IMPROVING IP CONNECTIVITY IN THE LEAST DEVELOPED COUNTRIES

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The views expressed in this paper are those of the author and do not necessarily reflect the opinions of ITU or its membership.

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Executive Summary

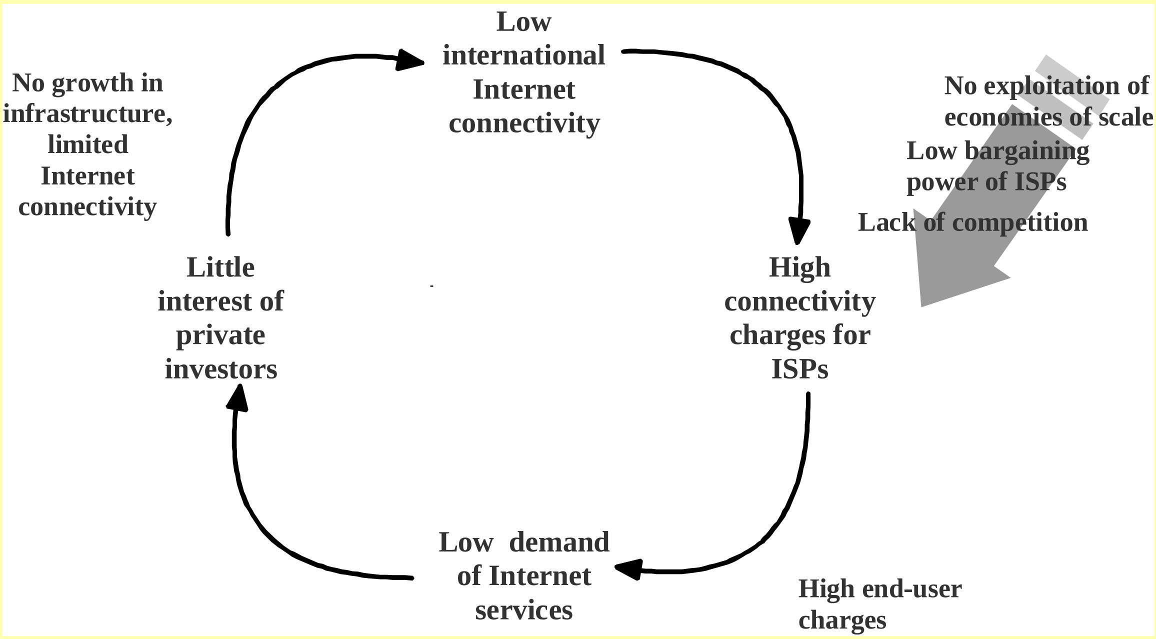
Since 2000, each of the 49 Least Developed Countries (LDCs), have had a direct connection to the global Internet. Nevertheless, the number of Internet users in those countries remains extremely modest: in 2000, there were only about 580 000 estimated Internet users in the LDCs, representing less than one per cent of the population and 0.16 per cent of global Internet users. The growth rate is also relatively low, falling from 234 per cent in 1999 to just 56 per cent in 2000, not much higher than the global growth rate, which has been assessed at 49 per cent.

This suggests the existence of certain bottlenecks that are affecting development, notably the lack of infrastructure, unfavorable regulatory environment, high pricing, and uncompetitive market structure. These elements together form what can be called a “vicious circle”, which cannot be broken without decisive intervention on one or more of the above-mentioned elements.

The questions that need to be answered before planning such an intervention are: which elements can be changed? What nature of intervention will be necessary to make a difference?

It may not be possible to apply actions directly on the demand for services or change the market structure, and issues of regulatory policy are a matter of national sovereignty, where good advice might not be followed. However the figure below suggests that all the elements are interconnected and that it could be sufficient to impact one of them in order to influence the evolution of the others.

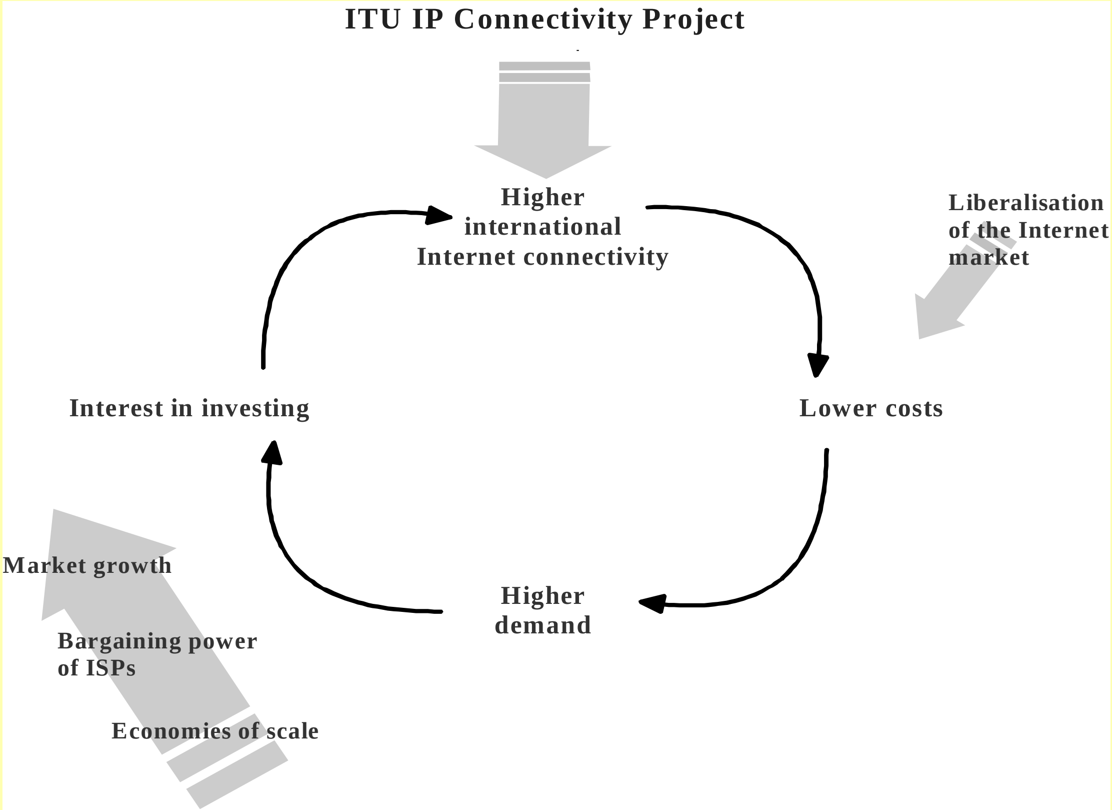
Figure 1: Internet vicious circle



It is unrealistic to expect significant benefits just from the liberalization of LDCs’ Internet market: although a process towards commercialization of the services is necessary, it is not sufficient to ensure that allowing competition telecommunication infrastructures will develop or that end-users will be able to afford Internet services. Some assistance will be necessary, at least for the initial phases of development, as has been the case in most industrialized countries, where telecommunications were still under public monopoly not so long ago and the Internet was subsidized by governments in its early years. Moreover, given that governments of LDCs are not able to invest large sums in telecommunications, an international intervention may be necessary.

Considering that Internet connectivity is a fundamental factor determining Internet access and use, it seems possible to promote Internet growth in the LDC market and overturn the current trend, increasing international Internet connectivity through an internationally funded project. The project could give momentum to other initiatives and could provide the necessary input to LDCs to enable them to sustain their growth independently within a few years.

Figure 2: Virtuous circle



1 Introduction

At the G8 summit in Okinawa in July 2000, the G8 Heads of State established the Digital Opportunity Task Force (DOT Force), in a cooperative effort to identify ways in which the digital revolution could benefit people worldwide, especially those in the most marginalized groups. The “digital divide” is threatening to exacerbate the existing social and economic inequalities between countries and communities and the potential cost of inaction is therefore greater than ever before.

The term “digital divide” may be defined as the gap between individuals, households, businesses and geographic areas at different socio-economic levels, with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities. There are therefore individuals and businesses that can enjoy the advantages of the Information Age, and others who are still waiting to see these benefits.

While the divide between developed and developing countries is narrowing, the Least Developed Countries (LDCs), often excluded from technological development, are failing to catch up. In most of these countries, especially remote islands or landlocked territories, national and international Internet connectivity is in short supply: optical fibres may not be available, satellite links are limited and expensive, and internal telecommunication infrastructures are typically concentrated in a few main cities and present severe shortcomings in the rural areas. These technical problems, together with unclear telecommunication policies and regulations and an internal market that is often closed to competition, lead to lack of investment and highly priced services, thereby hindering penetration of the Internet in the country. A critical barrier seems to be international IP (Internet Protocol) connectivity, which is fundamental to any consideration of the issue, as it precedes access to and use of the Internet.

The DOT Force[1] identified several action points which provide the basis for developing economies to achieve sustainable ICT development. In particular, action point No. 2 underlined the necessity to improve connectivity and increase ICT access. ITU is taking the lead on this particular objective of the DOT Force. Based upon this feasibility study, ITU may propose a project to provide Internet connectivity to LDCs in an efficient, cost-effective, and timely manner. [2] The present study will focus on a representative group of nine LDCs (Cambodia, Gambia, Lao PDR, Mali, Mozambique, Nepal, Rwanda, Samoa and Uganda), whose regulatory, social and economical situation/environment will be explored in order to seek to understand the factors that may be retarding the development of the Internet. In the light of the information gathered, the possibility of enhancing international Internet connectivity through the utilization of new, low-cost, technology, such as Very Small Aperture Terminals (VSATs), will be examined, together with the impact of such a system on the nation and those entities potentially interested in investing in the country.

VSAT systems, defined as low-cost earth stations equipped with small antennas and compact modem and signal processing units, are playing a growing role in the provision of telephony, distance education and data services in remote and rural areas. VSAT technology is considered a viable solution owing to falling equipment prices, a relatively short installation time, and in particular its capacity to create an instantaneous infrastructure in areas where terrestrial telecommunication infrastructures are either uneconomical or too difficult to install.

Increasing Internet connectivity is seen as the first step to bridging the digital divide. As Sir Donald Maitland stated in his report,[3] telecommunications play an important role in social and economic growth, and therefore should be part of every development programme.[4]

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1 See link <www.dotforce.org>.

2 Background materials and references can be found at the following website: www.itu.int/osg/spu/ni/ipdc.

3 The Missing Link, Report of the Independent Commission for World-Wide Telecommunications Development, (Geneva: ITU, 1984), [*hereinafter* The Missing Link].

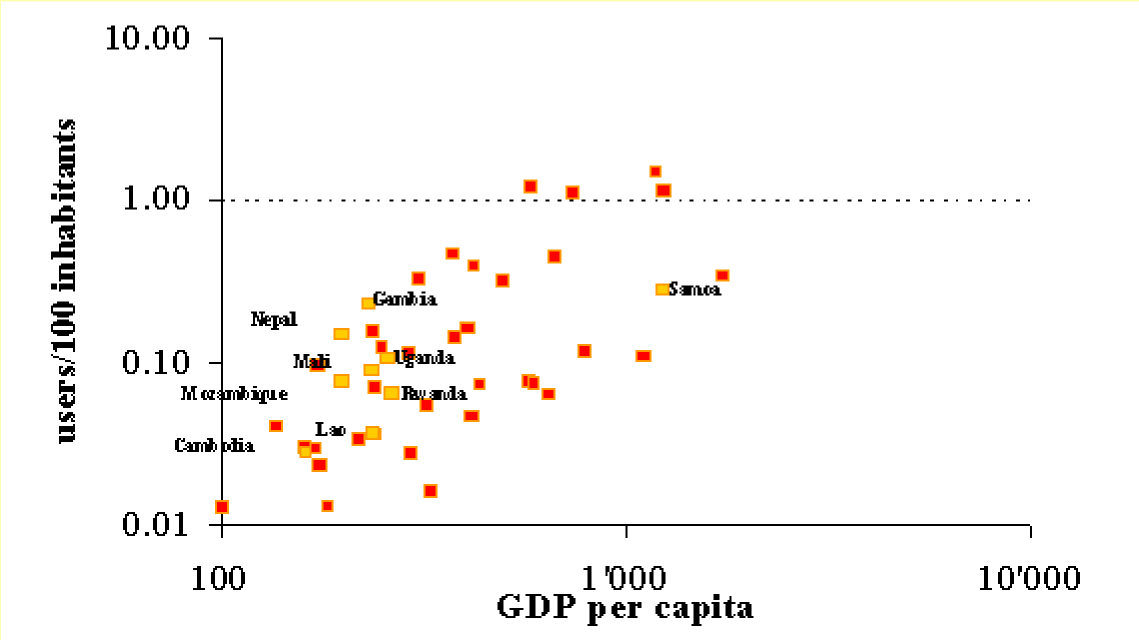
4 *Ibid*.

2 The Internet and the Digital Divide

2.1 Definition

In recent years, major advances in information and communication technologies (ICTs) combined with the rapid growth of global networks such as the Internet, have transformed business and markets, revolutionized learning and knowledge-sharing, generated global information flows, empowered citizens and communities in new ways that redefine governance, and created significant wealth and economic growth in many countries. This "digital revolution" has been made possible by the powerful combination of increases in power and versatility of technologies at significantly lower costs, with new applications of these tools and networks in all aspects of the economy and society.[5]

Figure 3: Estimated Internet users/GDP



Note: Each dot on the graph represents one economy
Source: ITU World Telecommunication Indicators Database.

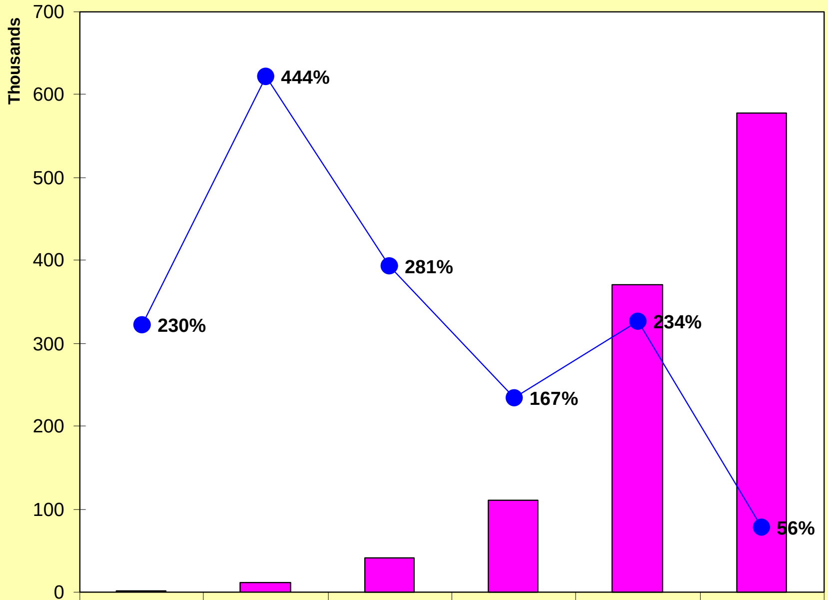
While in theory the global network is open to all, the vast majority of the world's population remains cut off from its economic benefits: 70 of the world's poor live in rural areas, where the access to ICTs is scarce; the international Internet bandwidth is not evenly distributed and a high percentage of the population is illiterate. This disproportion engenders a sense of isolation, impedes the flow of information and therefore creates a barrier between different sectors of populations. This barrier can today be defined as the "digital divide".[6]

The digital divide affects not only the capacity to communicate, but also all services provided on the basis of ICTs: countries that are unable to participate to this exchange of information will be left out of global trade, industrial development and world progress.

5 DOT Report, at http://www.dotforce.org/.

6 Understanding the Digital Divide, Paris: OECD, 2001 at 5. On-line at http://www1.oecd.org/dsti/sti/prod/Digital_divide.pdf

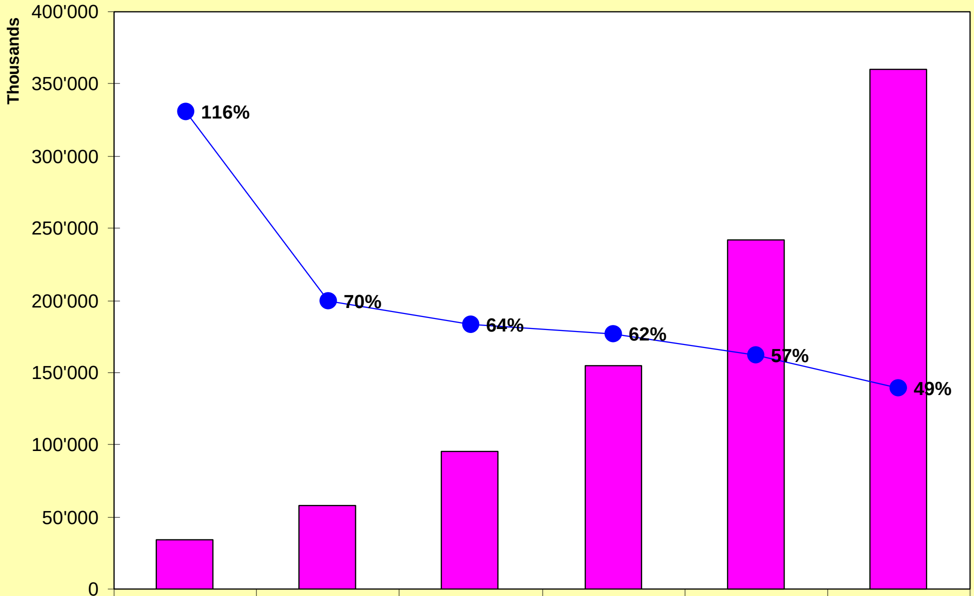
Figure 4: Estimated Internet users in LDCs and percentage growth



	1995	1996	1997	1998	1999	2000
Estimate Users LDCs (Total)	2'010	10'934	41'625	111'205	370'950	578'250
% Growth	230%	444%	281%	167%	234%	56%

Note: Internet users represent less than 1% of the LDCs population and the 0.16% of global Internet users.
Source: ITU World Telecommunication Indicators (2001).

Figure 5: Estimated Internet users (World) and percentage growth

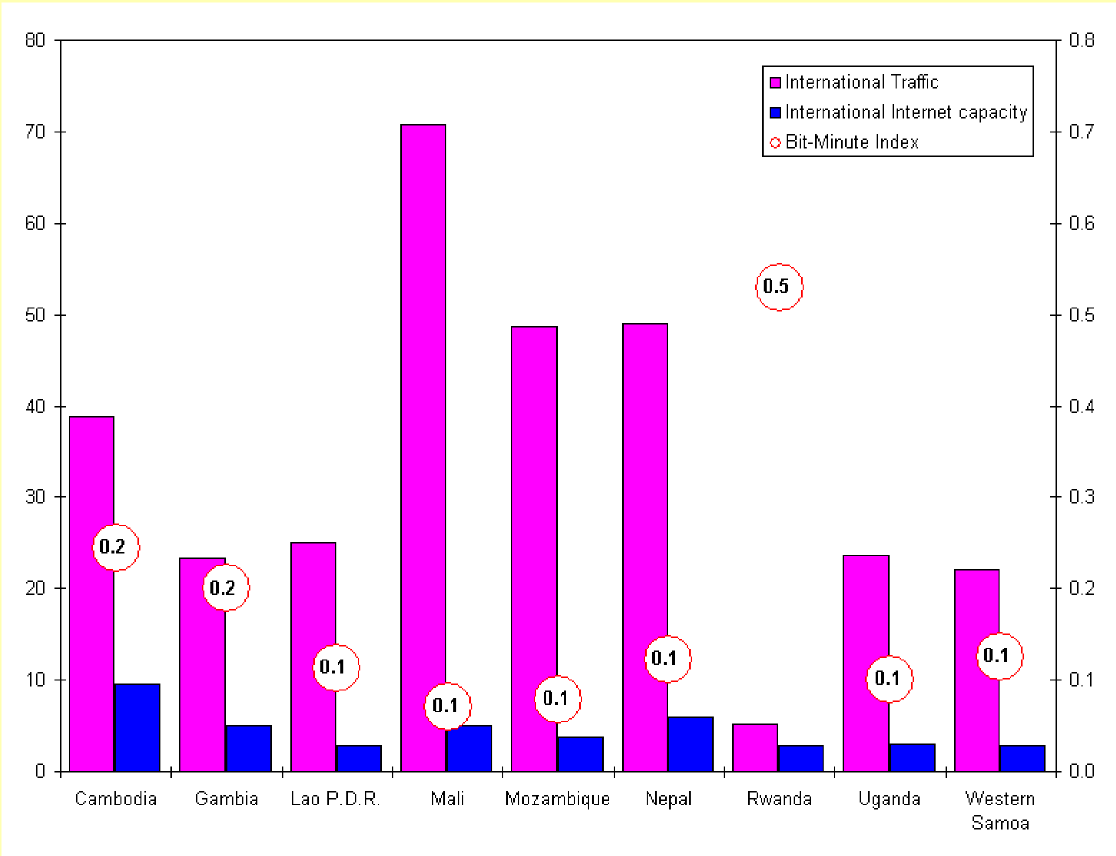


	1995	1996	1997	1998	1999	2000
Estimate Users World	34'283'397	58'205'652	95'476'710	154'521'409	242'259'527	360'374'519
% Growth	116%	70%	64%	62%	57%	49%

Source: ITU World Telecommunication Indicators (2001).

Digital technology is not a luxury, but the key that opens the door to the knowledge economy. The global effort of governments, businesses, academia and philanthropic organizations to bridge the digital divide is not about distributing sophisticated technology to a few selected countries, but about how to expand access to information and communication technologies to promote social and economical development, so that poorer countries will not be further marginalized. At the current Internet user growth rate, LDCs will not be able to catch up with most developed countries: the 56 per cent growth rate of 2000 is only a few points above average growth worldwide, and shows that, despite the pressing need for further expansion (see *Figure 6*), the Internet services market is stagnating (see *Figure 4-5*).

Figure 6: IP Connectivity



Note: The Bit-Minute Index is the relationship of Mbit/s of international IP bandwidth to millions of minutes of international traffic (incoming and outgoing). A Bit-Minute Index corresponding to 1 means that the demand for Internet capacity is satisfied, while any amount under 1 indicates the existence of latent demand for the Internet, as is the case in the countries represented above.

Source: *ITU World Telecommunication Indicators, 2001 (International traffic), International bandwidth: Ebrima Bandeh, Gambia Telecommunications Company Ltd., December 2001; Erik Stevance, Afribone Mali, by e-mail; MPT Samoa; David Main, Computer Service Ltd., Samoa, by e-mail; http://www3.wn.apc.org/; ITU Internet Case Studies http://www.itu.int/ITU-D/ict/cs/. Data valid for 2000-2001; Magda Ismail, Readiness for the Networked World.*

This situation is the result of the critical state of LDCs, and concrete action is needed to reconvert what could be a failure of the market into a new opportunity for local industry and populations.

2.2 Connectivity or Access?

Initiatives undertaken at a global or regional level often concentrate on "access" to, or "use" of, the Internet or ICTs in general. Indeed, the possibility of having a computer with a modem, the ability to use the Internet or even the awareness that the Internet can be crucial for health care, education and democratization of governments is important. A fundamental point, however, at the basis of all Internet use and application, is connectivity, the enhancement of which is one of the goals of both the UN ICT Task Force and DOT Force.[7]

Box 1: International Digital Divide Initiatives

Several international and regional organizations have undertaken new projects to bring the benefits of the information technology revolution to the developing world. These projects are often aimed at improving the access capacity of least developed countries, providing the population with equipment or creating multi-purpose telecentres and bringing them the knowledge necessary to use information resources. [See, for example, ITU Multipurpose Community Telecentre pilot projects in Benin, Mali, Mozambique, Tanzania, Uganda and elsewhere, sponsored by ITU, IDRC, UNESCO, UNDP, and by the national public and private entities involved or the UNDP Internet Initiative by Africa; the UNESCO Regional Informatics Network for Africa, providing training and computing equipment, and the USAID-Leland AfricaLink Project]

During the G8 Summit in Okinawa, the G8 Heads of State established the Digital Opportunity Task Force (DOT Force), in an effort to identify ways in which the digital revolution could benefit people worldwide, especially those in the most marginalized groups. The DOT Force has the objective of facilitating discussion with developing countries, international organizations, business organizations and other stakeholders, to promote international cooperation. Furthermore at the G8 Summit in Genoa, the Task Force identified various points of action, with the objectives of:

- fostering policy, regulatory and network readiness;
- improving connectivity, increasing access and lowering cost;
- human capacity building (training, education, e-literacy, e-awareness);
- promoting enterprise and entrepreneurship, encouraging foreign investment and public-private partnerships to foster local enterprise;
- establishing and supporting dedicated initiatives for the ICT inclusion of the Least Developed Countries, supporting local content and applications creation, and enhancing coordination of multilateral initiatives;

[http://www.dotforce.org/reports/DOT_Force_Report_V_5.0h.html]

Similar declarations of intent can be found in the United Nations ICT Task Force, set up by Secretary-General Kofi Annan to find new, creative and quick-acting means to spread the benefits of the digital revolution and avert the prospect of a two-tiered global information society. The Task Force priorities, defined by the ECOSOC 2000 Ministerial Declaration, include:

- raising policy-maker awareness and understanding on ICT development potential and assisting Member States in creation of national ICT strategies, policy frameworks, and regulatory environment;
- promoting universal and affordable access to ICT;
- building human resources and institutional capacity, including e-government and education and community-based technology training;
- building partnerships, networks and consortia for actions among relevant stakeholders, including the private sector, at global, regional and national levels and mobilizing new and additional resources for promoting and funding ICT-for-development programmes and projects;
- facilitating cooperation and coordination among the various programmes underway in UN agencies.

[http://www.un.org/esa/coordination/ecosoc/itforum/icttaskforce.htm]

The World Economic Forum Global Digital Divide Initiative and the Digital Opportunity Initiative should also be mentioned in this context.

The Global Digital Divide Initiative was launched at the WEF Annual Meeting 2000 held in Davos, Switzerland, during which a Task Force was established to develop public and private sector initiatives, to mobilize resources for digital divide-related projects and to raise awareness on the issue at the global and regional levels.

7 Final Report of the Digital Opportunity Task Force, Digital Opportunities for All: Meeting the Challenge, May 2001; ECOSOC Ministerial Declaration, Millennium Summit, September 2000; and UN ICT Task Force, First Meeting of the Task Force, Draft

The Task Force set up three steering committees to focus community interests and competencies on efforts relating to education, entrepreneurship and regulation policies. These committees conduct international surveys of digital divide-related projects, analyse and articulate best practices in policy capacity building, facilitate strategic partnerships and assist the sustainable development of ICT-related enterprises.

Furthermore the WEF presented a proposed Action Plan to the G8 Okinawa Summit, in which the Task Force suggested a series of concrete actions to be undertaken by governments, international organizations and the international business community, involving mostly cooperation and assistance to the growth of ICTs in less developed countries.

[http://www.weforum.org/digitaldivide.nsf/index]

The Digital Opportunity Initiative (DOI), a public-private partnership of Accenture, the Markle Foundation and the United Nations Development programme (UNDP), was launched at the G-8 Okinawa Summit in 2000, with the aim of identifying the roles that information and communication technologies (ICTs) can play in enhancing sustainable economic development and social equity. The DOI examined the impact of ICTs in developing countries and published a report laying out a strategic framework for action that developing countries can deploy to benefit from the networked economy and the information society. The report called for the assistance of the international community to help developing countries in integrating ICT into their development activities, and stressed, *inter alia*, the importance of infrastructure, which is seen as a development priority to be dealt with in synergy with other strategic areas for action, such as education, regulation, support for SMEs, and public-private cooperation.

[http://www.opt-init.org/; http://www.accenture.com/; http://www.markle.org/; http://www.undp.org/]

The above-mentioned task forces are not intended to be operational or executing bodies: they promote and support the initiatives undertaken by appropriate entities and facilitate connections among interested parties. However, for the further development of these projects there is a need to develop concrete plans. The next stage therefore implies going a step beyond mere declarations of intent, and asking for intervention in the field.

Connectivity is the possibility for a user on an electronic network to communicate with other networks.[8] If access to networks is non-existent, or too narrow, it will be impossible to communicate with other countries, regardless of the contents. The width of this “digital route” is the bandwidth, i.e. the maximum amount of information (bits/second) that can be transmitted along a channel (data transmission rate).[9]

The fast-paced growth of Internet connectivity in the world can create false expectations and erroneous notions: it seems that the entire world is connected today, and that each country has access to ICT services. It is true that today some 214 countries have Internet access and that the total bandwidth available is increasing every year. However, this bandwidth is not evenly distributed among countries. In Europe, users can benefit from almost 676 000 Mbit/s bandwidth, while the African countries have only 1 230 Mbit/s bandwidth, of which more than one third is concentrated in South Africa and another half in the more industrialized North African Countries (see *Figure 7*).[10] The rate of growth of IP connectivity in Africa between 1999-2001 was actually below that of the rest of the world, suggesting the digital divide may be widening.[11]

Plan of Action, 13-14 September 2001, p. 7 ff. See also Box 1.

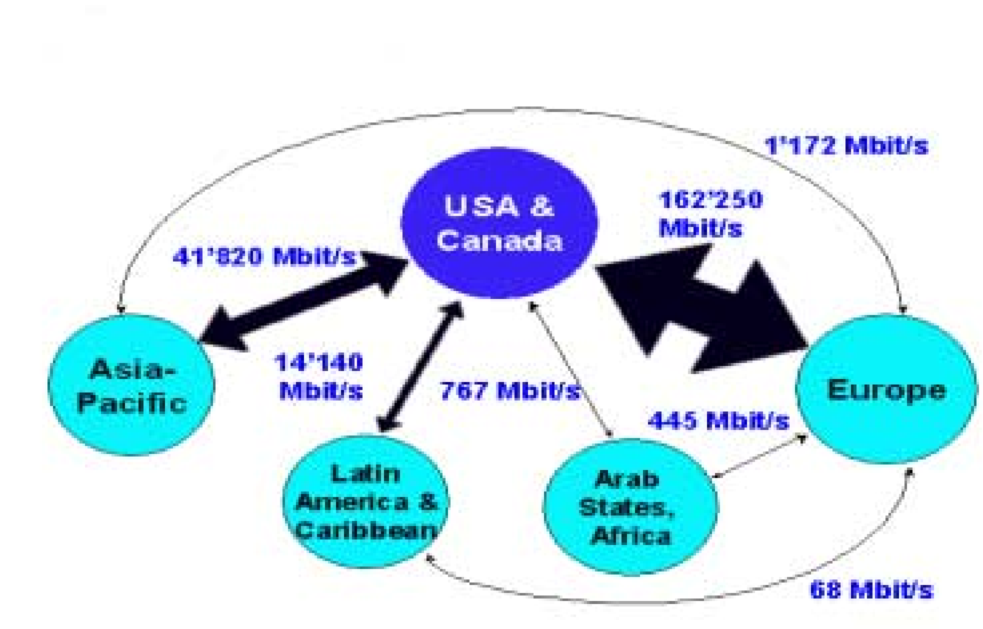
8 Newton’s Telecom Dictionary, 14th ed., 1998.

9 *Ibid.*

10 TeleGeography Inc., Global Backbone Database, September 2001, at 31 ff. See also link http://www.telegeography.com/.

11 ITU, African Telecommunication indicators 2001, at 13.

Figure 7: IP connectivity between regions, in Mbit/s



Note: Excludes IP connectivity within regions.
Source: *Packet Geography 2001, TeleGeography Inc., Global Backbone Database. Data valid for Sept. 2001.*

Even by providing increased access to the Internet for LDC populations, the problem of low connectivity cannot be solved. The scarcity of available bandwidth is related to an underlying lack of telecommunication infrastructure (both domestic and international) which causes prices to be higher than in more developed countries.

2.3 Who is falling behind? LDC Case Studies

2.3.1 Who are the LDCs?

Currently, 49 countries with a total population of 670 million, equivalent to approximately ten per cent of the world's population, are identified as "least developed countries" (LDCs). The particularity of these countries lies not only in the extreme poverty of their peoples, but also in the low level of their economic, institutional and human resources, often compounded by geophysical handicaps. They have great difficulty in developing their domestic economies and ensuring an adequate standard of living for their populations, and their economies are acutely vulnerable to external shocks or natural disasters. The group of LDCs thus constitutes the weakest segment of the international community and the economic and social development of these countries represents a major challenge for themselves as well as for their development partners.[12]

The LDC group includes some countries whose recent history has been very unsettled at the political level and whose networks have subsequently suffered. While the majority of them have initiated major reforms in the telecommunication sector, the paths followed, the speed adopted and the starting point for these reforms have differed considerably from one country to another. No one country can serve as a prototype, either in terms of the lessons to be learnt from the policies selected, or in terms of the representativeness of its

12 Least Developed Countries: Historical Background. http://www.un.org/events/ldc3/prepcom/history.htm. See also United Nations Conference on Trade and Development "Statistical Profiles of the Least Developed Countries", (Geneva: 2001); and INTUG Position Paper on Least Developed Countries, September 2001, at http://www.intug.net/views.ldc.html .

situation. It is, however, possible to find some common elements impairing the development of those countries and in particular retarding their entry into the information and communication society.

The cost involved in the development of telecommunication infrastructure and network, which are essential for the deployment of communication services, are too high for least developed countries. Furthermore, private investors are not always motivated to invest in such territories owing to the lack of market prospects and the high cost of building infrastructures. For these reasons, the international community should intervene in the field by providing funds to LDCs to develop a wider Internet network, enabling connection in cities as well as rural areas and providing enough bandwidth for efficient and effective use of the Internet.

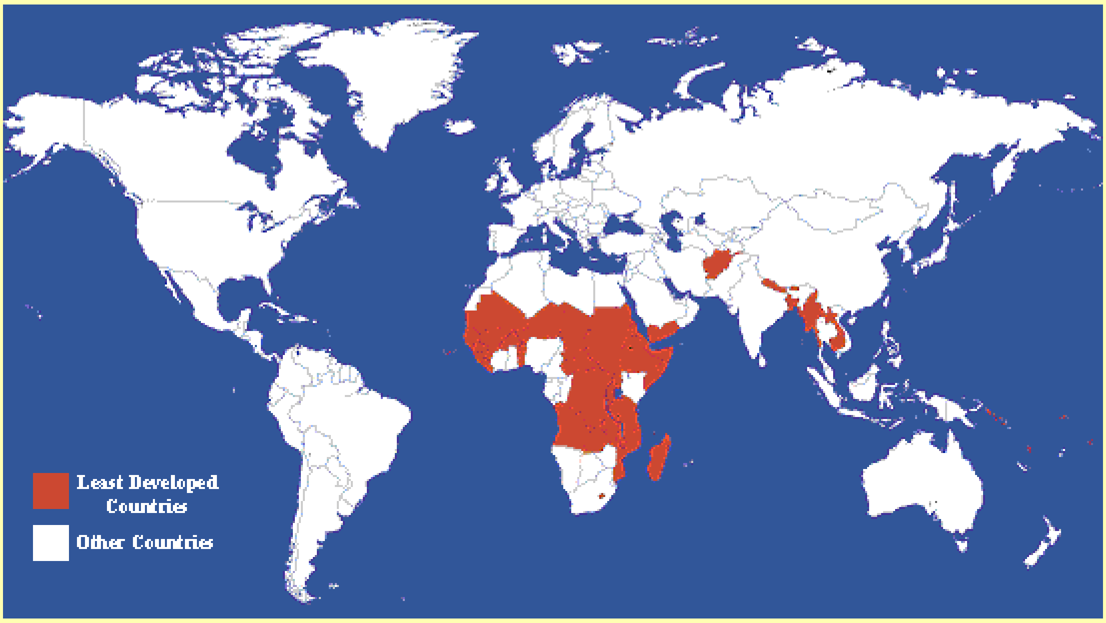
Box 2: The Least Developed Countries

In the mid-1960s, the UNCTAD secretariat embarked on basic research into what was termed the "typology" of developing countries. Following UNCTAD's work on classification and the recommendations of the Committee on Development Policy (CDP) which looked into the establishment of a list of least developed countries, the UN General Assembly approved a list of the LDCs in 1971. After considerable debate the CDP adopted the following criteria to identify LDCs: per capita gross domestic product (GDP) of USD 100 (in 1968 United States dollars) or less; share of manufacturing in total GDP of 10 per cent or less; adult literacy rate of 20 per cent or less.

Forty-nine countries are currently designated by the United Nations as "least developed countries" (LDCs). The list is reviewed every three years by the Economic and Social Council (ECOSOC), following three main criteria: low income, as measured by the gross domestic product (GDP) per capita; weak human resources, as measured by a composite index (Augmented Physical Quality of Life Index) based on indicators of life expectancy at birth, per capita calorie supply, combined primary and secondary school enrolment ratio, and adult literacy; a low level of economic diversification, as measured by the Economic Diversification Index (EDI), based on the share of manufacturing in GDP, the share of the labour force in industry, annual per capita commercial energy consumption, and UNCTAD's merchandise export concentration index. The criteria for determining the list of LDCs are under review: the CDP has recommended that the Economic Diversification Index be replaced by an Economic Vulnerability Index reflecting the main external shocks to which many low-income countries are subject, and incorporating the main structural elements of the countries' exposure to the shocks, including their smallness and lack of diversification.

The original LDCs list included the following countries: Afghanistan, Benin, Bhutan, Botswana, Burkina Faso, Burundi, Chad, Ethiopia, Guinea, Haiti, the Lao People's Democratic Republic, Lesotho, Malawi, Maldives, Mali, Nepal, Niger, Rwanda, Samoa, Somalia, Sudan, Tanzania, Uganda and the Yemen Arab Republic. Subsequently the following countries were added to the list: Bangladesh, Central African Republic, Democratic Yemen and The Gambia in 1975; Cape Verde and the Comoros in 1977; Guinea-Bissau in 1981; Djibouti, Equatorial Guinea, Sao Tome e Principe, Sierra Leone and Togo in 1982; Vanuatu in 1985; Kiribati, Mauritania and Tuvalu in 1986; Myanmar in 1987; Mozambique in 1988; Liberia in 1990; Cambodia, Madagascar, Solomon Islands, D.R. Congo and Zambia in 1991 and Eritrea and Angola in 1994. Botswana is the only country which graduated from the list of LDCs in 1994.

In its July 2000 review, in the light of recommendations by the CDP, ECOSOC declared the eligibility of Senegal for designation as an LDC (subject to the Government so desiring) and decided to postpone until 2001 its consideration of Maldives' graduation.



Sources: "Telecommunications Indicators for Least Developed Countries", first edition (Geneva: ITU, 1995), p. 1; "Samoa Case Study: The Changing International Telecommunications Environment" (Geneva: ITU, 1998), p. 2; UNCTAD "Statistical Profile of the Least Developed Countries" (UNCTAD/LDC/Misc.72), 2001; The Least Developed Countries 2000 Report, UNCTAD, and Third United Nations Conference on the Least Developed Countries (UNLDC III), link *http://www.unctad.org/conference/*.

2.3.2 Digital barriers

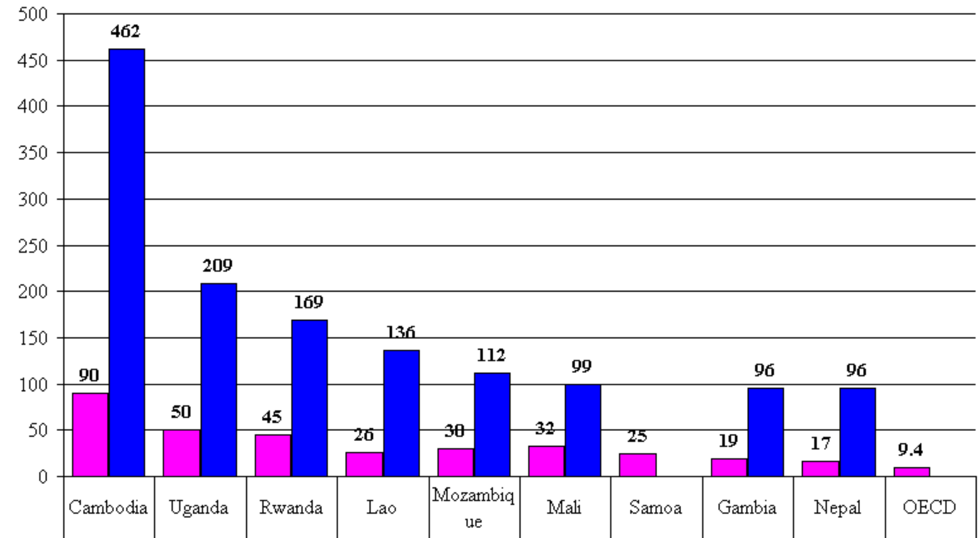
While most developing countries are experiencing fairly rapid expansion and modernization of their telecommunication networks, LDC teledensity has remained at less than two per cent of inhabitants and less than 1/100 in 31 of the LDCs. In some cases, the fixed-line network is old, damaged by wars or poorly maintained. Since the utility of the Internet depends to a great extent on the quality of the underlying telecommunication infrastructure, the poor quality of the network remains a fundamental impediment to rapid developments in this area.

The Internet has placed heavy demands on infrastructure with its requirement for high-quality, high-speed connections. Internet service providers (ISPs) need access to international communication lines in order to interconnect with Internet backbones, as well as needing local access for their customers. In most LDCs, telecommunication services are still under state monopoly, while in others only a limited level of competition is allowed. This policy is often the result of a protectionist approach towards communication: international services are seen as a source of revenue for the government as well as a means to cross-subsidize telecommunication services in less profitable areas. Regulations in force in LDCs and the costs of international Internet access for ISPs are two factors that greatly influence the ultimate price of Internet services to the end-user and the deployment of the system in LDCs.

International Internet access in LDCs has two main components: the International leased circuit between LDCs and the Internet backbone network, and global Internet connectivity for traffic exchange, which enables the connection between the leased circuit and the Internet backbone.[13]

[13] DFID Internet Cost Study, p.21.

Figure 8: Internet Access Cost in LDCs



	Cambodia	Uganda	Rwanda	Lao	Mozambique	Mali	Samoa	Gambia	Nepal	OECD
ISP Charges (month) USD	90	50	45	26	30	32	25	19	17	9.4
ISP Charges (month) PPP	462	209	169	136	112	99		96	96	

Note: *25h monthly access for Samoa, Mali and Cambodia; unlimited monthly access for the other countries.*
Sources: *ITU adapted from ISP data, ITU, Uganda Internet Case Study, DFID Internet Cost Study.*

Considering that international connectivity is usually a monopoly of the national public operator, ISPs often have no choice but purchase leased lines and global Internet connectivity from this operator. The cost of international connectivity is therefore effectively determined by the incumbent monopoly company that can establish particularly high tariffs for international leased lines.[14] For instance, the Ministry of Post and Telecommunication Cambodia (MPTC), which is the policy-maker, regulator and operator on the Cambodian Internet market, charges BigPond, one of its ISPs, USD 30 000/month for the satellite link (provided by Telstra Australia).[15]

If a country's regulatory framework permits, outside carriers can offer their services directly to the ISPs and end-users. In this case, ISPs could also connect directly with the international Internet backbone through VSATs. In a more competitive market, the price of international Internet connectivity is definitively lower, and the number of ISPs and users grow rapidly, allowing operators to benefit from a certain degree of economies of scale and the users to pay lower charges. In Nepal, prices dropped to the lowest level in the South Asia region following the liberalization of the VSAT market, while in Cambodia, where the government controls the international Internet link, ISP prices are among the highest in the region (see *Figure 8*).[16]

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14 International leased lines are usually purchased in half circuits. Although the distant end may be competitive, in practice price tends to follow those of the monopoly end. For Internet access, ISPs in LDCs would typically have to lease both half circuits, even though traffic may flow in both directions, in fact, countries wishing to connect to the United States must pay for the full cost of the circuit. In October 2000, a new ITU-T Recommendation (D.50) called on companies to negotiate more equitable ways of sharing the cost of international Internet circuits. See ITU Telecommunication indicators update, online at http://web/journal/200102/E/html/indicat.htm.

15 *ITU Internet Case Studies: Cambodia* (Geneva: ITU, 2001), online at : http://www.itu.int/ITU-D/ict/cs/. See also Cambodia Internet Country Overview [conference paper] online at http://www.itu.int/asean2001/documents/doc/Document-30.doc.

16 *ITU Internet Case Studies: Nepal* (Geneva: ITU, 2000), online: http://www.itu.int/ITU-D/ict/cs/.

The situation is similar for the African LDCs: countries that adopted innovative communication policies were often the first on the continent to obtain Internet access, lower prices and a wider user-base. Uganda provides a valuable example. Since the liberalization of the Ugandan telecommunication market in 1997, there has been a dramatic growth in Internet users with estimates increasing from less than 5 000 in 1996 to more than 40 000 in 2000.[17]

Nevertheless, the liberalization and privatization of the market alone probably would not be enough to have a positive impact on Internet growth. Even in highly industrialized countries, telecommunications have always been considered a public service and have been the object of particular attention and scrutiny by governments which protect, and often finance, operators. This is mainly due to the need for high investment in order to provide services, and to the crucial importance of economies of scale. Economies of scale in telecommunications can represent a deviation from the assumption that the market is perfectly competitive: the cost of services decreases as the scale of production increases. Furthermore, the higher the number of users, the lower the unit cost of providing the service, therefore a 'critical mass' of users needs to be reached before the market can stand alone. One example is the growth of the telecommunication market in Europe: public companies, protected by the monopoly, established the network and offered universal service. Once the market is well developed and a critical mass of users has been reached, the incumbent is privatized and new companies enter the market, offering a wider range of services at lower prices.

However, LDCs' potential may grow rapidly, as demand is particularly sensitive to price reductions and the geographical deployment of networks. Furthermore, as Metcalfe's Law states: "the usefulness, or utility, of a network equals the square of the number of users",[18] therefore the growth of the global market should increase communication opportunities.

In conclusion, the barriers to Internet connectivity can be summarized as follows:

- Telecommunication infrastructure (quality and availability);

- Regulatory environment;

- Cost structure for access to the network;

- Market issues (low demand, critical mass of users).

In this study on the development of a project to provide Internet connectivity to LDCs, all of the above factors will be taken into consideration. However, given the diversity of the different countries in the LDC group, only a limited number of nations will be the subject of a more in-depth analysis. The countries in question, which are presented in the next chapter, have been chosen as being representative of the wider group of LDCs.

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17 ITU Internet Case Studies: Uganda (Geneva: ITU, 2000), at http://www.itu.int/ITU-D/ict/cs/. About liberalization and privatization in Sub-Saharan Africa see also: United States Department of Commerce, International Trade Administration, Office of Telecommunications Technologies, "Status of Telecommunications Privatization and Sector Reform in Sub-Saharan Africa", February 1999.

18 At http://www.mgt.smsu.edu/.

3 Internet Connectivity

3.1 Introduction

A representative group of nine LDCs has been chosen for this study, comprising five African countries (Gambia, Mali, Mozambique, Rwanda and Uganda), three South Asian countries (Cambodia, Lao PDR and Nepal) and a South Pacific Island (Samoa).

As can be deduced from Table 3, the geopolitical characteristics of the chosen countries are quite varied. Populations may be small, as in Samoa and other Pacific Islands with only a few hundred thousand inhabitants; sparse, as in some African countries; or concentrated in the capital city, as is the case in Mozambique. The distribution of population is affected by political and geographical factors: in Nepal, due to the high mountains, there are only half a dozen cities where the population is over 10 000 (other than the capital), while civil unrest in Rwanda has provoked migration from certain areas.

Table 1: Basic indicators

Country	Population				GDP			
					Total 1999		Per capita 1999	
	Total 2000 (millions)	Density 2000	Main city 1999	% Urban Population 1999	US$ (millions)	PPP (millions)	US$	PPP
Cambodia	13.11	72	1'038'162	16%	2.14	11.00	160	821
Gambia	1.30	118	234'900	32%	*0.30*	1.49	230	1'141
Lao P.D.R.	5.43	23	425'000	23%	1.45	7.59	237	1'238
Mali	11.23	9	1'094'600	29%	*2.63*	8.03	234	715
Mozambique	19.68	25	2'991'500	39%	4.04	15.12	198	741
Nepal	23.04	157	780'000	12%	4.97	28.99	198	1'153
Rwanda	7.73	297	227'300	6%	1.90	7.15	262	983
Samoa	0.18	63	36'759	n.a.	0.21	n.a.	1'229	n.a.
Uganda	23.30	97	1'151'000	14%	*5.98*	24.96	257	1'071

Italic: CIA World Factbook or estimate.

Sources: *Population; Population of the Main City: STAR 2001*

GDP: Itu Telecommunication Indicators 2001, ITU Internet Report on IP Telephony, 2001.

Telecommunication infrastructure, however, does not always follow distribution of the population. In **Nepal**, teledensity reached one line for every 100 inhabitants in 1999, and the growth rate of the country in the last year is the highest of the region. However, the density of telephone lines is still low in rural areas, where most of the population lives, and the waiting time to obtain a fixed line is particularly long, estimated at more than six years. However, considerable efforts have been made by the Nepali Government, and today the country has all-digital lines and uses new technology and systems to surmount environmental difficulties: fibre cables are used to connect to India, a microwave link runs from east to west and VSATs complete the landscape, providing connectivity to some hard-to-reach areas, and constituting a satellite back-up to the terrestrial network.[19] The main international links are via fibre optical cable to India and INTELSAT.

Rural areas are not only the least served, but are also often the poorest. In **Cambodia**, which has the lowest GDP among South Asian countries, some 90 per cent of people living below the poverty line live in rural areas. The majority of Cambodia’s population is rural and the capital city, Phnom Penh, has about one million inhabitants. The poverty of the population, together with the unstable and often corrupt institutions and political environment, is one of the major factors hampering the development of telecommunication infrastructures in the country.

19 Internet Case Study: Nepal, p. 5.

Availability of other services is also particularly lacking in rural areas: in **Lao PDR**, for example, only 19 per cent of the rural population, which constitutes 80 per cent of the total, has access to electricity. Generally, the country is sparsely populated and the number of inhabitants small compared to neighbouring countries, which means an even smaller market. Lao PDR became increasingly reliant on Thailand for trade and investment during the 1990s, and a Thai Company, the Shinawatra Group, was awarded a 25-year contract to undertake all telecommunication projects in Lao PDR in 1996.[20] Laos' political situation is also a source of concern: the ongoing frictions between the Government, which still has a quite strong military implication, and its opponents have a destabilizing effect on the country.[21]

As regards the problem of small populations and remoteness, the most affected countries are undoubtedly the South Pacific Islands, which are further away from bigger (connected) countries. **Samoa** is far from under-sea cables. With only 180 000 inhabitants distributed across many islands, the limited potential and high cost deters most potential investment. In this case, satellite technology could be the solution: a local provider affirmed that the possibility of using VSAT technology would help them greatly and enable further development of service on the island.[22]

In addition to the problem of small population and territory, Gambia suffers from extreme poverty. The **Gambia** is not self-sufficient and, despite several development programmes, government commitment to economic improvement is weak.[23] Gambia, however, being a coastal region, is going to benefit from the fibre cable laid down around the African coast and should therefore be able to achieve cheaper connectivity (see *infra* paragraph 3.3).[24]

The same is unfortunately not true for **Mali** which, with its large territory, has a number of communication problems. The northern provinces are still barely connected to the rest of the country and the infrastructures (railroad, roads, telecommunication) are considered poor even by regional standards.[25]

Political instability is at the root of network under-development in other African countries, such as **Rwanda**, **Uganda** and **Mozambique**. These countries went through years of civil unrest which destroyed existing infrastructures and blocked most activities. Following the end of the civil war and the first democratic elections in 1994, Mozambique is an example of post-conflict development: dramatic social and economic progress marked the end of the 90s, poverty reduction and political stability have been strengthened by market reform and democratic development, the country has emerged as one of the most successful examples of national reconciliation, and in 1993, became the fourth country in Africa to be connected to the Internet.[26] Unfortunately, the floods that hit the country in 2000 caused severe damages to Mozambique economy, severely hitting infrastructures: the Government estimates that it will need about USD 300 million to rebuild more than 620 miles of roads that were completely swept away, and long stretches of railway track. Moreover numerous electricity and telephone lines and more than 600 schools are in need of repair.[27]

In Rwanda, the lack of fixed line network has been compensated for by the diffusion of cellular communications. RwandaCell has installed a GSM network in the country, almost completely covering its

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[20] Already in 1994 a joint venture was established between Laos government and the Shinawatra Group. In 1996 the Enterprise of Telecommunication Lao (ETL) merged with Shinawatra to form Lao Telecommunications Company Ltd (LaoTel), which was then granted a concession of 25 years with five-years exclusivity. See ITU, *Internet Case Study: Lao PDR* [unpublished], December 2001.

[21] Economist Intelligence Unit, Country profiles: Cambodia and Laos, 2001.

[22] David Main, Computer Service Ltd., Samoa, by e-mail (September 25, 2001)

[23] Economist Intelligence Unit, Country profiles: Senegal, The Gambia and Mauritania, 2001, p. 42 ff.

[24] See, for example, SAT-3 project, at http://www.safe-sat3.co.za or at http://www.alcatel.com/submarine/refs/cibles/atls/sat3.htm and *infra* note 66.

[25] Economist Intelligence Unit, Country profiles: Cote D'Ivoire and Mali, 2001, p. 50 ff.

[26] Economist Intelligence Unit, Country profiles: Mozambique, 2001 and Magda Ismail, *Readiness for the Networked World: Mozambique Assessment*, The Center for International Development, Harvard University [unpublished], 2001.

[27] The Guardian, "Floods Displace Thousands in Mozambique", 28 March 2000. See online: http://www.guardian.co.uk/Mozambique.

territory. Telecommunications enjoy a fairly modern infrastructure, consisting of a fully digital backbone with microwave links to main cities and of Wireless Local Loop capability.[28]

Unreliable infrastructures and limited networks are often the result of complex political, geophysical or economic circumstances. However, telecommunication services can help to alleviate the effect of these circumstances, bringing different parts of the country into contact, disseminating information and helping the population to participate in the global economy: telecommunications are influenced by, and in turn influence, social and economic development of the community.

3.2 Analysis of the current situation in LDCs: Status of telecommunication/Internet infrastructures

Even though the Internet seems to cover every single country in the world, there are still strong disparities between low and high income countries. In the year 2000, some 214 countries had some degree of Internet connectivity,[29] while Internet users rose to over 300 million worldwide.

Least Developed Countries represent a population of approximately 680 million inhabitants living in a total area of 22 000 000 km^2. In 2000, fixed lines[30] in service approached 3.6 million, representing an average teledensity of 0.54 lines per 100 inhabitants. World teledensity average is about 15 lines per 100 inhabitants, with western Europe and the United States in the lead with more than 50 per 100 inhabitants.[31]

The gap is even wider for new technologies compared to traditional technologies. The regional variation of Internet availability is striking: while accounting for nearly ten per cent of the world's population, LDCs account for only about 0.16 per cent of Internet users. There are more Internet users in New Zealand than in the 49 LDCs, and, despite having only 0.06 per cent as many people, Luxembourg has more international Internet bandwidth than the whole of Africa[32]. Estimated Internet users in LDCs only stand at 578 250, i.e. 0.09 per 100 inhabitants, far less than users in developing countries, which reach 2.8 per 100 inhabitants and, of course, of major economies, where Internet use can reach one quarter or more of the population.[33]

Low teledensity is the result of a limited national telephone network and explains the difficulties encountered in expanding Internet. In several countries, there is less than one telephone for every 200 inhabitants and existing infrastructures are often not completely reliable. It is worth noting that there is a strong presence of cellular mobile phones in a number of countries, in particular in Cambodia and Uganda, where the number of mobile subscribers exceeds the number of fixed lines. This positive development in the reduction of the telecommunication divide does not, however, help the development of Internet services, for access to these is provided principally through fixed lines: by delaying infrastructure growth, mobile phones can also delay Internet expansion. Development of 2.5 and 3G mobile may help to address this problem, however this remains a long way off in most LDCs.

There is also a digital divide within countries. This disparity is particularly evident between regions and income levels: the main cities of LDCs often benefit from Internet connectivity and access, while the penetration of Internet in rural areas is often negligible. This disparity is particularly a problem for landlocked territories, small islands and countries with large rural areas. Reducing this gap is a challenge, since those regions often lack basic infrastructures and are harder to wire. The fixed-line network, where it exists, is sparse and unreliable, and insufficient to meet the demands of the Internet. Having enough bandwidth to access the World Wide Web remains a critical problem for LDCs: the price of international

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28 Miller Esselaar & Ass. *A Country ICT survey for Rwanda*, Final Report, 2001.

29 http://www.itu.int/journal/200102/E/html/indicat.htm.

30 Main lines always refer to lines in fixed-line networks. When speaking of a total for fixed-line network lines and mobile network subscriptions we will use the term main accesses.

31 ITU World Telecommunication Indicators, 2001.

32 *Packet Geography 2001*, Telegeography Inc., p. 27 ff.

33 As in the United States ITU World Telecommunication Indicators.

connection is prohibitive (see *infra* paragraph 3.4) and the growing number of users is swamping existing connection capacity.[34]

Among the African countries analysed here, only two, Mozambique and Uganda, have more than one Point of Presence (PoP) in their territory, while the others have only one PoP located in the capital city. This means that users will have to bear the cost of a long distance call to connect to the Internet unless there is a special local call tariff for Internet access, as is the case in Mali. Mali's national telecommunication operator, SOTELMA, established a VSAT-based Internet hub in collaboration with four ISPs, which are now providing services in the entire country. The situation is similar in South Asian countries: in Cambodia the POPs are only located in Phnom Penh and Siem Reap, but the local call tariff for Internet access is extended to the whole territory. In Uganda, however, the PoPs are concentrated in Kampala or in the suburbs and there is not a nationwide dial prefix for Internet access, therefore rural users will incur long-distance call charges.

Table 2: Telecommunication infrastructure

Country	Fixed Telephone Lines				Cellular phone subscribers	
	1998	1999	2000	Teledensity (latest)	1999	2000
Cambodia	24'261	27'704	33'880	0.26	89'117	130'547
Gambia	25'609	29'216	n.a.	*2.30*	5'307	n.a.
Lao P.D.R.	28'472	35'107	40'876	0.75	12'078	12'681
Mali	26'758	n.a.	n.a.	*0.24*	n.a.	n.a.
Mozambique	75'354	78'072	85'714	0.44	12'243	21'969
Nepal	208'387	253'035	266'890	1.16	5'500	10'226
Rwanda	10'825	12'651	17'568	0.23	11'000	20'000
Samoa	8'480	8'500	n.a.	*4.87*	3'000	n.a.
Uganda	56'919	57'239	n.a.	*0.27*	56'358	126'913
LDCs Average				0.54		
Italic: 1999 data						
Source: *ITU World Telecommunication Indicators 2001*						

Moreover, owing to high international tariffs and lack of circuit capacity, it is still a major problem for most countries to obtain sufficient international bandwidth to send web pages over the Internet. Until a few years ago, very few developing countries had more than 64Kbit/s,[35] which means that an entire country had, on average, the same amount of bandwidth as a single user could enjoy in Europe or the United States.

In Uganda, where a process of liberalization was initiated with the Uganda Communications Act of 1997, all major ISPs have VSAT links to the international Internet backbone, with the result that Uganda's international Internet bandwidth has been growing exponentially over the last few years: from 384 Kbit/s in April 1998 to 4 Mbit/s up and 12 Mbit/s down in February 2002. A similar (although more limited) development took place in Mozambique, which has more than 2 Mbit/s of bandwidth: the University Eduardo Mondlane (UEM) provides Internet services with its own independent VSAT link to the US, and

34 See D. Akst and M. Jensen, "Africa Goes Online" (June 2, 2001) online at http://digitaldividenetwork.org/content/stories/index.cfm?key=158 and *Pacific Islands Knowledge Assessment*, Consultancy Report, at http://www.vita.org/technet/kajasum.html.

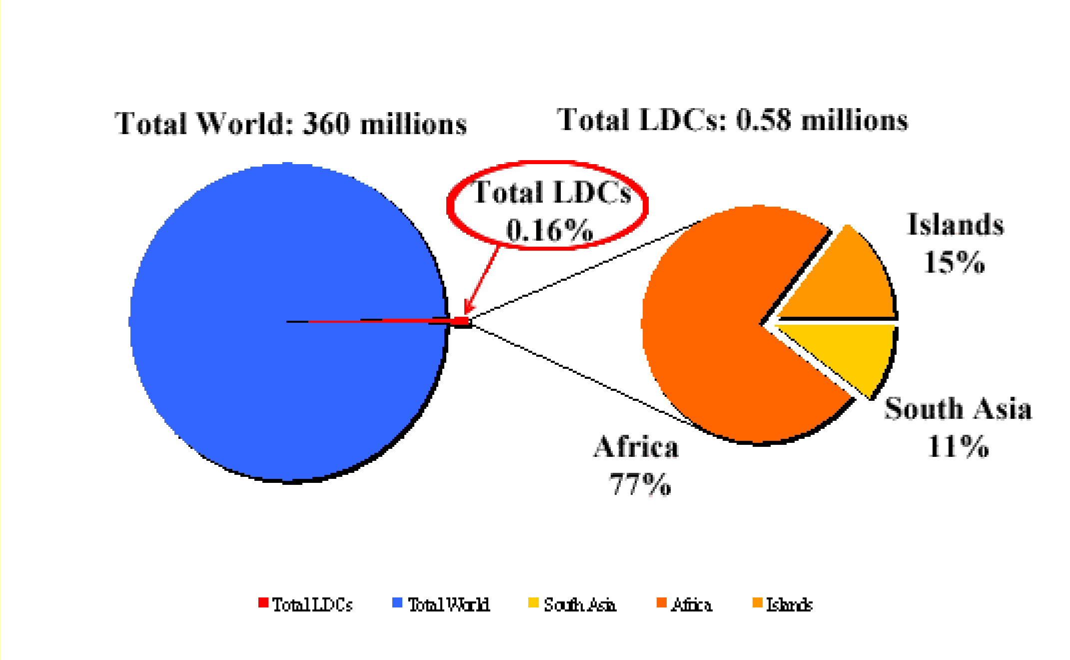
35 See link http://www3.sn.apc.org/africa/partial.html.

VSAT gateways are also operated by the national telecommunication operator TDM (Telecommunications de Mozambique).[36]

Gambia has been connected to the Internet for the first time thanks to the Internet Initiative for Africa, in which it participated in 1998. The development of the infrastructure was therefore financed by the UNDP for the 50% and by Gambia's government for the other half. Thanks to this contribution Gambia can today benefit from a developed terrestrial network and from a 1 Mbit/s satellite link to Teleglobe.

The participation of the country in the project ended in October 2001. Since then, Gambia has obtained further international IP connectivity via a terrestrial link to Senegal, which provides the country with an additional 4 Mbit/s capacity.

Figure 9: Estimated Internet users, 2000



Source: *ITU World Telecommunication Indicators Database.*

The situation is different in Lao PDR, where before 1998 only e-mail connectivity was available thanks to an IDRC project developed in collaboration with STEA (Science, Technology and Environment Agency). In 1998, Globenet established the first international Internet connection in Lao via a satellite link to Philippines, and in 1999 Lao Telecom launched a commercial Internet service using a 64 Kbit/s link to SingNet in Singapore. Lao Telecom IP capacity has since grown to 512 Kbit/s, bringing the total Lao international Internet capacity to 1.664 Mbit/s downlink and 1.244 Kbit/s uplink.[37]

International connections are provided to Samoa via an earth station in Apia, the capital, which operates a direct link to New Zealand for data transmission.[38] In Rwanda, the international Internet capacity is also very

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36 The Internet gateway at Telecomuniçoes de Mocambique (TDM) was up and running in June 1997 thanks to the Leland Initiative - a five years, $15 million USAID project to improve Internet connectivity in 20 African countries. TDM, in turn, would provide bandwidth to ISPs at cost-based tariffs. The Leland initiative allowed the establishment of five new ISPs in Mozambique: TDM (allowed to provide leased line access only), VirConn (Virtual Connection), Computer Solutions, Emil, Garp and Tropical Net. See Magda Ismail, *Readiness for the Networked World: Mozambique Assessment, supra* note 26, at 22.

37 Snith Xaphakdy, Depostel, Lao PDR, via e-mail, December 5, 2001 and ITU, *Internet Case Study: Lao PDR* [unpublished], December 2001.

38 Samoa Case Study, *infra* note 46.

limited: RwandaTel operates a 1 Mbit/s link and the other two institutions permitted to have direct satellite access, KIST (Kigali Institute of Science, Technology and Management) and NUR (National University of Rwanda), both have a 128 Kbit/s incoming and 256 Kbit/s outgoing international link via VSAT.[39]

Two-way satellite based Internet services using VSATs can also provide asymmetric links whenever the need for downlink bandwidth overtakes the need for uplink band. Thus, ISPs can limit the traffic on their expensive existing links to outgoing data, and use low-cost satellite dishes for receiving the high volume of incoming traffic.

The availability of adequate and reliable bandwidth on international links, together with the quality of the local network, is one of the primary obstacles to universal connectivity of and within the less developed countries.[40]

Table 3: International Internet bandwidth

Country	**Uplink**	**Downlink**	**International Internet Bandwidth Providers**	**Kbit/s per Internet User**
Cambodia	1.5 Mbit/s	1.5 Mbit/s	BigPond: satellite link with Telstra, international gateway in Cambodia owned by MPTC since 2000	1 Kbit/s downlink 0.5 Kbit/s uplink
	1 Mbit/s	2.5 Mbit/s	Camnet: 512 Kbit/s both ways connection with Singapore telecom; 2 Mbit/s down and 512 Kbit/s uplink connection through Thaicom	
	1 Mbit/s	2 Mbit/s	Telesurf (Mobitel)	
	3.5 Mbit/s	**6 Mbit/s**	Total bandwidth	
Lao PDR	512 Kbit/s	512 Kbit/s	Lao Telecom, via SingNet	0.3 Kbit/s downlink 0.2 Kbit/s uplink
	640 Kbit/s	220 Kbit/s	GlobeCom via Mabulhai Satellite	
	512 Kbit/s	512 Kbit/s	STEA	
	1.644 Mbit/s	**1.244 Mbit/s**	Total bandwidth	
Nepal	2 Mbit/s	2 Mbit/s	NTC	0.2 Kbit/s downlink 0.11 Kbit/s uplink
	2 Mbit/s	5 Mbit/s	Mercantile	
	1.5 Mbit/s	3 Mbit/s	Worldlink	
	5.5 Mbit/s	**10 Mbit/s**	Total bandwidth	
Gambia	1 Mbit/s	1 Mbit/s	GamTel via Teleglobe satellite link	1.28 Kbit/s
	2 Mbit/s + 2 Mbit/s	2 Mbit/s + 2 Mbit/s	GamTel via terrestrial cable with Senegal (2 Mbit/s both ways are dedicated to VoIP)	
	5 Mbit/s	**5 Mbit/s**	Total bandwidth	
Mali	1 Mbit/s	1 Mbit/s	Sotelma (two international satellite links: Teleglobe and Lyman Bros)	0.16 Kbit/s downlink 0.11 Kbit/s uplink
	1 Mbit/s	2 Mbit/s		
	2 Mbit/s	**3 Mbit/s**	Total Bandwidth	
Mozambique	128 Kbit/s	394 Kbit/s	UEM	0.08 Kbit/s downlink 0.06 Kbit/s uplink
	512 Kbit/s	512 Kbit/s	The 512 Mbit/s link is funded by the World Bank and uses its VSAT channel. It can be used only for educational purposes.	

39 Miller Esselaar & Ass. *A Country ICT survey for Rwanda*, Final Report, 2001. Because of the scarce bandwidth available, Internet use at university has to be limited to senior students.

40 UNDP and the communications revolution: Communications and Knowledge-Based Technologies For Sustainable Human Development, chap. II. Online at http://www.undp.org/comm/.

	512 Kbit/s	1 Mbit/s	TDM	
	192 Kbit/s	576 Kbit/s	Teledata	
	1.6 Mbit/s	**2.2 Mbit/s**	Total bandwidth	
Uganda	2 Mbit/s	1 Mbit/s	MTN Uganda (Teleglobe; BT Concert)	0.5 Kbit/s downlink 0.2 Kbit/s uplink
	2 Mbit/s		UTL Online (M-Link)	
	2 Mbit/s	2 Mbit/s	Infocom (Taide)	
	1 Mbit/s	512 Kbit/s	Sanyutel (UUNet)	
	1.5 Mbit/s		AfricaOnline (Verestar)	
	2 Mbit/s	512 Kbit/s	GlobalOnline	
	768 Kbit/s	256 Kbit/s	Spacenet International	
	576 Kbit/s		Wilken-AfSat	
	256 Kbit/s	38.4 Kbit/s DAMA	SchoolNet/Worldlinks	
	~ 12 Mbit/s	**~ 4 Mbit/s**	Total bandwidth	
Rwanda	1 Mbit/s	1 Mbit/s	RwandaTel (public operator)	0.3 Kbit/s downlink 0.26 Kbit/s uplink
	128 Kbit/s	256 Kbit/s	Kigali Institute of Science and Technology	
	128 Kbit/s	256 Kbit/s	National University of Rwanda at Butare (NUR)	
	1.256 Mbit/s	**1.5 Mbit/s**	Total bandwidth	
Samoa	**512 Kbit/s**	**2.256 Mbit/s**	Samoa Communication Ldt. (public operator) satellite link to Canada	4.6 Kbit/s downlink 1 Kbit/s uplink

Sources: Ebrima Bandeh, Gambia Telecommunications Company Ltd., December 2001; Erik Stevance, Afribone Mali, by e-mail; Antelope Consulting, *DFID Internet Cost Study*, at 43; MPT Samoa; D. Stern, Uganda, by e-mail; D. Main, Computer Service Ltd., Samoa, by e-mail; http://www3.wn.apc.org/; ITU Internet Case Studies http://www.itu.int/ITU-D/ict/cs/; Magda Ismail, *Readiness for the Networked World: Mozambique Assessment*, The Center for International Development, Harvard University [unpublished], 2001. Miller Esselaar & Ass. *A Country ICT survey for Rwanda*, Final Report, 2001. Data valid for 2000-2001;

3.3 Regulatory status in the LDCs

As seen above, the degree of connectivity of a given country depends partly on technical factors, but also depends on the regulatory environment: liberalization and privatization can transform the telecommunication market. In Nepal, for example, the decision of the Government to allow ISPs to have their own international connectivity using VSAT technology prompted an increase in the international Internet bandwidth available from 320 Kbit/s in May 1999 to over 1 Mbit/s by the end of 1999 and to 10 Mbit/s (downlink) in 2001.

Regulations have an impact on the level of international Internet connectivity, the diffusion of Internet services and, above all, the cost of these services to end-users.

As mentioned, several LDCs have restrictive and protectionist telecommunication regulations. Monopolies are fairly common, and while some countries allow the presence of more than one Internet service provider in the territory, only a few of them accept competition in international connectivity. There are in fact two aspects to consider: access to the end-user market and access to the international network. Depending on the liberalization of one or both of them, there will be different nuances of monopoly (or competition).[41] Even though absolute monopoly markets are dwindling, there are several examples of markets that are only partially competitive (e.g. ISP liberalized, but not international gateway access).

41 Challenges to the Network: Internet for Development (ITU: Geneva, 1999), p. 32.

An example of partial competition is provided by Mali, where the existence of private ISPs is allowed, but international Internet connection is provided only through the *Société des Télécommunications du Mali* (SOTELMA), which is both the regulator and the sole operator in the sector and reports to the *Ministère des Communications*. SOTELMA has a connection to the international Internet backbone via satellite and provides service (usually) only to service providers. Today there are five major ISPs in Mali, three of which have their own downlink (Simplex solution) while the others operate through a leased line link of 64Kbps with SOTELMA.[42] New ISPs are just starting up, however they may not have their own VSAT for Internet connectivity.[43] The existence of competition in the provision of Internet services would appear to help market growth: there is evidence that countries with greater numbers of ISPs also have a higher number of leased line connections (see *Figure 10*).

In Gambia, the telecommunication company, GAMTEL, has an unusual structure: it is owned by the Ministry of Finance and Economic Affairs (99 per cent) and by the Gambia National Insurance Company Ltd. (one per cent). GAMTEL was commercialized in 1984, and was established as a private limited company. The telecommunication market in Gambia is only partially open to competition: there are two commercial ISPs in Gambia, GamNet and QuantumNet, and a further two non-commercial ISPs, the Medical Research Council (MRC) and UNDP, however international Internet connectivity is provided only by GamTel through satellite and cable links (see Table 3), for which Gambia is paying respectively 10 000 USD and 17 000 USD/month.[44] GAMTEL is also planning to open the country to a controlled form of VoIP, while remaining the sole international bandwidth provider.

In Samoa, the Internet service has been fully privatized and there are currently three ISPs serving the market: lesamoa.net, samoa.ws and ipasifika.net.[45] Regulatory functions such as licensing and frequency management are located within the Ministry of Post & Communications (MPT), whereas broad policy objectives, such as corporatization and privatization initiatives, are dealt with at Cabinet level.[46] Even though it seems that the establishment of independent international connections is not prohibited,[47] all Samoa's ISPs are connected to international Internet backbones through the main telecommunication operator called Samoa Communications Limited (SCL).[48]

In some countries, the incumbent public operator also has regulatory and policy-making powers. In Cambodia the Ministry of Post and Telecommunications (MPTC)[49] is simultaneously policy-maker and regulator, and is involved in every telecommunication network in the country. Nevertheless, given the inability of MPTC to act as a commercial entity and the consequent lack of resources to extend the telecommunication network, MPTC has allowed private companies to invest in the sector in partnership with the public operator to improve infrastructures, as it is the case of Telstra, an Australian company which installed the first international gateway in Cambodia. Telstra and MPTC entered in a ten-year Business Cooperation Contract (BCC), which expired in October 2000, leaving the entire property of the station to MPTC. Programmes of bilateral assistance are also quite common in Cambodia: the country achieved full connectivity to the Internet via a link to Singapore thanks to financing by the Canadian International Development Research Centre (IDRC).

The first Internet provider, Camnet, was created by the MPTC. An additional licence was granted to Telstra, an Australian company, which established BigPond, the first private ISP in the country. Those two ISPs

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42 AISI National ICT Profiles, see link http://www2.sn.apc.org/africa.

43 As Afribone, which has 768Kbps downlink and 192Kbps full circuit with Sotelma. Erik Stevance, by e-mail (Sept. 25, 2001).

44 N'jie, Bakary "Internet Gateway for The Gambia", [conference paper] The African Internet and Telecom Summit, Banjul, The Gambia, June 5-9, 2000 and Ebrima Bandeh, Gambia Telecommunications Company Ltd., December 2001.

45 Online at http://www.lesamoa.net/, http://www.talofa.net and http://www.ipasifika.net/.

46 ITU, *The Changing International Telecommunications Environment: Samoa Case Study*, February 1998, p. 5; ITU T-Reg, Online Country Profiles: Western Samoa, http://www.itu.int.

47 See Samoa Post and Telecommunication Internet Act, n. 21/1997.

48 Ministry of Post and Telecommunication (MPT), Samoa, 06/11/2001, by e-mail.

49 http://www.mptc.gov.kh.

officially had exclusivity in the provision of Internet services until July 2001, although two other services have been operating since the beginning of 2001: Camintel, which does not seem to be a fully independent provider,[50] and Mobitel, which has its own international Internet gateway via satellite (Tele2).[51]

Whereas Cambodia avoided full monopoly, despite the concentration of powers in the same body, Rwanda did not. RwandaTel, the government-owned operator, dominates the sector, as the sole telecommunication operator and commercial Internet Service provider in the country. The only exceptions to this situation are the KIST and the NUR, two universities allowed by RwandaTel to provide non-commercial Internet services using an independent international Internet link via VSAT. The Government, as a part of the National Information and Communication Infrastructure (NICI) 5-years project, is planning to create an independent regulator for ICTs, to prepare the framework for privatization and liberalization of the communication market. There will be two main bodies, the National Information Technology Commission (NITC), responsible for advising the Government on all matters relating to development of ICT policies and strategies, and the Rwanda Information Technology Agency (RITA), which will coordinate and implement national policies under the supervision of the NITC.[52] It would also appear that the Government has recently been issuing licences to three new ISPs, but these have not yet been formally established.[53]

In Lao PDR, Government suspicions about the potential undermining influence of the Internet on national policy, together with the somewhat complex regulatory environment, are indeed two of the major factors retarding the development of the Internet.[54] There are currently four ISPs in the country: Globenet, Lao Telecom and Planet Online, which are commercial, and STEA, which is a governmental ISP and does not provide commercial services. Lao Telecom had a five-year exclusive reign over telecommunication services, which ended in October 2001. However, it is not clear if this exclusivity pertained to voice services only, opr also to Internet services. Competition among ISPs seems to be permitted, but it is not clear whether providers are allowed to have an international Internet connection. Globenet, a private company, has its own international gateway, licensed by the MoIC back in 1998, and several international organizations or corporations have been authorized to have their own VSAT link outside the country.[55] Voice over Internet is generally not allowed in Laos, even though it could be used by LaoTel or with its approval. It seems however, that several cybercafés are already offering the service illegally.

There are countries in which the process of liberalization and privatization is producing some results in terms of improved competition, increased Internet use and growing connectivity. In Mozambique, competition is allowed on both sides: access to international Internet backbones is provided to the several Mozambique's ISPs by TDM, the national operator, and by Teledata, a joint venture company between TDM and Marconi Portugal. There is also another provider which has its own independent link to the United States through VSAT: the University Eduardo Modlane (UEM), which operates the largest Internet service in the country.[56] In Mozambique, the telecommunication regulatory authority is the National Telecommunications Institute of Mozambique (INCM). Formerly a department within the Ministry of Transport and Communications, the INCM was created by a decree of the Council of Ministers in 1992. It is still controlled by the Ministry of Communications and is not yet independent. The Telecom Act of 1999 (Law 14/99) opens the market for other companies to provide value added services through a joint venture with TDM or independently. TDM maintains a monopoly over basic telephony services for a minimum of five years after it is privatized, while

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50 It could be simply a sub-renter of ISP services from Camnet. Internet Case Study: Cambodia, *supra* note 15.

51 *Ibid.*

52 *A Country ICT survey for Rwanda*, *supra* note 28.

53 See United States Department of State FY 2001 Country Commercial Guide: Rwanda The Country Commercial Guide for Rwanda (released by the Bureau of Economic and Business in July 2000 for Fiscal Year 2001) at 9-13. See link http://www.state.gov/www/about_state/business/com_guides/2001/africa/rwanda_ccg2001.pdf; and Country Profile 2001: Rwanda and Burundi at 17, see link http://www.eiu.com/schedule.

54 See ITU, *Internet Case Study: Lao PDR* [unpublished], December 2001.

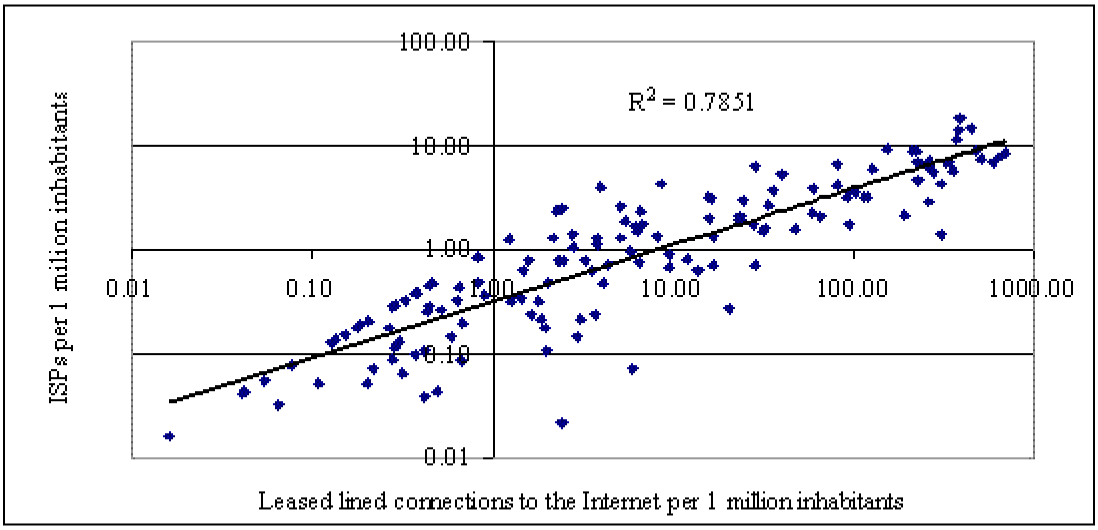
55 But following the Internet Decree, issued by the Prime Ministry in 1997, the body in charge of licensing should be the MPCTC, while national Internet policy and regulation should be under the responsibility of the Lao Internet committee, created by the same Decree.

56 See AISI National ICT Profiles, see link http://www2.sn.apc.org/africa.

value-added services and Internet service provision are open to the public. This allows the existence of several ISPs in the territory and the possibility for them to connect directly to international Internet backbones through VSATs.[57]

The use of VSAT requires an authorization that must be obtained through the INCM.[58] VSATs are to be used for data only and two-way links have to be specifically authorized. There are no licensing requirements for companies wishing to offer Internet service provision in the market. Providers need to simply register as a company at the Ministry of Commerce and register as an ISP with the INCM. However, there is no enforcement of the law if the procedures mentioned above are not followed.[59]

Figure 10: ISPs and Leased Line Internet connections in countries with more than 1 million inhabitants



Source: OECD

Since 1997, Uganda has embarked on a process of liberalization of the telecommunication sector.[60] An independent telecommunication regulator, the Uganda Communication Commission (UCC),[61] administers the licensing regime. There are two types of licence: “major licences”, issued directly by the Ministry, which are required for main facilities-based providers (for example in the field of satellite services), and “minor licences”, which cover all the other non facilities-based services and Internet Service Provisions. Today there are seven licensed ISPs in Uganda, and most of them have their own independent international Internet connectivity via VSATs.[62]

Nepal has been through a process of privatization and liberalization over the last ten years. A National Communication Policy was launched in 1992 and gave birth to the 1997 Communications Act. The Act established a regulatory body, the Nepal Telecommunications Authority (NTA), as an independent entity

57 See art. 13 ff. Law 22/92; AISI National ICT Profiles, see link http://www2.sn.apc.org/africa. See also SDNP in Mozambique: Taking a Risk: Developing Regional Connectivity, at http://sdnhq.undp.org/it4dev/stories/mozambique.html and see Magda Ismail, *Readiness for the Networked World: Mozambique Assessment*, *supra* note 26, at 15.

58 VirConn, USAID (United States Agency for International Development), the World Bank and CIUEM but have authorization to use VSAT’s.

59 Magda Ismail, *Readiness for the Networked World: Mozambique Assessment*, *supra* note 26, at 17.

60 *Uganda Communication Act*, August 1997.

61 Basic telecommunications services, in particular international service, have been awarded a period of protection from further competition. *The Internet in an African LDC: Internet Case Study: Uganda*, *supra* note 15, at 7.

62 *Ibid.* p. 18.

from the telecommunication policy maker, the Ministry of Information and Communications (MoIC) and from the national public operator, Nepal Telecommunications Corporation, which is partially overseen by the MoIC.[63] The Act liberalized the Internet service providers market and data transmission via VSAT, enabling a growth in Nepal's Internet connectivity. Today there are seven VSATs operating in Nepal and another five are planned.[64]

3.4 Market status

One of the main obstacles affecting Internet diffusion in LDCs is the price that is charged to end-users for access. It can be broken down into three components: hardware equipment, which includes the price of a PC and modem for interfacing with Internet, telephone service cost, which includes the price of renting a telephone line and the local (or sometimes long-distance) charges while connected to the Internet, and the access cost, i.e. the price charged by the ISPs for connection to the Internet.

The cost of Internet service provision for LDC users is particularly high. Personal computer costs are unaffordable to the great majority of LDC inhabitants, charges paid to telecommunication companies may account for about one half of the total end-user cost and Internet access fee charged by the ISPs is generally more expensive in LDCs than in developed countries (see *Figure 8*). The costs an ISP bears are divided between local costs (e.g., salaries, accommodation and equipment), and international costs, composed of the international leased circuit (by cable or satellite) and global connectivity. The international component may account for up to 80 per cent of total ISP costs in some LDCs (e.g. Cambodia and Mozambique),[65] while in other countries it normally hovers between 20 and 30 per cent.

There are many factors influencing the price of international Internet access. First, the differences in the technology employed to connect countries result in differences in the amount of available bandwidth in certain areas and its cost. There are currently three main communication technologies, which have varying capacity on different international routes. These are satellites, terrestrial fibres and submarine cables. Land-based optical fibres give access to a much larger pool of capacity than submarine cables[66] and, more generally, advances in fibre optics have outpaced increases in satellite transmission. Countries connected to the outside world via satellite links alone, therefore, will probably face considerable constraints, particularly in view of the fact that total satellite fleet capacity is expected to reach a meagre 200 Gbit/s in 2002, compared to the estimated 17 Tbit/s of submarine fibre cables and the even greater terrestrial network capabilities.[67]

However, the benefits of growth in capacity of optical fibre will not be equitably distributed. While some areas, including the majority of developed countries, will have bandwidth in excess, other territories continue to suffer from "bandwidth drought".[68] LDCs will probably not be considered as commercially attractive by cable companies, so it is unlikely that fibre cable will reach all these countries in the near future. This is

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63 The Chair of the board of NTC is the Secretary of MoIC. *The Internet from the Top of the World: Nepal Case Study* (Geneva: ITU, 2000), p. 7 ff. Link http://www.itu.int/ITU-D/ict/cs/.

64 *Ibid.*

65 See DFID, *Internet Costs Study, The costs of Internet access in developing countries: Overview report*, Antelope Consulting, August 2001, p. 22 [*hereinafter* DFID cost study] and Magda Ismail, *Readiness for the Networked World: Mozambique Assessment*.

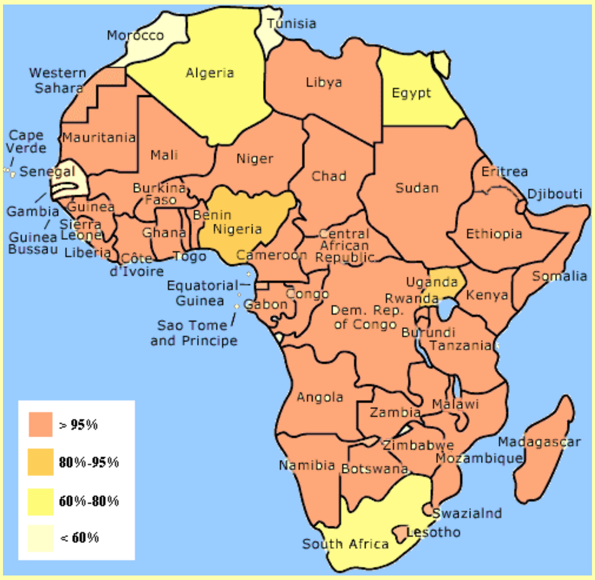
66 Ships laying cables can handle only a certain amount of equipment, placing constraints on the design of submarine systems. See T. Stronge & G. Finnie "Global Bandwidth: Feast or Famine?", Network Magazine, online at http://www.networkmagazine.com/article/NMG20001004S0004.

67 There are Pan-European networks that have the potential to carry 1Pbit/s of traffic, equivalent to two Mbit/s per person in Europe. See Telegeography, "How Satellites Prosper in the Fiber Optic Age", online at http://www.telegeography.com/Whatsnew/ib01_press2.html.

68 *Packet Geography 2001* (Telegeography Inc.: Washington, 2001), p. 31.

particularly due to the fact that, despite a drop in the cost per bit over recent years[69], construction costs are still high: a kilometre of transoceanic cable may cost up to USD 80 000,[70] a prohibitively high price for small (and isolated) markets. Cables have been proposed for the coastline of Africa, but only a few countries are currently connected and the future development of this network is still uncertain.[71] As a result, LDCs will have to rely on satellite connections (see *Figure 11*) which are more expensive and offer significantly lower economies of scale compared with cable networks (see *Figure 13*).[72]

Figure 11:African Satellite Dependency (satellite bandwidth as a share of total bandwidth to country)



Source: *Packet Geography 2001 (Telegeography Inc.: Washington, 2001). Senegal and Gambia: GamTel and M. Jensen, December 2001.*

Beside infrastructure shortcomings, the price of international capacity depends also on the level of liberalization and competition in the country.[73] In some cases, ISPs in LDCs may have the sole option of buying a bundled package of international circuit and Internet connectivity from the incumbent telecommunication operator, which often still holds a monopoly on the international gateway. The incumbent, usually a public company under government control, can therefore set the price, typically at a

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69 The cost per Mbit/s decreased thanks to the increase in the channel bit rates of the systems: from the 280 Mbit/s on TAT-8 to the 10 Gbit/s on FA-1. Additionally, modern technologies allowed the use of multiple wavelengths (using the Dense Wavelength Division Multiplexing, DWDM), versus a single wavelength used by previous systems. See *ibid.*

70 *Ibid.*

71 See, for example, Alcatel cable map at http://www.alcatel.com/submarine/refs/cibles/maps/ and SAT-3 cable map at http://www.alcatel.com/submarine/refs/cibles/atls/sat3.htm: SAT-3 is expected to link Portugal, Spain, Angola, Gabon, Cameroon, Nigeria, Benin, Ghana, Ivory Coast, Senegal, Canary Islands and South Africa. It is currently being implemented and should be operating starting from the last term of 2002. The AfricaOne project to build optical fibre ring around the entire African continent should be functioning in 2003. The deployment of both the above-mentioned systems has been delayed several times. See D. Akst and M. Jensen, "Africa Goes Online" *supra* note *34*, and *Packet Geography 2001* (Telegeography Inc.: Washington, 2001), at 31.

72 Following Telegeography *International Bandwidth 2001 Report*, almost half of the world's countries remain dependent on satellites for international connectivity. S. Beckert, analyst of the company, noted that satellite and fibres play complementary roles in international networks, "fibers offers network builders practically unlimited bandwidth, but limited geographic reach, while satellites can provide limited bandwidth, but essentially limitless reach." IP backbone connectivity is currently the fastest growing service segment for satellite operators.

73 Internet Toolkit for African Policy Makers [*hereinafter* Toolkit], at 36. Online http://www.infodev.org/projects/finafconf.htm.

high multiple of the actual cost.[74] This is the case in Cambodia, where the international component has a heavy influence on ISP total costs (~80 per cent), while in more liberalized countries the percentage is lower. For example, in Nepal it is on average 24 per cent, and in Uganda 30 per cent. This difference is then reflected in end-users' access costs, of which the ISP charges may constitute a high percentage (see *Figure 8*). The ISP charge constitute the 65% of end-user access cost in Cambodia, the 46% in Uganda and the 62% in Nepal, where, however, the local telephone charges are very low. End-users charges are influenced by international ISP costs for a percentage that varies depending on the country, exceeding the 30 per cent in Cambodia, where the cost of international Internet connectivity is the higher in the region.[75]

Internal regulation not only affects the price directly, but also indirectly. A clear and more favourable regulatory environment would actually attract foreign investment, which could help in improving the national Internet market.

Control over international connectivity and over prices, which is imposed on ISPs, can be seen as a consequence of the importance of international telecommunication for LDCs' economies. High prices of international calls and the settlement rates transform communication to a source of funding for the government, a "cash-cow", through which revenues are often used to subsidize local call services or other sectors of the economy.[76] The unwillingness of those countries to allow ISPs to directly connect with international gateways can thus be explained by the fear that businesses with leased lines may resell capacity (for instance, for Voice over IP (VoIP) traffic, as has taken place in Nepal) undercutting the incumbent's international call prices and diverting revenues, or that through the use of e-mail or voice over Internet services,[77] users could by-pass the national network.[78] However, irrespective of Internet introduction, a rebalancing of tariffs will take place in the near future, as there is a strong push towards a reduction of settlement rates in developing countries.[79]

While a clearer and liberalized regulatory environment helps the development of Internet infrastructure and lowering of costs, it does not provide a solution to connectivity problems. In Mozambique, for instance, where a certain degree of liberalization has been achieved, ISPs are allowed to connect directly to international Internet backbones through VSATs, but the cost of international connectivity still accounts for 88 per cent of network costs.[80]

As mentioned above, the same forces that have driven recent expansion of the market are however beginning to define its limits: regulatory incentives and competition have resulted in communication systems moving along with major markets, creating spotted coverage. The phenomenon is similar to the experience in the United States, where it took considerable government subsidies and investment of local financial resources to bring telecommunication services to many rural areas.[81] Given the limitation of a pure market approach, the intervention of an international organization, financed by multi-lateral funding agencies, to meet the needs of poorer and more isolated countries, may be necessary.

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74 Toolkit.

75 See DFID Internet Cost Study, see *supra* 13, at 19 ff.

76 See ITU WTPF 1998, The changing International Telecommunications Environment: Country Case Studies, p. 14 ff. Online http://www.itu.int/osg/spu/wtpf/wtpf98/cases/Final/overview2.pdf

77 This is forbidden in many countries. See, for instance, ITU Internet Reports 2001: IP Telephony.

78 Toolkit, introduction, *supra* note 73.

79 ITU, World Telecommunications Policy Forum, Geneva 1998. Online: http://www.itu.int/osg/spu/wtpf/wtpf98/index.html.

80 Toolkit, *supra* note 74. Several ISPs in Mozambique rent Internet access from TDM, which tariffs do not follow the cost-base principle (ISPs are charged tariffs above the real cost, thus subsidizing TDM). Furthermore, the connection price in several districts using a VSAT is still calculated on the basis of distance (as happens for leased lines), which does not matter on a satellite connection. As a result, ISPs in remote areas are probably overcharged. See and Magda Ismail, *Readiness for the Networked World: Mozambique Assessment*, *supra* note 26, at 30.

81 G. Schrffenberger, "The Case for Alternative Bandwidth Management to Help Bridge the Digital Divide", online at http://www.vita.org/leo/bandwidth.htm.

The high cost of connectivity becomes particularly evident when compared with the cost of connectivity in developed countries. In OECD countries, for example, the average price for a 64 Kbit/s leased circuit is around USD 360 a month, while 2 Mbit/s may cost only just USD 2078 a month.[82] In Nepal and Uganda, despite competition in the Internet market and the possibility for ISPs to use VSAT connections, the price for 1Mbps is respectively around USD 10 000 and USD 17 000[83] and prices are even higher in Cambodia, where liberalization is still too limited to produced results.[84] In Mali, ISPs pay about USD 1 500 a month for 64Kbps of bandwidth,[85] which is almost twice the amount paid by a Samoan ISP: USD 840 a month (see *Table 4*).[86]

Table 4: Cost of Internet bandwidth

Countries	Bandwidth cost to ISPs (month)	Proportionate cost per 64 Kbit/s unit
Cambodia	USD 20’000 (2 Mbit/s)	*USD 625*
Gambia	USD 10'000 (1 Mbit/s) USD 17’000 (4 Mbit/s – cable link)	*USD 625* *USD 265*
Mali	USD 1'500 (64 Kbit/s)	*USD 1’500*
Nepal	USD 10'000 (1 Mbit/s)	*USD 625*
Uganda	USD 17'000 (1 Mbit/s)	*USD 1’062*
Samoa	USD 840 (64 Kbit/s)	*USD 840*
OECD	USD 360 (64 Kbit/s) USD 2078 (2 Mbit/s)	*USD 360* *USD 65*

These data demonstrate the failure of the Internet market in LDCs. The relatively low bandwidth an ISP buys does not allow it to achieve economies of scale and does not give it enough bargaining power to obtain more attractive prices, consequently inhibiting any impetus towards growth.

New satellite-based systems to provide larger bandwidth at a lower price have already been implemented in Europe and North America, but they are not fully exploited in LDCs because of low expectations of demand and the uncertain nature of the regulatory environment, which limit competition in the Internet sector. In South Africa, some results have been achieved by pooling ISP resources through a tiered approach: a small number of larger international providers resell capacity to smaller operators.[87] The provision of low-cost Internet connectivity will give momentum to the latent demand, and to the various efforts that are being deployed for the liberalization and commercialization of the sector in many countries.[88]

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82 The elevate economies of scale are allowed by the utilisation of fibre cables, the improvement of which has made the marginal price for additional unit of bandwidth insignificant. DFID Internet Cost Study at 25.

83 DFID cost study, *supra 65*, at 19 and Uganda Internet Case Study, at 18, Table 2.6.

84 See *ibid*, and DFID Internet Cost Study, Appendix A.

85 Erik Stevance, Afribone, by e-mail (Sept. 25, 2001)

86 David Main, Computer Service Ltd., Samoa, by e-mail (September 25, 2001).

87 DFID Internet Case Study, at 20.

88 *Ibid*., see also African Regional Internet Initiative Consultation, AITEC Africa on behalf of the Department for International Development, 18 April 2001, at http://www.aitecafrica.com/about.html.

4 Improving Internet connectivity in LDCs

4.1 Internet via satellite: a solution to connectivity problems?

Given that LDCs are poorly served by fibre cables and that such connections are not likely to be possible in the near future, for the reasons explored in this study, satellite-based Internet connectivity seems to be the most appropriate solution to lack of bandwidth. The aim of this proposal is to explore ways to provide low-cost satellite-based international Internet connectivity to LDCs, most of which are located in sub-Saharan Africa, South Asia and the Pacific. Satellite technology will help to link those countries to the global Internet backbone located either in Europe or in the United States.

There are already several initiatives aimed at providing low-cost Internet connectivity to developing or least developed countries. However, these projects often concentrate only on a particular region, frequently in the African continent, or do not take into account the particular problems of LDCs, which are more extreme than those faced by larger low or lower-middle income countries.[89] Specifically, they do not address the problems of market failure identified in this report.

A short description of VSAT technology can be found in Box 3, while regulatory, economical and financial issues relating to the deployment of such a project are dealt with in the following paragraphs.

Box 3: What are VSATs?

VSATs or Very Small Aperture Terminals, are small earth stations, used for the reliable transmission of data, video, or voice via satellite. A VSAT network consists of a central hub,[90] many remote VSATs, and the satellite transponder space segment. VSAT equipment consists of two units: one placed outdoors (ODU) for a line-of-sight to the satellite, and one placed indoors (IDU) to interface with the user's communication device (e.g. data terminal equipment). The outdoor unit consists of a small antenna, mount, and electronics for signal reception and transmission. The indoor unit is a small desktop box that contains receiver and transmitter boards and an interface to the user's equipment. Both units are connected via cable. A VSAT network can be provided through a purchase or lease arrangement with fixed transmission costs regardless of distance or number of receiving sites. VSATs have become a solution in many developing countries for the provision of high-quality digital links to locations where telephone services are unavailable, unreliable or too expensive.[91]

The VSAT network can be conceived in Star topology (used for point-to-multipoint services), where each terminal transmits and receives only to the hub, or in Mesh topology (point-to-point), which allows terminals to communicate with each other directly. The Star configuration usually comprises a hub Earth station, with a larger aperture antenna, controlling a cluster of VSATs, with antennas typically in the range from 0.75 to 4 meters diameter.[92] This configuration constitutes the base for all the one-way and most of the two-way systems[93] and it is particularly suitable, *inter alia*, for e-mail and Internet services: the ground station hub will be set up in a location for transiting the traffic to the global Internet backbone, and will transmit and receive signals to/from the many remote VSATs[94] (See *Figure 13*).

89 For example, the PanAmSat project is aimed to Sub-Sahara, the African Regional Internet Initiatives regards just Africa, as the African Internet Initiative, the USAID Leland programme etc.

90 In the Star configuration.

91 J. Everett (ed.), *VSAT: Very Small Aperture Terminals*, (Peter Peregrinus Ltd: London, 1992); ITU, *VSAT systems and Earth* Stations: handbook on satellite communications (ITU: Geneva, 1994); See also ECOSOC, Economic Commission for Africa, Second Meeting on Development Information, E/ECA/DISD/CODI.2/18, Addis Ababa, 2001, p. 6. Online http://www.uneca.org/fr/eca_resources/Major_ECA_Websites/CODI2/doc18en.pdf.

92 See http://www.gilat.com.

93 In one-way systems the VSATs only receive data from the satellites, and are not able to transmit. This system is normally used for services such as TV broadcasting. Two-way VSATs are able to transmit and receive data, and are therefore suitable for telecommunications and Internet services. See J. Everett (ed.), *supra* note 91.

94 See *Intelsat VSAT Handbook* (Intelsat: Washington, 1998).

VSAT networks provide an efficient, cost-effective method for reliable distribution of data regardless of location: they can be installed in a few days and can connect desert areas, forests or mountain terrain. The cost of VSAT is not comparable to the cost of their terrestrial equivalent, as leased line tariffs are generally charged according to distance, while charges for a VSAT connections are the same whether the sites are 1 or 1 000 km apart (flat cost). Additionally a VSAT network can be managed independently from the terrestrial network, has low power requirements, and does not necessitate complex maintenance. For these reasons it is a technology that is particularly suitable for LDCs, where it can bypass terrestrial network gaps and can function - thanks to the use of solar cells - in areas not reached by electricity.[95]

4.1.1 VSAT and satellite-based Internet

The success of VSAT technology in recent years is due to the coincidence of several factors relating to technological improvements, market growth and telecommunication services liberalization. Consequently, VSATs have also been considered for the provision of IP-based services, which were initially excluded because of the transmission time delay.[96] Today it has been estimated 11 per cent of world's ISPs use satellite, either directly or indirectly, to establish IP links. This percentage is even higher among Latin American (66 per cent), African (47 per cent) and Middle Eastern (43 per cent) ISPs.[97] VSAT services are not used only where other telecommunication means are not available, but also as a complement in developed countries, such as the United States and Europe, where fibre cables are largely used for the point-to-point communication, but satellites are considered more cost-effective for point-to-multipoint data broadcasting (multicast).[98]

Figure 12: VSAT equipment.

Source: *www.gilat.com and http://www.mcs.harris.com/land-based/vsat_services.html*.

[95] A normal VSAT installation, comprising IDU and ODU, has a power consumption of around 25W. See http://www.gilat.com.

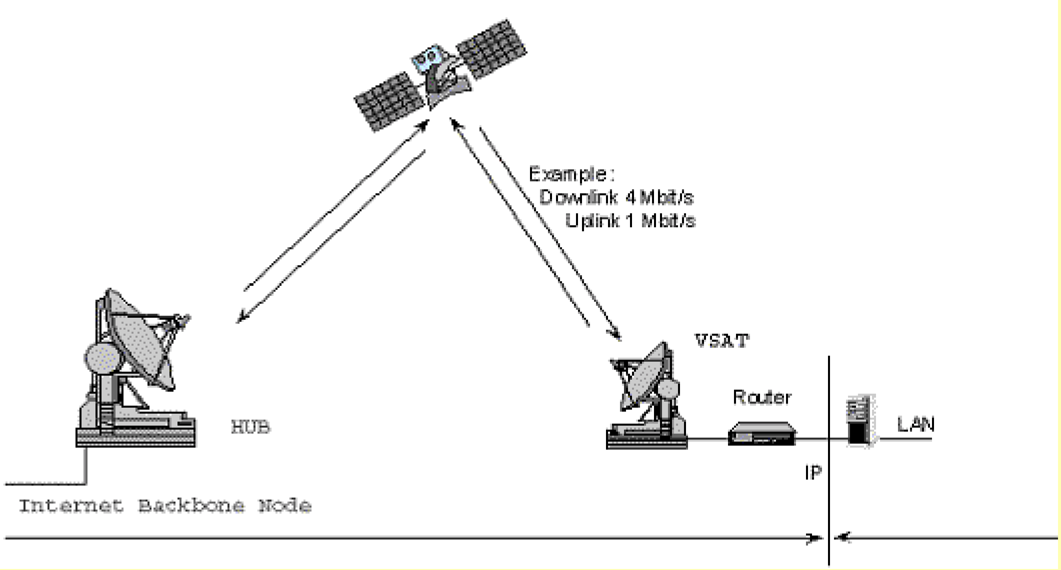
[96] Communications through geostationary satellites, located at about 36,000Km above the equator, have a propagation delay of ca. 0.25 second for one way (one up and one down link). This delay may cause problems to data transmission applications of VSATs, however, applications and communications protocols can be accommodated for handling it. Furthermore such delay is not uncommon even for terrestrial network, considering the storing and switching operations in the different nodes. See ITU, *VSAT systems and Earth Stations, supra* note 91.

[97] Via Satellite, "Global VSAT Review: The Truth About Myth", June 10, 2001.

[98] *Ibid.*

Additionally, VSAT are considered more suitable for the requirements of Internet, owing to the possibility of purchasing asymmetric connections that more closely resemble the bandwidth utilized or to buy only the downstream link. ISPs generally receive much more data than they send if the main use is for Web browsing: an ISP's average bandwidth usage (in developed countries) may be 1.544 Mbps upstream, for website requests or to send e-mails, but 10 Mbps downstream, for downloads, website returns etc.[99] Rather than purchase a full 10 Mbps of terrestrial fibre connectivity in both directions, the ISP can lease an asymmetric satellite connection.[100] An Internet provider operating in LDCs, for example, could buy a connection of about 512 Kbps uplink and 2 Mbps downlink or even use a terrestrial return channel, such as a telephone line. The possibility of asymmetric service permits Internet connections that are specifically engineered to match actual bandwidth requirements therefore allowing ISPs to operate more efficiently by leasing the exact amount of capacity required in each direction, thereby reducing overall circuit and hardware costs.

Figure 13: VSAT system.



Source: Gilat website, www.gilat.com

In most developed countries, satellite Internet is now a reality. Thanks to its flexibility, it is used by business and residential customers, offers a wide range of services and is the perfect complement where cables are not sufficient for new high-speed data services. VSATs have permitted European companies to bypass the bottleneck created by terrestrial connections prior to 1998, when the market was liberalized, and have enabled North Americans in rural areas to enjoy services comparable to those available in main cities. Gilat, one of the biggest manufacturers in the sector,[101] offers Internet connectivity at competitive prices through Starband. Basic VSAT equipment can cost around USD 700, with subscription charges starting from USD 70 a month.[102] Satellite service providers using PanAmSat satellites are providing Internet backbone via satellite

99 Traffic pattern depends on the main applications in use. Web brousing, media streaming and site download will typically have asymmetric use patterns, whereas e-mail, VoIP or peer-to-peer applications will tend towards symmetry.

100 Asymmetric access seems usually based on a ration of 1:2 or 1:4. See "Product Application note: Asymmetric Internet Over Satellite" at http://www.panamsat.com/serv or http://www.e-sax.com/.

101 See www.gilat.com. Gilat is providing VSAT to the United States PTO: they furnished the United States about 34 000 terminals.

102 http://www.starband.com/faq/starbandfacts.htm#cost.

to international ISPs, and recently started a low-cost VSAT-based Internet service specifically directed at sub-Saharan Africa.[103]

4.2 VSAT and low-cost connectivity in LDCs: a proposal.

Now that we have looked at the advantages of using VSAT technology in a project to improve Internet connectivity in LDCs, it needs to be established who the beneficiaries of the project are likely to be. As mentioned above, countries that can benefit more from having satellite connectivity are those where terrestrial or submarine cables will not be available in the near future, and that are experiencing a sort of Internet market failure caused by technical and economic bottlenecks. Satellite connectivity can help LDCs to improve their Quality of Service (QoS) by upgrading their capacity.

The project will be addressed at ISPs in particular, rather than to end-users, because ISPs are already providing Internet services and have some degree of connectivity and the necessary equipment and training to make a better use of bandwidth capacity. Additionally, aiming at ISPs rather than end-users will allow fewer larger antennas to be used, enabling improved transmission and obviating the need to set up a hub. This approach therefore simplifies management of the project, establishes the basis for further development and probably has more chances of success in the long term, i.e. once the phase of international assistance has ended.

The other option, namely to provide connectivity directly to end-users utilizing smaller VSATs, does indeed offer several advantages, as this can reach more isolated areas and bypass the local network, however it implies more substantial changes in Internet policies and regulation in the different countries, requires more complex maintenance and the presence of technically trained personnel, who are rarely available even in major cities. In addition, addressing end-users directly might have the unintended consequences of putting existing ISPs out of business. In any event, it will not be available for the population at large, which does not have the means to buy the necessary equipment.

The ISPs, with improved IP connectivity, will then provide lower cost services to cybercafés, schools, hospitals, public institutions and their other customers using terrestrial or wireless/microwave links. Private companies and other organizations will also benefit from the improved connectivity which they will be able to buy from the ISPs. Reducing the cost of IP connectivity should also allow more ISPs to enter the market, thereby increasing consumer choice and price competition.

Technically, to provide this type of service, the most cost-effective solution may be to provide an IP connection to the Internet backbone using a multicast channel downstream and a terrestrial or satellite upstream link. The down-link can be expanded from 2 Mbit/s to 100Mbit/s allowing a certain flexibility and the future upgrading of the system.

For the implementation of such a service it is necessary to analyse three points in order to assess the feasibility of the project:

– the cost of providing connectivity;

– the regulatory response of governments;

– the necessary financial incentives.

[103] See Africa Regional Internet Initiative (ARII), AITEC Africa, 2001.

Box 4: Satellite IP

Internet connection to the Internet backbone can be established via a DVB (Digital Video Broadcasting) satellite outbound channel with either satellite or terrestrial return. The DVB feed can be expanded from 2 Mbit/s up to 100 Mbit/s and uses low-cost IRD[104] at the customer site. The use of advanced frequency transmission schemes will maximise the use of the available bandwidth, while maintaining an acceptable quality of service.[105]

The return channel could be via the existing ISP's Internet connection or, if this channel is too limited, a S-CDMA (Synchronous Code Division Multiple Access) satellite return channel could be established. This technique, which is particularly suitable for a reliable and flexible broadband return channel implementation, is a viable option. It offers spectral efficiency, robustness to narrowband and impulse noise distortion, and is well suited for interactive multimedia services. Furthermore, it allows the use of smaller dishes, and eliminates the delays of the TDMA system and the throughput problems in slotted DAMA systems.

Other systems that could be used are: SCPS (Single Channel Per Carrier), which is utilized in analogue satellites and supports one transmission per frequency channel; DAMA (Demand Assigned Multiple Access), which shares a channel's capacity by assigning capacity on demand to an idle channel or an unused time slot; TDMA (Time Division Multiple Access), which permits many simultaneous conversations assigning each users a specific timeslots for transmission; and CDMA (Code Division Multiple Access), which uses spread spectrum in conjunction with individual correlating codes and allows simultaneous data transmission through the same frequency band.

Sources: *J. Enssle, H. Halbauer, J. Otterbach, G. Schwoerer, "S-CDMA flexible broadband return channel concept for fixed access networks" at http://www.hhi.de/komnet/338.pdf, and P. Howard, Tentronics Corporation, by e-mail (November 6, 2001).*

The necessary equipment is now affordable in developed countries, but may not be so in countries with a low GDP per capita. Indeed, it is still too expensive for small ISPs in LDCs to bear the initial cost of the service. Moreover, it is difficult to determine whether similar low-cost services will be soon available for *all* LDCs, particularly because, in absence of a coordinated approach, it will be more complex to overcome difficulties relating to import controls, monopoly, fragmented market and strict licensing regimes. To increase connectivity, it is therefore necessary to develop a comprehensive approach to the three points illustrated above, an approach that only a *super partes* international organization can have.

4.2.1 Cost of VSAT-based connectivity

The cost of the provision of international Internet connectivity depends on a set of elements that are necessary for the setting up and functioning of the service. Those elements may be divided into two main categories: space segment and earth segment (comprising international Internet backbone connection).

The earth segment equipment list for an ISP, where a DVB connection will be used, would include:

- IRD (with CDMA return channel modulator);
- 2.4 or 3.8 metres off-set antenna plus a band amplifier;
- Earth station charges;
- Backbone connection.

The space segment cost is given by the price of leasing transponder capacity. This factor varies depending on the amount of bandwidth required: a 64 Kbit/s full duplex circuit may cost around USD 625 a month.[106]

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104 Integrated Receiver Decoder: a receiver for satellite signals that also decodes encrypted or scrambled signals. Especially used in the cable TV business. See Newton Telecom Dictionary.

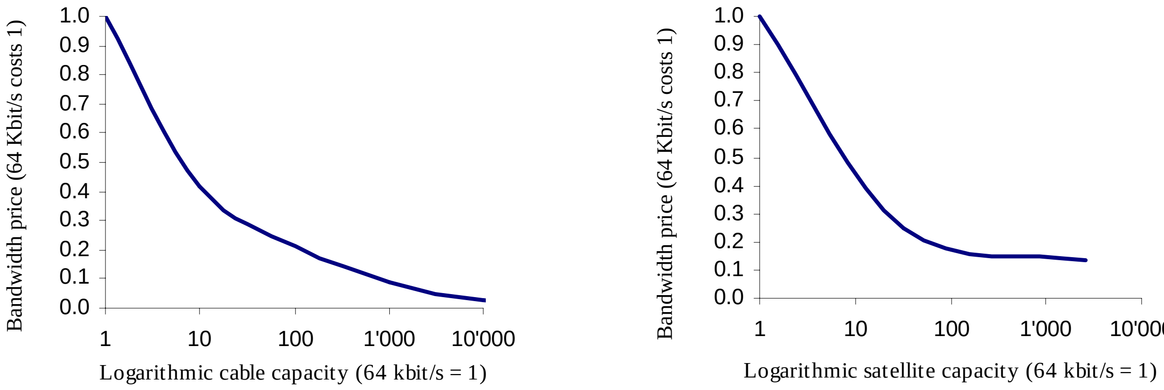
105 P. Howard, Tentronics Corporation, by e-mail (November 6, 2001).

106 Paul Howard, Tentronics Corporation, by e-mail (November 6, 2001).

When the amount of bandwidth required is higher, it may even be appropriate to rent a full transponder, usually with a capacity of 36MHz, which may support around 75 Mbit/s, depending on the system used to maximise the use of the available bandwidth (bit/Hz). The cost of leasing a transponder is around USD 1.5 million a year[107]: assuming 64 Kbit/s as a unit with the value of 1, the 75 Mbit/s offered by a transponder will have a value of 1 200 (64 Kbit/s*1 200). The price for a segment of 64 Kbit/s will therefore be USD 1 250 per year, i.e. only about USD 100 a month. The lease of an entire transponder is appropriate only if a certain cut-off-point is reached: ISPs or governments of LDCs will not usually be able to gain from leasing a transponder, because demand in those countries is lower and revenues would not cover the charges incurred. For this reason, a project that can help in pooling the necessities of multiple countries (covered by the same satellite beam - see, for example Intelsat coverage maps[108]), could help LDCs to benefit from economies of scale and could give them a certain degree of power in the global Internet market.

As a further step, it will be necessary to identify which entities, private or public, might be interested in providing connectivity to LDCs, and subsequently to find the most suitable system to implement it, including configuration of the system, number and size of the antennas, availability of satellite services in the area, lease of a partial or entire transponder, etc. The project should be aimed at Internet operators that already have a certain degree of connectivity. It should therefore be assessed where there are ISPs operating in the countries concerned, and where the project is likely to have a positive impact.

Figure 14: Cable and satellite capacity economies of scale.



Source: *DFID Internet Cost Study (cable), ESAX Index and Paul Howard, Tentronics Corporation (satellite), via e-mail (6 November 2001).*

For smaller bandwidth requirements, it may be possible to lease satellite and station capacity from the operator (a kind of one-stop shopping). The Tentronics Corporation currently offers a turnkey service using a DVB outbound channel with a CDMA satellite return and fibre connectivity to United States Internet backbone, for a price of about USD 63 000 a month for 8 Mbit/s downlink and 2 Mbit/s uplink. To this price it will be necessary to add the cost of the equipment, as explained above.

As can be deduced from *Figure 14*, the monthly cost per unit of 64 Kbit/s connectivity decreases dramatically as the capacity purchased increases.

[107] Paul Howard, Tentronics Corporation, by e-mail (November 6, 2001). The monthly lease of 1 MHz of satellite capacity in C or Ku band is around USD 5 000, accordingly to ESAX World Satellite Transponder Index. See online: http://www.e-sax.com/.

[108] Online at http://www.intelsat.com/satellites_coveragemaps.asp.

4.2.2 Legal barriers to VSAT connectivity.

Despite having the technical means to virtually connect the whole world, companies that provide satellite capacity for Internet services, did not plan, until recently, to cover less developed areas. They perceived the market as being too limited, and the regulatory environment as too restrictive and complex. More recently, projects to provide services to these regions have been under way: The market is considered to be commercially viable, however regulations are still a major barrier.

As things currently stand, an independent VSAT Internet connection is possible in only a few of the countries under consideration (Mozambique, Nepal, Cambodia and Uganda), and even there the procedure for obtaining a license still constitutes a barrier to uptake of the service. In Cambodia, regulation is unclear and even in the few liberal environments such as Mozambique, where anyone can apply for a VSAT license for data, the telecommunication environment is still being established in terms of transparency and is quite unpredictable for the ICT community. It should be noted that VSAT intended for data only can easily be used to carry packetised voice (e.g. voice over IP).

Most countries do not allow ISPs to own and operate a VSAT for the provision of services, as this usually contravenes the PTO’s international operator license agreements. This is the case for Gambia, Mali, Rwanda and Samoa. However, with the availability of a low-cost service, national pressure for change in countries with restrictive regulations is likely to increase significantly. In such circumstances, the involvement of an international organization like ITU could be beneficial for the development of the project. ITU is a *super partes* body which has the confidence of the public and private sectors: it may therefore be favourably received and be able to offer advice to governments requesting assistance to reorganizing their telecommunication policy.

Those countries with a liberal regulatory environment which allows VSAT for both outbound and inbound traffic will initially benefit most from this project and, once its implementation has been successfully demonstrated, this will help break down regulatory barriers in other countries. The overall impact would give momentum to the LDCs’ Internet market, show that increased demand is possible and attract increased competition among providers.

Overall, for the development of such a project, a more detailed assessment of the regulatory environment surrounding VSAT and Internet services is necessary and awareness of the advantages of this service needs to be raised among regulators.

4.2.3 Financial incentives

The liberalization of LDCs’ telecommunication markets, the introduction of competition, and the technical possibility of setting up a system to provide Internet connectivity, will, however, not be sufficient to ensure improved public access to Internet services. Connectivity, even at low cost, may still be too expensive for countries where the average GDP per capita may be as low as USD 240 a year[109] and the cost of Internet access often represents several times the income of an employee. In Uganda for example, GDP per capita stands at USD 257 a year, while the Internet monthly subscription charge amounts to USD 50.[110] Therefore, even where VSAT Internet services are already available, only a small section of the population, normally the wealthy, can use them.

[109] ITU, World Telecommunication Indicators (2001).

[110] Uganda Internet Case Study, p 21.

Box 3: Telecom initiative in Peru : FITEL.

The financing system for the "IP connectivity yin LDCs" project could be modelled on the projects recently implemented in South America. In Peru, in order to develop the telecommunication infrastructure and to guarantee the universal availability of communication services in the territory, the Government created a fund for investment in telecommunications, FITEL. This body manages the resources that will be granted to operators willing to provide telecommunication services in rural areas or areas that have been declared of public interest. Additionally, through this fund, FITEL has the objective of fostering participation of the private sector in the field and of effectively allocating its resources.

To achieve its aims, FITEL examines the different projects presented and selects the most appropriate on the basis of the type and quality of the services offered, the timescale for their deployment, the cheapest tariff for consumers and the lowest level of financing required by the operator for the implementation of the project.

Source: *FITEL (Fondo de Inversion en Telecommunicaciones). Online: http://www.osiptel.gob.pe/*

Enabling foreign companies to invest and provide connectivity in those countries, without foreseeing any specific project or plan, would mean only allowing a few bigger entities (foreign companies or NGOs) to have their individual international Internet link, but will not help to break the vicious circle in which LDCs currently find themselves. One possible solution might be to directly finance local Internet service providers: ISPs could obtain funds to buy VSAT equipment and to lease the necessary bandwidth, and therefore provide better services to end-users for just a fraction of the normal price. The use of 'reverse' auctions, where awards are granted on the basis of the least subsidy required, is an approach that is currently being tried out in certain Latin American countries (see Box 3) to ensure investments in services in rural and poor communities. Monitoring of the outcomes of this approach will help to determine its broader applicability. Furthermore, ISPs could provide enhanced services[111] at the current price to commercial or institutional customers (such as embassies, NGOs, tourist operators, etc): those users will be a source of revenue and will allow a partial 'self-financing' of ISPs.[112] Internet services could be readily available for schools and public institutions, which will help the spread of Internet services among the population, as well as cyber cafés, which should charge prices that are affordable to a larger segment of the population.

The project could utilize such a scheme, pooling resources and the necessary information, gathering small ISP demand (possibly even across countries) and being the negotiating partner *vis-á-vis* Internet backbone and satellite service providers. ITU could propose to all ISPs in LDCs that they increase their IP connectivity using VSAT technology, and for this purpose could offer some financing to the interested ISPs over a limited period of time, perhaps three to five years. To receive this financial aid, the ISPs should submit a plan in which they specify the amount they need to deploy the service (VSAT installation, maintenance, bandwidth cost), allowing for the fact that the service should be capable of being self-financed after the end of the project.

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111 The service could be provided by installing a receive-only dish and an IRD at the customer location. Each user will receive data from the satellite directly, and have terrestrial dial-up, leased line or WLL link back to the ISP.

112 In Mozambique, for example, organisations and ministries are using dial up access because the leased lines are too expensive. VSAT system can provide improved services at a lowest price.

5 Next Steps

Global connectivity is growing at a dramatic pace. Information and communication technologies play a fundamental role in national economic and social development and new opportunities will arise in the near future. However, the digital divide between industrialized and non-industrialized countries is growing, and the benefits of ICTs remain virtually unknown for a large part of the world's population – in particular for LDCs, which are at risk of being left out of the global information society. The current approach to communication technologies in such countries is undoubtedly not up to meeting the new Internet challenges, which are placing a ever greater strain on existing network capacity: new policy, regulatory and market solutions are therefore necessary.[113]

The two major obstacles to Internet diffusion, which accordingly constitute two of the primary causes of current stagnation of the market, would appear to be unreliable infrastructure and high costs of Internet services.[114] These two factors are inter-related, and - in conjunction with other factors - propagate the vicious circle described in the present study. By establishing a reliable infrastructure that can provide access to international Internet capacity at low cost, part of the circle can be modified in a way that will have an impact throughout the entire Internet market, thereby transforming a market failure into new opportunities for development.

The initial contribution through an internationally-funded project and the establishment of a particularly low price for Internet access should boost Internet development and diffusion in the countries involved. Financing connectivity could therefore be the first step towards creating a virtuous Internet circle in LDCs.

There are, of course, other factors to be taken into consideration that also require attention, such as the cost of PC equipment, scarce energy supply or lack of the appropriate training. However, it is assumed that by raising the quantity and quality of Internet connectivity, a corresponding drop in costs and increase in user numbers will ensue. Acting on infrastructure can therefore have a leverage effect by bringing about a reduction in the prices charged to the end-user, which will in turn stimulate market growth and result in attracting more international investors, who are generally absent from the least developed countries (partly also due to the often restrictive regulations and rules governing market entry). A change in national regulations will undoubtedly be necessary in the near future, although this alone may not be enough, especially where there is limited scope for market competition.

Poor market performance is linked to the supply of investment finance. This is because of a combination of low income levels and high investment/revenue ratios among operators. This imbalance is something that can be addressed by an international body such as ITU, in close collaboration with other international organisations of the sector and public and private institutions from the countries concerned. In addition to international initiatives, actions will need to be taken at the national level in order to create the appropriate environment for telecommunication development. It is up to individual States to adapt their policies in the field of telecommunications in order to foster expansion of telecommunication and ICT services. Moreover, involvement in an international project may act as an incentive to modernize legislation and could provide them with a taste of belonging to the information society.

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113 As underlined by the ECOSOC-ECA during the Second Meeting Committee on Development Information, held in Addis Ababa last September "ICT initiatives aiming at bridging the digital divide call for the need to revisit and reorient the national information and communication strategies to fit into wider regional and international frameworks […]" See *supra* note 83.

114 See D. Akst and M. Jensen, "Africa Goes Online" and *Pacific Islands Knowledge Assessment*, *supra* note 34, and Magda Ismail, *Readiness for the Networked World: Mozambique Assessment*: "Limited speed of Internet and price are major barriers to connectivity" *supra* note 26, at 38.

Acronyms

CDMA	Code Division Multiple Access
DAMA	Demand Assigned Multiple Access
DOI	Digital Opportunity Initiative
DOT Force	Digital Opportunity Task Force
DVB	Digital Video Broadcasting
DWDM	Dense Wavelength Division Multiplexing
GDP	Gross Domestic Product
ICT	Information and Communication Technology
IDU	Indoor Unit
INCM	National Telecommunications Institute of Mozambique
INTELSAT	International Satellite Telecommunication Organization
IP	Internet Protocol
IRD	Integrated Receiver Descrambler
ISP	Internet Service Provider
LDC	Least Developed Country
ML	Main Line
MoIC	Ministry of Information and Communications
MPTC	Ministry of Post and Telecommunication Cambodia
NTA	Nepal Telecommunications Authority
ODU	Outdoor Unit
PoP	Point of Presence
PTO	Public Telecommunication Operator
S-CDMA	Synchronous Code Division Multiple Access
SCL	Samoa Communications Limited
SCPC	Single Channel Per Carrier
SOTELMA	Société des Télécommunications du Mali
TDM	Télécommunications de Mozambique
TDMA	Time Division Multiple Access
UCC	Uganda Communication Commission
UEM	University Eduardo Mondlane
UN ICT	United Nation ICT Task Force
UNDP	United Nations Development Programme
VoIP	Voice over IP
VSAT	Very small Aperture Terminal
WEF	World Economic Forum