly by the Fundación Costa Rica para el Desarrollo Sostenible, the Media Lab at the MIT, and the Instituto Tecnológico de Costa Rica in 1998 (Saxe et al 2000). It has alliances with over 10 academic institutions, and at least 10 technology companies (United Nations 2000). LINCOS uses recycled shipping containers² to house computers, peripherals and generators, which allow intelligent uses of ICTs in the regions with few development opportunities.

LINCOS integrate multiple ICTs into a single technology platform. The units are installed in a container equipped with five computers and other facilities to provide a broad range of services including Internet access, health, education, banking, and government services, electronic trading, technical support for SMEs, telecom and Information center, video conference and entertainment, forest, soil and water analysis, etc. Each unit is satellite operated and solar power enabled and can operate independently of traditional infrastructures. The satellite dish antennae link them to any telecom network or “master station” as needed.

Thirty such communities are being planned in the Dominican Republic and another 30 in Central America (Proenza 2001). Although the cost was about US\$70000 in the pilot stage, it is expected to decrease significantly with the increase in production (United Nations 2000).

Alcatel Telemedicine and E-Government Networks

Alcatel, the Europe-based telecommunications giant, has designed an Internet platform to offer end-user services aiming at solving a part of daily population concerns (OECD

2001). Senegal. In St Louis, Senegal, weight collectors, women living in the area are equipped with a laptop and a balance to take the weight of the children of families subscribed to its telemedicine system³. The weight of children is regularly surveyed, twice a week, as a significant indicator of children health. The data is loaded via Internet into the database of a Pediatrician, who then detects the 10% of those children requiring further attention. Then, the cyber-pediatrician sends emails to the concerned weight collector who informs the families and invites them for a medical visit. During February 2001, three children were saved from malnutrition. A child died since his mother did not follow the pediatrician's prescription. The families are paying their subscription and the waiting list for the service is long. This pilot project lead by Afrique Initiatives serves as an example to show how Internet can leverage very weak health care resources.

Likewise, in Mali, a nationwide project is being prepared which has the potential to impact the entire organization of civil society. To increase the decentralization process, the proposed system will connect 700 new local authorities to the central government authority via the Internet. It will also be possible to access both public and private services over the same infrastructure. All these services will be accessed via the community cyber-center. The network architecture is based on broadband IP accesses, used as a leapfrog technology solution. The cost is about US\$2000, which is considered to be reasonable since the Telecenter's mean revenue in already-served areas varies between US\$500 and US\$1000 a month for the telephone service only (OECD 2001).

The program will be conducted with local partners strongly involved in Internet services such as ISPs, project incubators, software developers, IS designers and local

² The container is selected for its availability, ease of transport, durability and convenience (Saxe et al 2000).

³ Personal communications with Susanne Wahler, Marketing Manager, Voice Networks Division, Alcatel.

International Non-government Organizations (INGOs). Although the program is more business oriented than philanthropic, it is expected to generate benefits for the population.

Johns Hopkins Global Access System

Johns Hopkins Global Access System is based on the premise that anyone who wishes to have a second opinion on a diagnosis from anywhere in the world can receive it from a Johns Hopkins physician. The system combines advancements in technologies such as imaging internetworking and workflow systems to create state-of-the-art telemedicine-based patient referral system (Billie 2001). When a referring physician requests a second opinion from a Johns Hopkins physicians, the patient's records are sent to the Hopkins campus and placed into an electronic medical folder. The electronic folder is then sent to a hub at Johns Hopkins. The case coordinator reviews the medical record within two hours and then assigns it to a physician for review.

Once assigned, the physician gets five hours to accept or decline the case. Once accepted, the physician is required to complete the review process within 40 hours using a standard Web browser. Once reviewed, the physician produces a report using a dictation service that is incorporated into the patient's medical record. This report is automatically forwarded to the case coordinator who then retrieves the report and forwards it to the referring physician. The entire process is completed within 48 hours (24 hours for emergencies).

Table 2: A comparison of the four networks designed to reach the global poor

Attributes	UNCTAD GTPN	LINCOS	Alcatel Telemedicine	JHI Telemedicine
Services operating at	<ul style="list-style-type: none"> • Global level 	<ul style="list-style-type: none"> • Latin America (Costa Rica and Dominican Republic) 	<ul style="list-style-type: none"> • Senegal 	<ul style="list-style-type: none"> • Middle East, Far East, South America and Europe
Primary services	<ul style="list-style-type: none"> • International trade related, mainly for SMEs 	<ul style="list-style-type: none"> • Health, education, banking, and government service • Electronic trading • Technical support for SMEs • Telecom and Information center • Video conference and entertainment • Forest, soil and water analysis 	<ul style="list-style-type: none"> • Telemedicine 	<ul style="list-style-type: none"> • Telemedicine, clinical services, discovery research, and medical education
Alliances with	<ul style="list-style-type: none"> • Over 35 universities, government organizations, and private companies (like Sun, Informix, Netscape, Oracle and Cisco). 	<ul style="list-style-type: none"> • Over 10 academic institutions and at least 10 technical companies 	<ul style="list-style-type: none"> • National government 	<ul style="list-style-type: none"> • Lucent, DoxSys
Salient features/functioning of the network	<ul style="list-style-type: none"> • A database-driven, interactive Internet system with password-protected areas which uses state-of-the-art tools for uploading, downloading, automatically updating and searching for information • Clients access the network through "trade points" that compile, standardize, centralize and update information on a national or local basis • Information on each trade point is formatted into standardized categories and codes. Data on member enterprises are verified periodically. 	<ul style="list-style-type: none"> • Use recycled shipping containers to house computers, peripherals and generators • Solar power enabled • Multipurpose, multimedia mobile units • Can provide high Internet access • Can operate independently of traditional infrastructures • Satellite dish antennae link them to telecom networks or 'master stations' if necessary 	<ul style="list-style-type: none"> • Weight collectors (equipped with PCs and a balance) take the weight of children of families subscribed to the system. • The data is loaded via Internet into the database of a Pediatrician, who detects the 10% of those children who require further attention. • The pediatrician sends emails to the concerned weight collector who informs the families and invites for a medical visit. 	<ul style="list-style-type: none"> • A referring physician can request a second opinion from Johns Hopkins physicians. • The patient's records are sent to the Hopkins campus and placed into an electronic medical folder. • The electronic folder is then sent to a hub at Johns Hopkins. • The case coordinator reviews the medical record and assigns it to a physician for review. • The physician's review is automatically forwarded to the case coordinator who then forwards it to the referring physician.

A COMPARISON OF THE FOUR NETWORKS IN TERMS OF SEVERAL NETWORK ARCHITECTURE DIMENSIONS

The architecture of a network is likely to serve its purpose if it is simple, functionally adequate, affordable, immediately implementable, meets actual end client requirements, uses and develops local expertise, and uses locally available components if it is feasible to do so (Huston 1994). Additional characteristics of a good network design include obvious and beneficial capabilities: user friendly, use of “state of the practice” rather than “state of the art” technology, upgradeable, secure, predictable, robust, and reliable (Hancock 1990, pp. 68-69). It should be noted that the above characteristics are not mutually exclusive. Moreover, it is very unlikely for a given network architecture to satisfy all of the above criteria at once and the relative importance of a criterion is a function of several contextual factors.

The following is a comparison of the architectures of the four networks along some important dimensions.

Scalability

A scalable computer application or product continues to function well as it is changed in size or volume and also takes full advantage of the rescaled situation⁴. Three of the four networks – UNCTAD GTPN, Alcatel Telemedicine, and Johns Hopkins global access system—are mainly based on the Internet. The most important component of growth on the Internet is the demand for greater speed in the communications lines that make up the end-to-end Internet. Since the basic design of the Internet is remarkably scalable⁵, these three networks are likely to perform well on the scalability dimension. The performance, however, is likely to vary significantly from one country to another. Since 2-Channel ISDN is already available in many developing countries and some Asian cities are

⁴ See http://search390.techtarget.com/sDefinition/0.,sid10_gci212940.00.html

⁵ See http://www.nap.edu/html/coming_of_age/ch2.html

connected with the major U.S. cities with OC-48 Network (Dholakia and Kshetri 2001), scalability is not a major problem in these countries. Although available bandwidth at present is very low in African countries, several initiatives are being taken that have the potential to bring a bandwidth boom in the near future. For instance, Africa ONE Limited is undertaking a project to build, own and operate a 32,000-kilometer undersea fiber optic telecommunication cable system⁶, which will link African nations to each other and the rest of the world.

Although ALCATEL⁷ and Johns Hopkins Global Access System are relatively newer and are yet to be tested, GTPN is performing relatively well on scalability dimension. The United Nations Trade Point Development Center (UNTPDC) incubates a significant proportion of GTPN and a huge amount of data content⁸. GTPN architecture has been viewed as an appropriate model to assist least developed countries and those without the capability to establish Intranet or to use the Internet efficiently (Moreira 1997).

For LINCOS, Internet access is only one of the several services they provide. The units are installed in a container equipped with five computers. Additional LINCOS units are to be provided if more computers need to be added. The investment for each unit was as high as US\$ 85,000 in Dominican Republic and US\$ 50,000 in San Marcos de Terazu, Costa Rica (Proenza 2001). Thus, in terms of scalability dimension, LINCOS are not as good as the other three networks.

Robustness, reliability and predictability

A robust system continues to provide service even if some of its components or capabilities are lost to failure or it is subject to malicious attack. Reliability is a measure of whether a system provides the expected level of service. Reliability is typically

⁶ See http://www.africaone.com/english/about/technical_description.cfm

⁷ In fact, the long waiting list indicates that Alcatel is not performing well in scalability dimension.

achieved by combining component reliability, component redundancy, and a robust system design. While a robust system typically provides a reliable service, a reliable system need not be robust. The Internet has been quite resilient against failures so far and since most of the networks mainly rely on the Internet, they are reasonably robust and reliable. Although about 3% of the routers may be down at any moment, major disruptions are rarely observed since the protocols governing the switching of data packets have built in mechanism to tolerate significant amount of error (Barabási 2001).

Predictability, on the other hand, has to do with the user's expectations about the availability and quality of the services. A service can be predictably poor, but predictable services are often meant to be reliable whose occasional failures can be anticipated. Since the reliability of supporting infrastructure such as telephone lines varies widely across the world, so do user expectation and hence the predictability of a network.

In case of LINCOS, each unit is satellite operated and solar power enabled which can operate independently of traditional infrastructures. Thus, robustness, reliability and predictability of LINCOS are more dependent on the quality of the elements that constitute each unit such as solar power generator and computer. The satellite dish antennae link them to any telecom network or "master station" if necessary, which partly influence the robustness, reliability and predictability of LINCOS.

Affordability and adoptability

The Affordability and hence adoptability of a network is partly determined by its size.

Since GTPN is one of the highest volume services on the Internet today, per-unit cost is likely to be very low and hence the services are affordable and adoptable even for SMEs⁹.

⁸ In 1997, UNTPDC incubated 97% of the GTPN and over 12 GB of data content (Moreira 1997).

⁹More than 1.6 billion electronic trading opportunities (ETOs) were exchanged in the GTPN between 1993 and 2000 with 4-5 million hits per day (see <http://www2.asianconnect.com/untpdc/info/sunpress.html>)

A survey (UNCTAD 1997) found that a large majority of trade point customers (85.7 %) are SMEs and micro-enterprises.

Affordability and adoptability of a network is also a function of supporting infrastructures and services. Since telephone and Internet access in many African countries in general and Africa in particular are more expensive than in the US¹⁰, the services provided by the networks are also likely to be more expensive in these countries.

For LINCOS, although the initial cost of establishing each unit seems high, it should be noted that – unlike other networks – they are designed to work independently of traditional infrastructure. Since a large proportion of people in developing countries lack electricity and still higher proportion do not have telephone connection, a network that needs electricity and telephone for its operation is of no use to them. If the costs to provide electricity and telephone to the rural community are taken into account, LINCOS networks become relatively more affordable and adoptable.

Security

While robustness refers to a network's capability to provide service even if some of its components or capabilities are lost to failure or it is subject to malicious attack, security refers to the proneness to such attack. It should be noted that security is not equally important for the end users of all the networks discussed in this chapter. For instance, security tends to be less important than affordability for networks like ALCATEL and LINCOS. On the other hand, security might be crucial in the case of GTPN and Johns Hopkins Global Access System – networks that handle sensitive trade or medical records.

Password-restricted areas have been added to the Global Trade Point website which uses state-of-the-art tools for uploading, downloading, automatic updating, and searching for information. Only Trade Points and members of Trade Points can send

¹⁰For instance, a study conducted by the Organization for Economic Cooperation and Development found that an Internet account in Africa is over eight times more expensive than in the U.S.

electronic trading opportunities (ETOs) and see “hot” ETOs¹¹. Java is used to control access, certify trading partners, and handling payments. This Java-based secure infrastructure ensures integrity and confidentiality of all trade information.

Certification is the first step in secure trading. Prospective traders download the UNTPDC’s 100% Pure Java-based applet and use it to provide the UN with reference data about their banking, trading, and services. After the UN certifies it, the company uses the Java applet residing in their standard Internet browser to access the network. Likewise, the smart card project of the UNCTAD is facilitating the payment flow in international trade. As discussed in the previous section, the first and second level smart cards allow secure ETO, confidentiality, payment information integrity, authentication, etc.

The Johns Hopkins Global Access System has similarly taken sufficient measures to ensure the confidentiality of patient records by using the Lucent Managed Firewall.

Quality of services

Quality of service provided by a network should be evaluated in terms of customer expectation and the quality of alternative services. Since the networks discussed in this chapter are mainly designed to reach the global poor (or disadvantaged enterprises) who were previously unconnected by any other networks, it is difficult to judge the quality expected by the customers. The networks, however, are designed to provide as much benefits as possible to the poor people or disadvantaged enterprises, though not necessarily in philanthropic ways.

For the GTPN, interactivity and decentralization have been the keywords of the new network architecture. Users have access to the state-of-the-art tools for uploading, downloading, automatically updating and searching for information.

¹¹ ETOs that are less than eight days old.

The “quality” of a telemedicine network is partly determined by its ability to diagnose and provide the required treatment at the earliest. ALCATEL telemedicine performs well in this dimension, given the fact that there is only one pediatrician for every 10,000 children in St Luis, Senegal and a child is very unlikely to get alternative diagnosis and treatment. In the ALCATEL network, within less than five minutes, the pediatrician detects the 10% of those children showing odd curves that require further attention. Then she sends an email alert to the concerned weight collector who informs the family and invites them to come for a medical visit.

In the Johns Hopkins Global Access System, consulting process is completed in less than 48 hours. As the treatment progresses, follow-up consultation can be provided which also includes video-conferencing. To facilitate communication and information transmission efficiently and effectively, the entire patient process will be available to all involved staff at JHM as well as referring physicians in real time. A Customer Relationship Management (CRM) system based on Lucent’s CRM products and services is also used, including a comprehensive suite of software to assist in customer contact and information management and integration of quality assurance and billing software.

Other Dimensions

Use of local resources and expertise: ALCATEL and LINCOS are using local expertise and locally available components whereas JHI and GTPN have not given much attention to this dimension. For instance, ALCATEL’s proposed e-government network in Mali will be conducted with local partners strongly involved in Internet services such as ISPs, project incubators, software developers, IS designers and local INGOs. Likewise, LINCOS are using recycled shipping containers mainly because their local availability.

State-of-the-art vs. stat- of- the- practice: GTPN and Johns Hopkins Global access system are emphasizing state-of-the-art rather than state-of-the-practice technologies and

hence are likely to be of little use for the people really excluded digitally. ALCATEL and LINCOS fare better on this dimension.

Obvious and beneficial capabilities: In terms of this dimension, again ALCATEL and LINCOS perform better than the other two networks. ALCATEL telemedicine network has already saved the lives of many children in Senegal. Likewise, LINCOS are providing a variety of services that are most essential for the rural community. Johns Hopkins Global Access System, on the other hand, can serve only those people who already have access to physicians. Likewise, GTPN's main role lies in bundling the services previously provided by several parties.

FUTURE PROSPECTS FOR THE DIGITALLY EXCLUDED POPULATIONS

Rapidly dropping costs of ICTs, developments of user-friendly software and interfaces, and versatility of the Internet offer the potential for leapfrogging the development obstacles for civil society, governments, and entrepreneurs of developing countries. The digital divide can be minimized by targeting highly excluded communities, by designing appropriate combination of new and old technologies, and by setting projects in the context of a longer term plan to extend the benefits more widely.

The long waiting list and people's willingness to pay for the services provided by Alcatel Telemedicine Network in Senegal indicates that there is a huge untapped market in developing countries if the service is relevant to them and e-business companies need not provide their services in philanthropic ways. The extent to which e-business companies can exploit the opportunity provided by a market of size more than 4 billion people depends upon the architecture of their networks. Some of the important dimensions of network architecture that need special attention to serve developing market include affordability, state-of-the-practice rather than state-of-the-art technology, and utilization of locally available resources and expertise.

CONCLUSIONS

The electronic architectures discussed in this paper are designed to provide such services as telemedicine, international trade, e-government, environmental protection, and entertainment to the people in developing countries. Although, such networks are helping to bridge the digital divide between the developing and developed countries to some extent, most of them are not yet able to reach really excluded population in developing countries. The digital divide existing *within* developing countries needs equal attention and such a divide can only be bridged if the network architecture is appropriate for the most excluded populations.

Any network architecture that is not affordable within available resources will never be implemented. Hence, it must be reiterated that affordability should be the main focus of the network architecture aimed to reach the global poor. Of the four networks considered in this chapter, LINCOS offers reduced capital cost (when infrastructure expenditures are added), flexible architectures, and at the same time access to worldwide information systems and hence have the highest potential to reach effectively the most excluded population in developing countries.

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Figure 1: UNCTAD GTPN

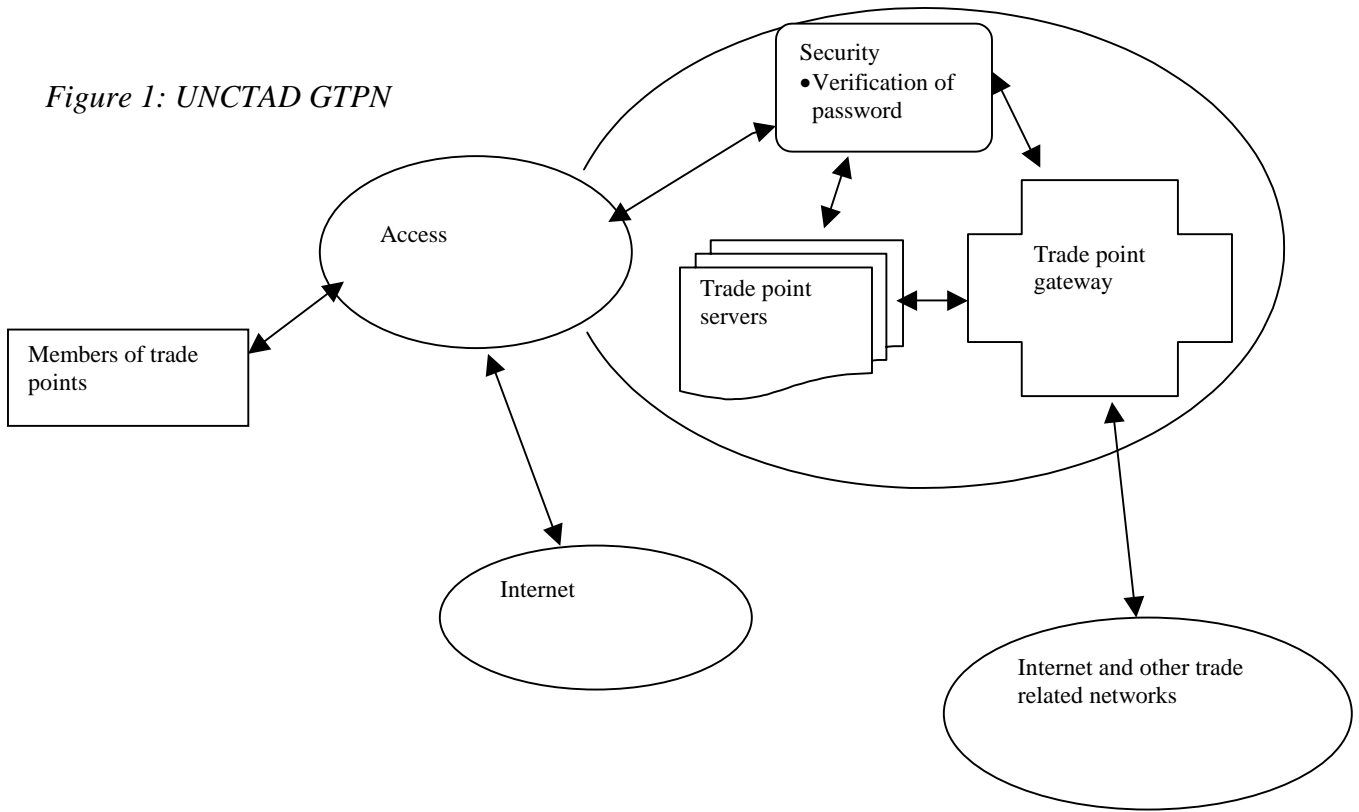


Figure 2: ALCATEL Telemedicine Network in St Luis, Senegal

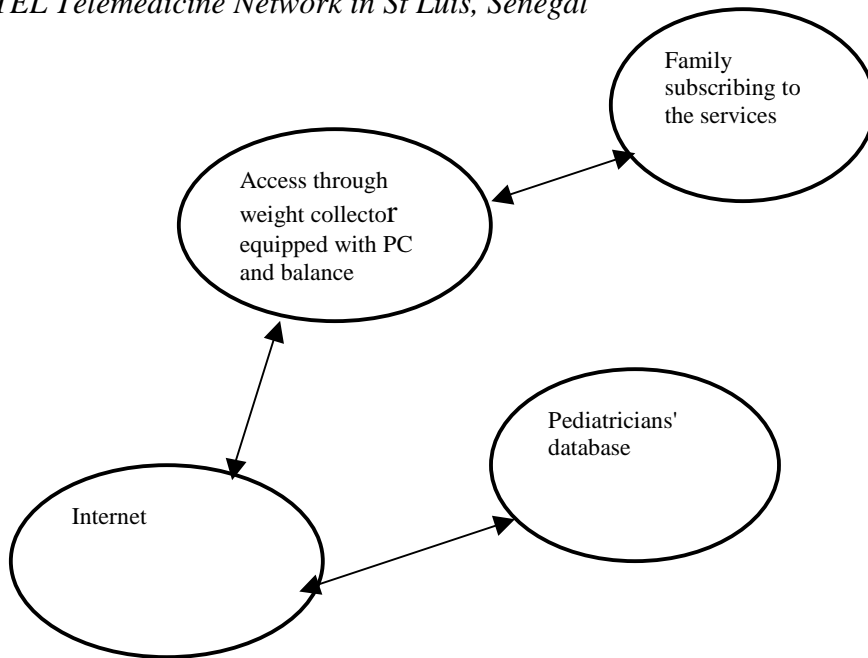


Figure 3: LINCOS Network

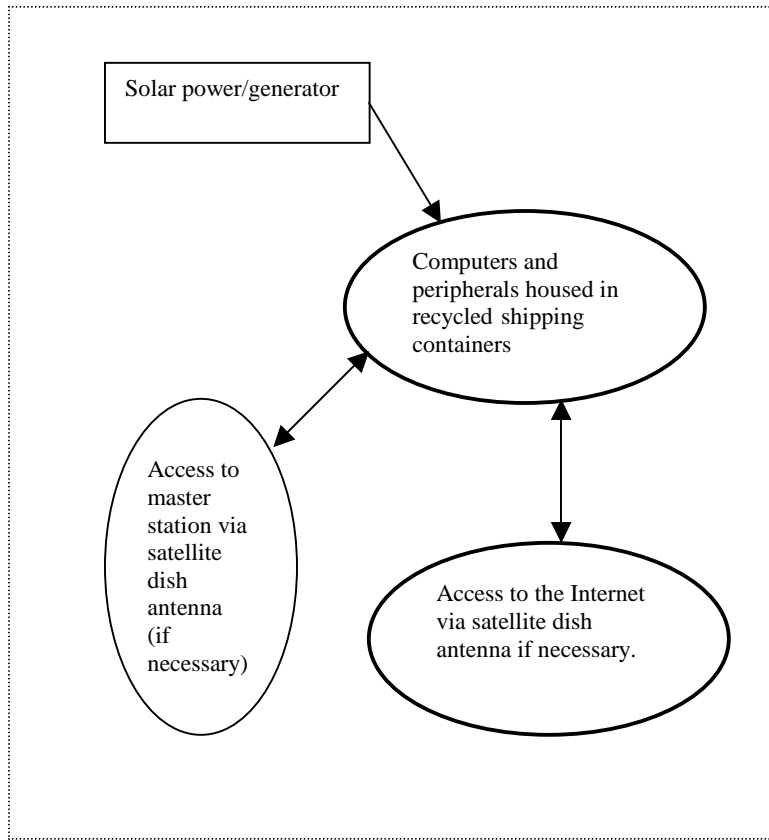


Figure 4: JHI telemedicine network

