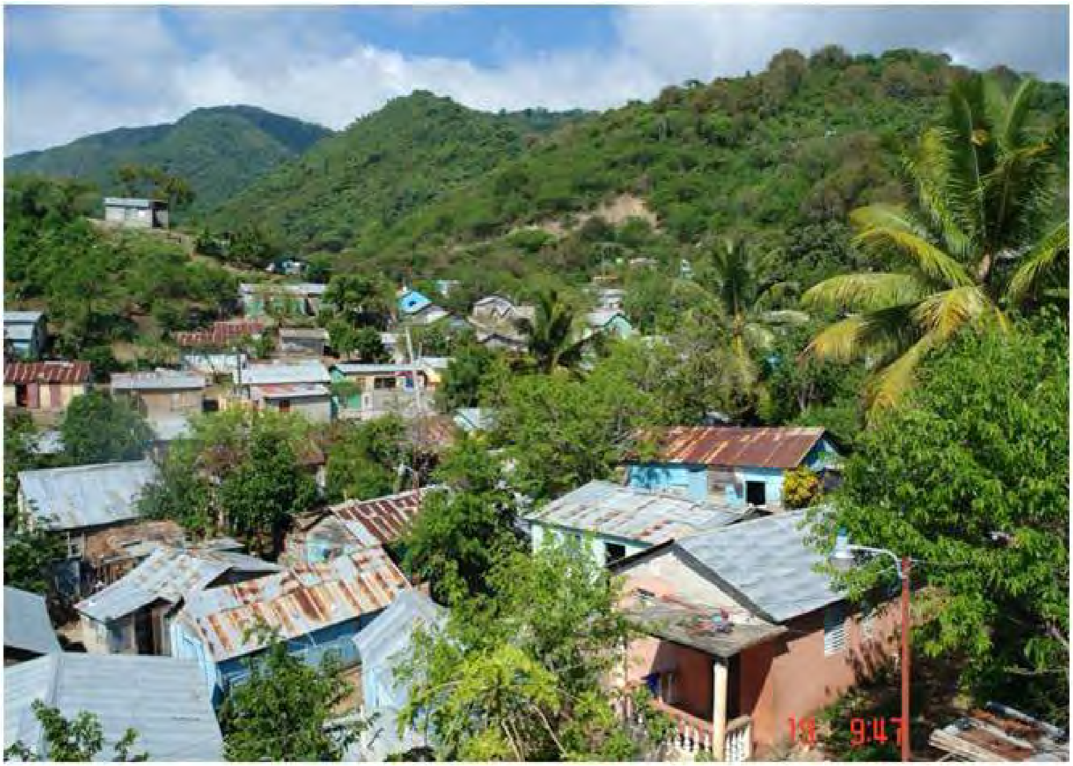

BRINGING BROADBAND ACCESS TO RURAL AREAS: A STEP-BY-STEP APPROACH FOR REGULATORS, POLICY MAKERS AND UNIVERSAL ACCESS PROGRAM ADMINISTRATORS

THE EXPERIENCE OF THE DOMINICAN REPUBLIC

International Telecommunication Union

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Annex 1:

OTHER SUCCESSFUL EXPERIENCES: THE PERUVIAN RURAL BROADBAND CONNECTIVITY PROJECT

PART I: INTRODUCTION TO RURAL BROADBAND ACCESS

1. Bringing broadband to rural areas

Broadband[1], today's the principal means of delivering ICT applications, is considered by an increasing number of policy makers and regulators around the world to be a basic telecommunications service. Current universal access and service (UAS) policy for telecommunications and ICTs emphasizes the need for access to broadband applications in order to achieve the goals of economic development and social inclusion for all communities. Experience has shown that the arrival of basic telephony (in any form, such as public payphones, fixed residential or mobile lines) and broadband Internet constitutes a critical take off point in a community's path to economic and social development[2]. The impact is even greater in rural communities where local institutions, NGOs and young people quickly become the main users of ICTs opening the way to what could be considered to be a virtuous circle of development (Picture N^{o} 1). Yet, in most developing countries, access to broadband services is generally restricted to the capital city and sometimes to other important economic and political centres and surrounding areas.

In the communities with limited or no access to basic voice services, the Internet becomes a less expensive alternative, often serving as a substitute for the former. Generally, it costs very little to access the Internet in public Internet cafés, where a user can chat for an hour with friends and family, conduct business with people all over the world and get information on education, health, government and other matters for about the same cost as a three minute call from a public payphone.

This is why universal access and service (UAS) policies and the institutions in charge of developing and implementing UAS policies and projects are promoting and, where necessary, financing deployment of infrastructure to provide broadband access in rural areas.

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[1] The term is used in this document to describe high speed always on internet connections which are over 256 kbps.

[2] www.ictregulationtoolkit.org

This was precisely the objective of the government of the Dominican Republic and the telecommunications regulator, INDOTEL, in 2007 when they initiated an ambitious project to provide broadband access to 508 mostly rural communities in the country.

Picture N° 1: Young man using the Internet in a rural area of the Dominican Republic

Source: Edwin San Román

2. Purpose of the course and this background paper

This document like the accompanying ITU course, "Bringing broadband access to rural areas: a step-by-step approach for regulators", draws primarily from the real experiences in implementing successful rural broadband connectivity projects in the Dominican Republic and, to a lesser extent, similar experiences from previous projects in Peru. It focuses on the practical aspects of these projects, including the procedures followed, the challenges encountered and the lessons learnt. While the procedures followed in the Dominican Republic were similar to those in Peru, the two countries differ significantly in the time taken from conception of a project to its implementation. In the Dominican Republic, where there is only one institution involved in the process, it takes typically less than one year from start to implementation of a UAS project. In Peru because of all the requirements in national legislation and the involvement of several government institutions in the approval process, it can easily take as long as three years. The experiences in implementing rural broadband projects in both these countries serve as the basis for the course and this background document.

While the procedures described here are applicable in most other countries, a person responsible for initiating and implementing such projects must keep in mind that particular requirements of national legislation in one country may have a negative impact on what would be a successful project in another country.

In this document and the associated course, it is presented the overall context and general aspects of rural connectivity projects, which is illustrated with examples from the Dominican Republic and to a lesser extent from Peru. The document is divided into five parts:

Part I (Sections 1 and 2) gives background information and outlines the purpose of the course and offers a brief discussion about the justifications for, and potential benefits of bringing broadband to rural areas.

Part II (Section 3) presents the context for promoting broadband rural access in the Dominican Republic and includes a brief geographical, political, demographic and economic overview of the country, its telecommunications sector, government policy on information and communications technologies (ICTs), the role of the policy maker and regulator, and the extent of their involvement in promoting and developing universal access and service. Special attention is paid to policies that promote broadband access. In this part it is presented the concept of the Universal Access Fund and how it is used. This part concludes with a brief presentation of the Dominican Republic's Rural Broadband Connectivity project.

Part III (Sections 4-7) elaborates on the general methods and tools needed to develop a rural broadband project. The importance of local knowledge and especially of rural areas and the need to consult and involve the main stakeholders is discussed in Section 4. Section 5 explains the importance of undertaking pilot projects to test and demonstrate the technical and economic feasibility of rural connectivity projects. Section 6 gives a general overview of technologies that provide broadband access. Section 7 describes the use of geographical information systems (GIS) and Google Earth and how they can be used when planning rural telecommunications projects.

Part IV (Sections 8 – 9) describes the practical steps in developing and implementing a rural broadband project and is illustrated with examples from Peru and the Dominican Republic. Section 8 elaborates on the contents of and the steps involved in the development of a rural broadband project and Section 9 discusses alternative innovative funding mechanisms. Section 10 focuses on sustainability issues.

Conclusions and best practice guidelines are summarized in Part V (Sections 11 – 12) and Annex 1 gives a brief overview of the Peruvian rural broadband connectivity project.

In addition to public and country specific information available on the Internet and cited as footnotes in this document, the two main outside references used in developing and implementing the project presented in this document and associated course are the following:

- The ITU - infoDev ICT Regulation Toolkit module on Universal Access and Service[2]; and

- Peter A. Stern and David N. Townsend, New Models for Universal Access to Telecommunications Services in Latin America: Lessons from the Past and Recommendations for a New Generation of Universal Access Programs for the 21st Century, a Joint Study by the World Bank, Regulatel (The Forum of Latin American Telecommunications Regulators), and the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), June 2007[3]

[3] http://www.regulatel.org/SU_Peter_31_08_07/Full_report-COMPLETE-June_11,2007.Edited_PAS_v.1.pdf

PART II: THE DOMINICAN REPUBLIC'S RURAL BROADBAND PROJECT

3. The Dominican Republic: The national context for promoting broadband access in rural areas

Figure N° 1: Location of the Dominican Republic

Source: Google Earth

3.1 Geographical, political, demographic and economic overview

The Dominican Republic occupies the eastern two thirds of the Island of Santo Domingo (also known as Hispaniola) bordered on the north by the Atlantic Ocean and on the south and west by the Caribbean Sea. Haiti occupies the western third of the Island. The Dominican Republic has a land surface area of 48,730 km^2 and a population of more than 9.5 million giving it a density of 195 inhabitants per km^2.

The Dominican Republic is a democratic republic divided into 31 provinces and one national district. There are three levels of government: the central government is responsible for national policies including telecommunications, ICTs, education and health; each of the 31 provinces has its own provincial government; and there are 383 local governments that include municipalities and district municipalities. Politically there is a fragmented multiparty system with three main traditional parties.

The population is made up of mixed ethnic groups (73%) and black (11%) and white (16%) minorities. During the course of their history Dominicans have emigrated to other countries in search for better economic and social opportunities. Many Dominicans today are very dependent on the remittances they receive regularly from family members living abroad, mainly in the USA. Indeed, these remittances represent about 10% of GDP.

Like most all of its neighbours in the Caribbean the Dominican Republic's economy was traditionally based on the exports of sugar, coffee and tobacco. However, more recently the services sector (mainly tourism) has overtaken agriculture as the economy's largest employer. The USA represents nearly 75% of the country's export income. The country has experienced strong economic growth since 2005. Yet according to 2007 figures, distribution of wealth is still very unequal: 10% of the population received nearly 40% of the country's GNP.

As a result mainly of the Central America-Dominican Republic United States Free Trade Agreement (CAFTA – DR)[4], which came into force in March 2007, GDP in 2007, grew at a rate of 9% with respect to the previous year. In 2007 exports reached US$ 7,237 million, 45% higher than in 2006. Net reserves were US$ 2.3 billion and tax income grew at a rate of 23% that same year.

Picture N° 2: A Caribbean landscape

[4] The Central America-Dominican Republic-United States Free Trade Agreement (CAFTA-DR) which creates the United States' second largest free trade zone in Latin America after Mexico has seven signatories: the United States, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, and Nicaragua. It was approved by the U.S. Congress in July 2005 and the President signed it into law on the 2nd of August of that year. The Agreement which entered into force on a date agreed upon by all parties, has been approved by the legislatures in the Dominican Republic, El Salvador, Guatemala, Honduras and Nicaragua but not in Costa Rica. Inter alia, the Agreement includes trade in services including telecommunications.

Source: Edwin San Román

3.2 The telecommunications sector

Telecommunications services have been provided by private companies since 1930. The telecommunications market which was opened to competition in 1998 has been completely liberalized for all services since 2002. Codetel (Compañia Dominicana de Teléfonos), later GTE, Verizon Dominicana and now Claro-Codetel held a monopoly until 1992 when a concession was awarded to TRICOM, which provides fixed and cellular mobile services and Internet (dial up, ADSL and cable modem) and cable TV services. TRICOM was able to start providing services only after concluding lengthy interconnection negotiations with Verizon[5]. All America Cable and Radio (AAC&R), later Centennial and now Trilogy Dominicana (commercial name VIVA), was awarded a license a short time later. By 2008 there were four competing mobile operators. Claro-Codetel and Orange Dominicana were the two dominant operators with, respectively 54% and 33% of the market share; Tricom and Trilogy Dominicana (commercial name VIVA) had together 13% of the market; OneMax and Wind Telecom, the latest entrants, started offering wireless internet and telephony services in 2008. There are also many ISPs and three submarine cable systems (Antillas-1, Arcos, FibraLink) connect the Dominican Republic to the rest of the world. The most recently

[5] http://nuevositio.tricom.net/historia.aspx

completed, FibraLink Jamaica, a subsidiary of Columbus Communications[6] has a submarine cable that connects Jamaica with the Arcos landing station at Puerto Plata.

Figure N° 2: Logos of the main telecommunications operators in the Dominican Republic

Source: INDOTEL

A new pro-competition General Telecommunications Law (Ley 153-98), promulgated in May 1998 created an independent, administratively decentralized telecommunications regulator, *Instituto Dominicano de las Telecomunicaciones* (INDOTEL), with judicial and financial autonomy and legal personality INDOTEL is the only government institution that has both the policy setting and regulatory responsibilities for the sector[7]. It is headed by a five-member Executive Council appointed every four years by the Executive Branch of the Government, coinciding with the four-year mandate of the President of the Republic[8]. The President of the Executive Council has the rank of Secretary of State.

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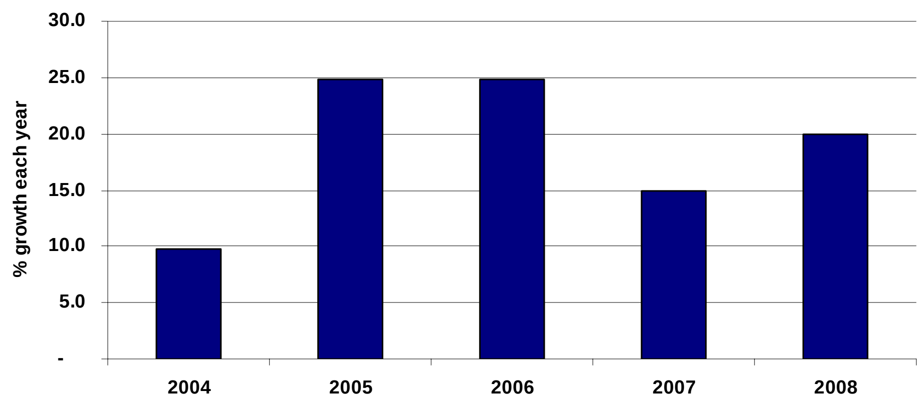
[6] Columbus Communications is a newly established, Barbados-based company which owns Cable Bahamas, the only cable TV company in the Bahamas, the Bahamas Internet Cable System (BICS), a submarine cable system connecting The Bahamas to the USA, the Cable Company of Trinidad & Tobago (CCTT), the dominant cable TV operator in Trinidad & Tobago, and 85% of the Arcos submarine cable system.

[7] http://www.indotel.gob.do/component/option,com_docman/Itemid,587/task,doc_view/gid,66/ (article 76).

[8] The President of the Republic who is elected every 4 years by popular vote, appoints all ministers and governors of the 32 provinces and promulgates all laws approved by the Congress, which is made up of a 150 member Chamber of Deputies and a 32 member (one per province) Senate.

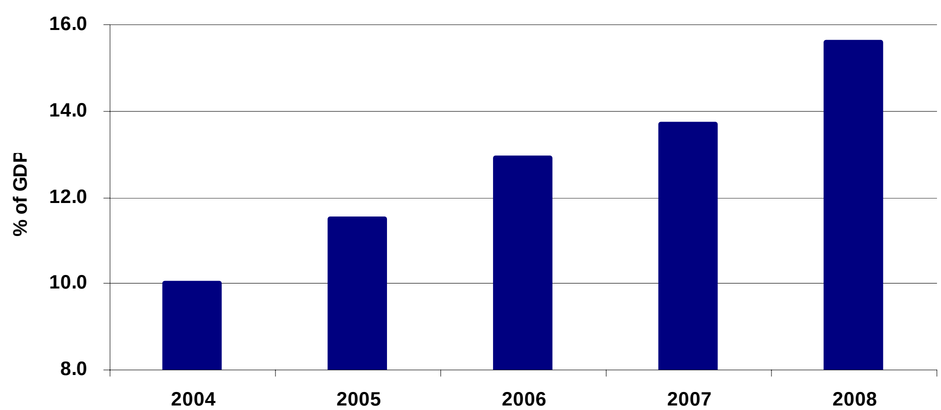
In the period since Law 153-98 was proclaimed, telecommunications has been among the sectors experiencing the highest rates of growth in the Dominican Republic. The sector has played an important role in the diversification of the economy from primary industries such as agriculture, mining and fishing, to manufacturing and services based activities such as tourism and transportation[9]. Between 2005 and 2008, the telecommunications sector grew year on year by more than 15% (24.8 % in 2005 and 2006) and represented between 10% and 15.6% of GNP.[10] (Figures 3 and 4)

Figure N° 3: Growth of the Telecommunications Sector in the Dominican Republic



Source: *Banco Central*

Figure N° 4: % of GNP represented by the Telecommunications Sector in the Dominican Republic



Source: *Banco Central*

[9] The part of GNP of primary industries (agricultural, mining and fishing) has decreased from 25% in 1980 to15% in 2002.
[10] Source: *Banco Central de la República Dominicana* (preliminary figures for 2008).

Table 1 shows the number of telephone lines, penetration rates and growth of fixed and mobile lines as of December 2008:

Table N°1: Basic telecommunications indicators

	Number of lines	Penetration rate	Annual growth rate
Fixed telephones	985,711	10.3%	8.7%
Mobile telephones	7,210,483	75%	30,8%

Source: *INDOTEL*

Eighty seven percent of the mobile lines are prepaid and it is estimated that today over 65% of the territory and over 90% of the population have access to basic telephone services through either fixed or mobile connections.

There has also been significant growth in the number of Internet users and subscribers. Between 2000 and 2008 the number of Internet users who accessed the Internet mainly in Internet cafés, universities and their work places increased by more than ten fold. During the same period the number of Internet subscribers increased by nearly five times and Internet users increased from 2.4% to close to 26.7%.

Picture N° 3: Antenna in Miches, in northeastern Dominican Republic

Source: Edwin San Román

Law 153-98 also established a Universal Access Fund (*Fondo de Desarrollo de las Telecomunicaciones*), which is administered by INDOTEL. Each operator of public telecommunications services contributes 2% of its gross income. Forty percent of the Fund is used to finance regulatory activities of the INDOTEL and 60%, to finance development projects which are awarded through minimum subsidy auctions. There are two types of projects which are eligible for funding: (i) Development Projects, which form part of biannual universal access and service project plans and are approved every two years by the Executive Council, and (ii) Special Projects which are of a strategic and social nature and can be approved by the INDOTEL Executive Council on an as-required basis so long as they do not surpass a defined maximum amount[11].

3.3 Universal access and service (UAS) in the Dominican Republic

One of the main functions of a policy maker and regulator in helping societybridge the digital divide is to be the prime enabler, facilitator and promoter of telecommunications infrastructure deployment and, especially, broadband access throughout the country. In the Dominican Republic this task is carried out by INDOTEL, the only government organization responsible for telecommunications related matters.

As part of its mandate to promote UAS, INDOTEL in 2001 issued a policy paper, *Social Policy on Universal Service* and *Regulations for the Telecommunications Development Fund* which, *inter alia,* proposes bi-annual plans for projects to extend universal access and service to yet unserved areas[12].

Definitions for universal access and universal service can be found in Box N° 1.

[11] http://www.indotel.gob.do/component/option,com_docman/task,doc_details/gid,656/Itemid,739/
[12]http://www.indotel.gob.do/component/option,com_docman/task,doc_details/gid,612/Itemid,739/

Box N°1: Definitions of Universal Access and Universal Service

Universal access is defined as "the reasonable availability of network facilities and services, on either a private or a shared, public basis, to citizens and institutions within a given community."

Universal service is defined as being *"a more absolute condition, in which telecommunications services are delivered ubiquitously to households or individuals throughout an area, and thus are both accessible and affordable, with no practical impediments to subscription and usage".*

Source: *New Models for Universal Access to Telecommunications Services in Latin America*[3] *and* ITU - infoDEV ICT Regulation Toolkit[2] module on universal access/service

In addition to national strategies that promote universal access and service through broadband, it is important that the country's legislation also addresses the financing mechanisms needed to achieve these policies including the deployment of broadband infrastructure and the acquisition and installation of terminal equipment such as computers, PDAs, smart phones and other devices that need broadband connections. In countries where by law the universal access fund does not finance the procurement of terminal equipment, changes in the law would be required.

One of INDOTEL's primary efforts in promoting broadband and the use of computers has been directed towards the installation of local community Informatics Training Centres (CCIs[13]) and supplying them with computers since 2004. The number of computers in each CCI varies according to the population and capacity of the organization in charge of managing each CCI. INDOTEL also provides the entire technical infrastructure including hardware, software, and a backup electric supply system.

The main purpose of these centres is to train people in the use of computers. They are free of charge and open to anyone who wants to learn how to use a computer. Some CCI's already have connections to broadband Internet, while others are being connected as the deployment of broadband infrastructure reaches their area.

[13] *Centro de Capacitación en Informática* (CCI) are community informatics training centres, some with Internet access, and where the computers are funded through INDOTEL's Universal Access Fund.

It is important to note here that the CCIs are administered by local people and organizations from the community in which they are located and who manage and ensure the sustainability of these centres, for example, paying instructors and all associated running costs. In planning their deployment, INDOTEL identified civil society organizations and individuals who were willing and capable of undertaking this task.

By January 2009 there were more than 867 CCIs in operation and 462 were in the process of being created. The initiative can so far be considered to have been a great success, with thousands of people throughout the country regardless of their social and economical status, age, sex and race, having learnt how to use a computer. Most centres have monthly graduation events for students who have successfully completed the standard 6-month computer training course[14]. INDOTEL has funded the cost of these CCIs and other universal access and universal service projects with resources from the Universal Service Fund[15].

Picture N° 4: Woman and child from Rio Limpio, northwest of the Dominican Republic

Source: Edwin San Román

[14] Even though all centers give training courses, only some of them have public graduation events.
[15] See reference 11.

3.4 The Dominican Republic's Universal Access Fund (UAF) and how it is used

Universal Access Funds (UAFs) are commonly used as a financial mechanism to create an extra level of economic incentives for private investment in network expansion and service delivery with the objective of achieving universal access and service goals[16].

In the Dominican Republic, there is a two-year planning cycle for UAF financed projects. Once projects are approved by INDOTEL's Board, their execution can begin, the first step being the elaboration of a bidding document. This document explains the purpose, objectives and characteristics of the project, as well as its technical specifications and terms of reference of the bidding process. The next step is for INDOTEL to initiate a tender, which given the characteristics of the project can be national or international in scope. Potential investors are given a certain time to prepare their bids which are evaluated according to a strict tender and adjudication procedure after the bids have been submitted. The company with the bid that meets all the technical specifications and asks for the least amount of subsidy from the Fund is awarded the project. Bids are evaluated by an INDOTEL tender evaluation team, consisting of a project manager, a telecommunications engineer, an economist, a lawyer and an assistant. Depending on the project the team may have additional support from other technical, legal or administrative sources.

3.5 The Government's policy on Information and Communications Technologies (ICTs) and the role of the regulator

Government involvement and, most importantly, political support at the highest level are essential if a country wishes to implement a national strategy to transform the current "pre-modern" into a "post-modern" society, namely, one based on information and knowledge. ICTs play a key role in this fundamental transformation. Just as important is the active participation of the public and private sectors and civil society in the design and execution of projects which promote the use of ICTs throughout society.

[16] http://www.ictregulationtoolkit.org/en/Section.3272.html

E-Dominicana[17] is a national strategy which has as its mission "*to promote the use and appropriation of Information and Communications Technologies in the Dominican Republic by means of initiatives that create synergies between the governmental sector, the civil society, and the productive sector, to offer all its inhabitants better opportunities which will contribute to their development, by bringing them welfare and progress in the exercising of their capacities*". Its vision is "*to place the country in a position that will allow it to compete in the new scenario of a globalized world, by achieving sustainable development in the economic, political, cultural, and social scope, and to assume the challenge of converting inequality and Social exclusion from the digital divide into a digital opportunity*".

Picture N° 5: Accessing internet in a CCI in Don Juan, province of Monte Plata

Source: Edwin San Román

The objectives of *e-dominicana*[18] are grouped into eight thematic areas, namely, infrastructure and access, social inclusion, education, training, awareness-raising, development of contents, digital state, and industry. The objectives relating to infrastructure are to:

i. provide access to broadband[19] services for all Dominicans with a speed of at least 128 Kbps within a radius of no more than 5 km of their homes;

[17] Extracted from *National Strategy for the Information and Knowledge Society, 2007-2010:*

[18] http://www.cnsic.org.do/media/plan_edominicana/ObjetivosgeneralesdelaE-Dominicana.html#Topic11,

ii. achieve an Internet penetration of 40% of the population with at least 30 % of the connections having a speed of 128 kbps or more;
iii. achieve a penetration rate of personal computer users of at least 50% of the population.

These three objectives are to be achieved by 2010 by:

a) developing sustainable models with prices within reach of the whole population as a means of encouraging ubiquitous access to ICT infrastructure;
b) stimulating the ICT market and contributing to its growth through joint efforts between the government and the private sector;
c) reducing the costs of broadband access by encouraging competition; and,
d) promoting the use of the Internet in small companies and throughout the public sector.

3.6 The Rural Broadband Connectivity Project

What convinced INDOTEL to give a special impulse to the deployment of broadband in rural areas was the fact that in July 2007 only 62 (16%) out of the country's 383 local governments had fixed lines and broadband Internet service. Most of these are the Dominican Republic's most populated cities and their surroundings including the capital, Santo Domingo. This meant that many of the less populated municipalities and rural areas had no access of any kind despite the fact people living in these municipalities were just as anxious as their neighbours living in more populated and richer areas to have broadband services.

By May 2007 more than 400 CCIs had been established across the whole country but due to the lack of telecommunications infrastructure only a few had access to broadband. Local organizations responsible for managing these centres were unhappy with this situation and made sure that their dissatisfaction came to the attention of Jose Rafael Vargas, the President of INDOTEL, who often

[19] This capacity was considered as broadband at the time *e-dominicana* was launched, currently minimum speed for broadband access is 256 kbps.

attended CCI inaugurations. Vargas was besieged everywhere by demands from local authorities, residents, students and the young, for broadband and home telephone services.

Picture N° 6: A CCI

Source: INDOTEL

As a result in 2007 INDOTEL took an important decision to launch the *Rural Broadband Connectivity Project* as part of the government's *e-Dominicana* strategy. The Project has as its objective to bring residential, public telephones and broadband[20] services to 508 localities[21] throughout the country that had no residential telephone connections or broadband Internet access. Broadband services were also to be made available through Internet cafés and telephony through public call centres[22].

The Project included a program of awareness raising, training in the use of the telephones and computers as well as in the managing public call centres and cyber cafés. Training was proposed

[20] Download and upload speeds of 256/128 to 1,500 /256 Kbps under conditions similar to those found in the big cities such as Santo Domingo and Santiago.
[21] Those 508 localities include all municipalities and districts municipalities of the country and 179 localities of the 16 poorest provinces in the country.
[22] Public call centres are public places where a person can make a telephone call and pay for it in cash.

for both end users and entrepreneurs and included the development of locally generated web pages with important information about each community, such as location, how to reach it, tourist attractions, products made in the community and the names of the local authorities. To promote entrepreneurship it was also proposed that the Internet access and public call centres be managed by local entrepreneurs.

Before finalizing the tender documents for this ambitious project, INDOTEL had estimated the total cost to be US$ 4 650 000, including all applicable taxes.

The conditions of the tender provided that as yet unassigned frequencies could be used in the project if requested by the bidder free of charge.

When the public tender was officially launched on 23 August 2007, 20 potential bidders acquired the document. Of these, five completed the initial requirements; two prequalified but only one presented a technical and economic proposal. This was Claro-Codetel, which eventually was awarded the project deposited its offer on 8 January 2008, the closing date of the tender. It requested zero subsidies and offered to complete the project in 345 days but asked for the use of 2 x 15 MHz of frequency in the 3.5 GHz band.

Following market and field studies, Claro-Codetel decided to deploy ADSL where there were fixed lines and 3G (UMTS) wireless access where there was no existing fixed-line infrastructure. By the end of January 2009, 108 of the 508 localities had been connected and it was planned to have all 508 connected by the end of September 2009.

Before launching the full scale project, however, INDOTEL decided to do a pilot project (described in detail in Section 5 below) in a small community called *Los Botados*, near the capital, Santo Domingo, to confirm that the whole project was viable economically and technically.

PART III: METHODS AND TOOLS FOR DEVELOPING A RURAL BROADBAND PROJECT

In this part it is showed why it is essential to have local knowledge and to undertake consultations with stakeholders, to present the project to them, to secure their support and involvement and then to run a pilot project to test and prove its technical and economic feasibility, essential for the regulator, operators and service providers alike. It is also showed how recent innovations in wireless technologies and geographical information systems (GIS) and Google Earth have been used for developing and implementing rural telecommunications projects.

4. The importance of local knowledge and consulting with stakeholders

4.1. Knowing the country and especially the rural areas

A thorough knowledge of the country, its geography, demography and social and economic characteristics is essential in the elaboration of any universal access and service project. Similarly, it is important to have a good appreciation of the existing telecommunications infrastructure, where it is located, its characteristics and plans for its expansion to ensure that rural telecommunications projects take into account the actual situation in the target areas. The practical way of doing this is to establish a project technical evaluation team typically composed of at least an economist and a telecommunications engineer and have them visit the target areas to gather all the essential technical, economic, geographic, social, political and other information necessary for the design of the project or projects.

In the Dominican Republic the project technical evaluation team consisting of two engineers, an economist and a lawyer drew the following general conclusions about telecommunications infrastructure in rural areas:

- Small entrepreneurs were using a variety of technological solutions including satellite and wireless and, with their own limited resources had already installed public telecentres, cyber-cafés and public call centres for which the local population often paid very high prices.

- Some people had home telephones[23] installed at their own expense and without any help from the network operators, an example of what people in the rural areas are willing to do to have a telephone even if the costs are high.

- Many people already knew about the Internet and were willing to pay to have access in a public place or even at home.

Picture N° 7: Getting to know the country

Source: Edwin San Román

4.2. Consulting with public institutions and local entities

Consultations are critical to the drafting of the bidding document and should involve all or most ICT stakeholders[24]. These consultations should have as their main objectives the gathering of information, linking stakeholders, and assessing the size of the market. Before meetings are held with operators and ISPs, the consultation team needs to have a good understanding of stakeholders' needs, expectations, current levels of connectivity and how they are currently using ICTs. For example, during the Dominican Republic's Rural Broadband Connectivity Project the

[23] Fixed telephones connected via the mobile network.
[24] The consultation team in Dominican Republic was the project technical evaluation team.

Ministry of Education, the Ministry of Health, and local municipalities were consulted to assess the need for telecommunications, especially Internet services and to get a better understanding of the infrastructure they currently had. The local governments were invited to support and to get actively involved in the project. These consultations revealed the degree of unanimity among stakeholders on the need for broadband access and also a general dissatisfaction not only with the lack of broadband access and services in rural areas but also with the high costs and poor quality of satellite access.

4.3. Consulting with telecommunications operators and service providers

Once the objectives of the initial consultation process have been achieved, having face to face meetings with each of the operators and, in particular, with the incumbent is an important next step. In the Dominican Republic each of these meetings started with a short presentation about the project and was followed with an open discussion about the deployment of broadband infrastructure throughout the country and the reasons for its absence in certain underprivileged areas, especially in rural areas. The operators were also encouraged to talk about their plans for expanding their networks in rural areas.

Consultations with operators should ideally be held after the technical project evaluation team has completed its field visits because it will then be possible to refer to real instances of people in rural areas asking for broadband and indicating their willingness to pay for it. These meetings have the additional benefit that they allow project team members to establish contact with the regulatory, technical and other experts from these organizations. This is very important as the project progresses through its different implementation stages where easy and quick access to these key people is essential to get quick replies to urgent requests for various types of information and data.

Consultations with operators were an integral part of the implementation of the broadband projects in the Dominican Republic, where invitations were sent by INDOTEL to the CEOs and regulatory experts of all of the major operators. At least one representative of each major company attended the meetings. Their feedback was very useful and was taken into account in planning these projects. It greatly enhanced the projects and had the additional benefit of inciting the operators to participate in the tender process.

4.4. Cooperation with NGOs and other agencies

Establishing contact with civil society agencies and especially non-governmental organizations (NGOs) should not be underestimated because many of them work in rural areas. They are often very interested in broadband projects because they understand the benefits of high speed access and have a very good appreciation of demand for services that require broadband access. Almost all use the Internet as a working tool and want to have access available for staff situated in the rural areas.

Some CCIs are connected via VSATs but are experiencing serious delay problems, poor quality of service and high prices. Since many of these are managed and used by NGOs to provide computer training in the communities they are serving, they are willing to pay the operational expenses. Contacting these organizations was made easier because INDOTEL had all their contact information.

5. The importance of a pilot project as a way of testing and demonstrating the technical and economic feasibility of a universal access and service project

One of the most important steps in developing a rural telecommunications project is to show that it is technologically viable and sustainable. This is why a pilot project is highly recommended and why in the Dominican Republic a pilot was carried out as part of the *Rural Broadband Connectivity Project* as a pre-feasibility study to prove that it is possible to bring broadband to rural areas using low cost technologies when there is a demand.

In this section it is discussed the characteristics of an ideal location and the importance of involving local authorities and especially young people. It is also presented the *Los Botados* pilot project which was funded by INDOTEL, the local government and a telecommunications operator.

5.1. Characteristics of the location of the pilot project

The ideal location for a pilot project is one which has little or no access to telecommunications services but is situated near the capital city or a large population centre that has access to the network. In Dominican Republic's rural broadband access pilot project, a small community of 3,986 inhabitants, located 35 km or one hour from the capital, Santo Domingo, called *Los Botados*, was chosen. *Los Botados* is located in a rural area where the main economic activity is agriculture. It had minimal telecommunications services in May 2007 when it was selected for the pilot. Only 5 families had fixed WILL (Wireless Local Loop) telephone lines with a rather poor quality of service;, the rest of the community had to travel 5 km to *Yamasa*, the nearest town, 5 km to make and receive phone calls.

Picture N° 8: Municipality of Los Botados

Source: Edwin San Román

5.2. Involvement of local authorities

Given that the local authorities have a fundamental role in securing local support from the start of the project to its completion, raising awareness among them about the importance of telecommunications, especially broadband and how it will benefit the community is fundamental to the success of the project. Local authorities play a very important role in explaining and promoting the benefits to the community of access to telecommunications and its applications. In communities where local authorities are not familiar with these benefits, it is necessary to work with other local organizations, especially young people, who will in turn bring the message to local politicians.

When the *Los Botados* pilot project was launched in November 2007, the mayor*,* Ramon Santos, was new to computers; however, not long after INDOTEL was able get his support, Mayor Santos rapidly gained a good understanding of the importance of ICTs, the importance of having broadband access, and the benefits this could bring to his community.

Picture N° 9: Los Botados Mayor Ramón Santos

Source: Edwin San Román

5.3. Involvement of the young

The importance of involving the whole community and especially young people should not be underestimated. It is young people who are most familiar with what the latest in technology, telecommunications and broadband Internet access can offer and will ultimately be the biggest users of the Internet and all the applications that broadband can deliver. Even though *Los Botados* had virtually no telecommunications services or training centres many of its young people had already had contact with ICTs and were using them in cybercafés and training centres in nearby towns.

Picture N° 10: Young people trying the Internet

Source: Edwin San Román

5.4. How they made it happen in the Dominican Republic

Once the target community had been selected and the support of the local authorities had been obtained, INDOTEL started examining the best technological and economic options available for providing broadband access. As part of this exercise, it contacted all operators that had infrastructure deployed in the vicinity of *Los Botados.*

INDOTEL's own study concluded that the cheapest and most feasible solution was to build a radio link of almost 25 km with a midway repeater between *Los Botados* and *La Naviza,* where VIVA had a network. It helped that INDOTEL was able to secure the involvement of the president of VIVA, who after agreeing to participate in the project, instructed his technical staff to give the pilot project his company's full support.

Under an agreement with INDOTEL, VIVA was required to build this radio link, install a Wi-Fi hot spot in *Los Botados,* and carry out initial tests on the network. For its part, INDOTEL selected and provided low-cost radio equipment.

Unfortunately the initial trial by VIVA technicians proved unsuccessful and they were not able to establish the desired point-to-point wireless link. VIVA's technicians failed to establish the link due to their lack of experience in working with low-cost equipment. They were more familiar with installing and working with more robust and powerful equipment. INDOTEL's team was, however, not convinced that the link would not function and asked the operator to let them make a final test. Due to the inaccessibility of the site and the time needed to reach it by road, INDOTEL's team hired a helicopter to transport its technicians, who succeeded in establishing the link in less than one hour. Once the link was established with equipment supplied by INDOTEL, VIVA installed a Wi-Fi hot spot in *Los Botados,* installed the link to its existing broadband network in *La Naviza* and started to provide broadband services to the community and to the CCI on 11 August 2007.

Picture N° 11: Technical team at La Naviza

Source: Edwin San Román

The enthusiasm of young people was overwhelming. It did not take long for them to put Wi-Fi cards into their computers and go online. The day that the link and hot spot were turned on, ten computers from the CCI and 11 private computers were connected to the Internet via broadband. The CCI started to operate full time and many children, young people and even adults started attending training courses. In November 2007, the graduation of more than one hundred people from a basic computer course turned out to be a great and festive community event attended by many relatives, “godfathers” of the graduates and others. This was concrete evidence that people in rural areas are just as much at ease as their brothers, sister, cousins and friends in the cities and large urban areas in adapting to the new technology when given the opportunity.

Picture N° 12: Graduation ceremony in Los Botados

Source: Edwin San Román

The arrival of broadband in *Los Botados* changed the lives of many people in a very short time. Fredy Ortega (Yendy), is a case in point. He used to be a motorcycle taxi driver with an interest in technology, in general, and computers, in particular. Once his community had been connected, Fredy took a short training course in Santo Domingo and became an expert in assembling and repairing computers. He set up a small cyber-café where the young people of *Los Botados*, who did not have computers, could access Internet by paying a small fee. He has also become an ICT teacher in the CCI in *Don Juan*, a community some 15 km from *Los Botados*. In a very short time, Yendy went from earning a living by driving people around on the back of his motorcycle to becoming a small entrepreneur and teacher of computers and software.

Picture N° 13: Cyber-café in Los Botados

Source: Edwin San Román

It soon became evident that the ten computers at the *Los Botados* CCI were not enough to meet demand. Following the mayor's request, INDOTEL decided to provide ten more computers which, however, needed to be assembled. They were given to a group of young people who, under the supervision of the former motorcycle taxi driver, assembled them and installed Wi-Fi cards in a matter of only five hours.

Picture N° 14: Young people assembling computers for internet access

Source: Edwin San Román

The arrival of broadband provided a big creative stimulus for other young people as illustrated by the cases of Wilfrido de Paula and Jean Carlos de León, two university students, who lived in the small community of *La Yautía*, 2 km from the *Los Botados* hotspot. Not long after broadband was available in *Los Botados*, Wilfrido and Jean Carlos, who like their friends in *Los Botados* also wanted to be able to connect from their homes, put their minds together in an attempt to figure out how they could do this. They bought a US$ 15 Wi-Fi card and started looking for ways to get connected. Using only old kitchen pots and coaxial cables they built an antenna, which allowed them to establish a wireless broadband link with the Wi-Fi transmitter in *Los Botados*. Since they did not have enough money to build a tower, they attached their home-made antenna to a coconut tree (pictures N° 16 and 17).

Picture N° 15: Antenna made of kitchen pots

Source: Edwin San Román

Their efforts made the headlines not only in national newspapers and on local television but also in the international media including UNIVISION, an American broadcaster with an international audience. Reporters visited *La Yautia* interviewed them and took note of the installations they had connected.

Picture N° 16: Home-made antenna in coconut tree

Source: Edwin San Román

In January 2009, they were honoured with the National Youth Award, and in February 2009, they received scholarships to study information technology in the *Instituto Tecnológico de las Americas* (ITLA) in Santo Domingo[25]and to participate in a one week leadership training course in Miami.

Picture N° 17: Home-made antenna in coconut tree

[25] http://www.itla.edu.do/

Source: Edwin San Román

VIVA is providing Internet access services to the whole of *Los Botados* for free and the community is covering all the costs of the CCI since August 2007. Since then, the support given by the telecommunication operators to the pilot has been very proactive. As a result of this pilot, the people of *Los Botados* can today choose between two companies that offer mobile telephony services and wireless Internet services, and one of them, Claro-Codetel, now also offers a connection through fixed wireless residential lines. The pilot opened the eyes of the national operators to the telecommunications demand and potential business opportunities throughout the country.

The inauguration of the pilot project in *Los Botados* was a turning point in INDOTEL's *Rural Broadband Connectivity Project*. Many guests were impressed by the project's success and coupled with the full press coverage of the event, stakeholders no longer needed to be convinced that such a rural broadband project was viable.

6. Overview of broadband technologies[26]

Several different technologies can be used to build broadband networks. Each has a different impact on the cost, acceptability and feasibility of a rural broadband connectivity project. This section gives a short overview of both wired and wireless technologies that are currently available or that are in the process of being developed. Their use is illustrated with reference to rural broadband projects in the Dominican Republic, supported by the example of similar projects carried out in Peru.

While it is important that regulators and those in charge of promoting rural broadband projects be well informed about current and future technologies, their costs and suitability for a given application and their evolution, it is very important that no specific technology be imposed on operators and service providers who will ultimately be given the responsibility for building and operating these networks. The principles of competitive market and technological neutrality must be allowed to prevail to ensure that the best, most economical and sustainable solution is chosen

[26] http://www.ictregulationtoolkit.org/en/Section.1318.html

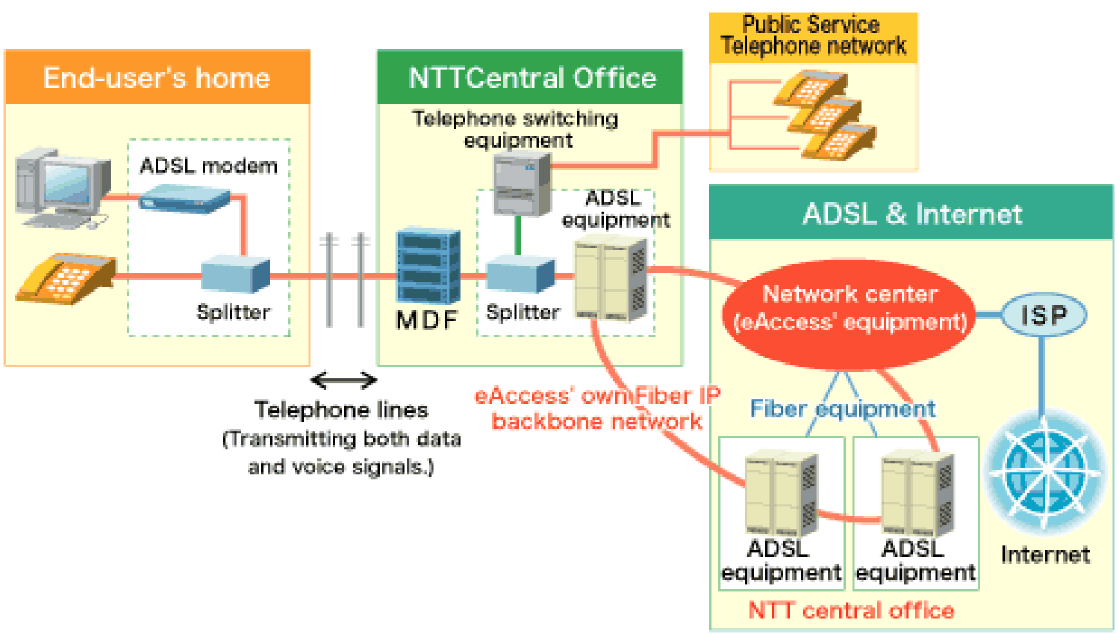
from among all available ICT technologies. Technology is neither independent of the market nor the sole determining factor for the success of a rural broadband project.

6.1. Wired

6.1.1. DSL over copper local loop[27]

Wired digital subscriber line or DSL uses the copper local loop of the telephone network to the home or business to provide high speed data access with speeds up to 52 Mbit per second (Mbps). Data traffic is transmitted over the same copper pair as voice telephony but in a different frequency band separated using a filter or splitter. The data channel can be connected directly to a data network or to the Internet. There are several versions of DSL including ADSL (where A stands for asymmetrical) and VDSL (where V stands for very high bit rate). The most common and economic version, ADSL-Lite, can support down-link speeds of up to 1.5 Mbps and up-link speeds of up to 384 Kbps. Table N° 2 shows an overview DSL types.

Figure N° 2: ADSL Network Structure (MDF = main distribution frame)



Source: www.eaccess.net/en/company/img/etc/ttl_enterprise_sub5.gif

[27] See reference N°2.

Table N° 2: Overview of types of DSL

Table 2.2: The flavours of DSL

Description of selected xDSL technologies with data rate

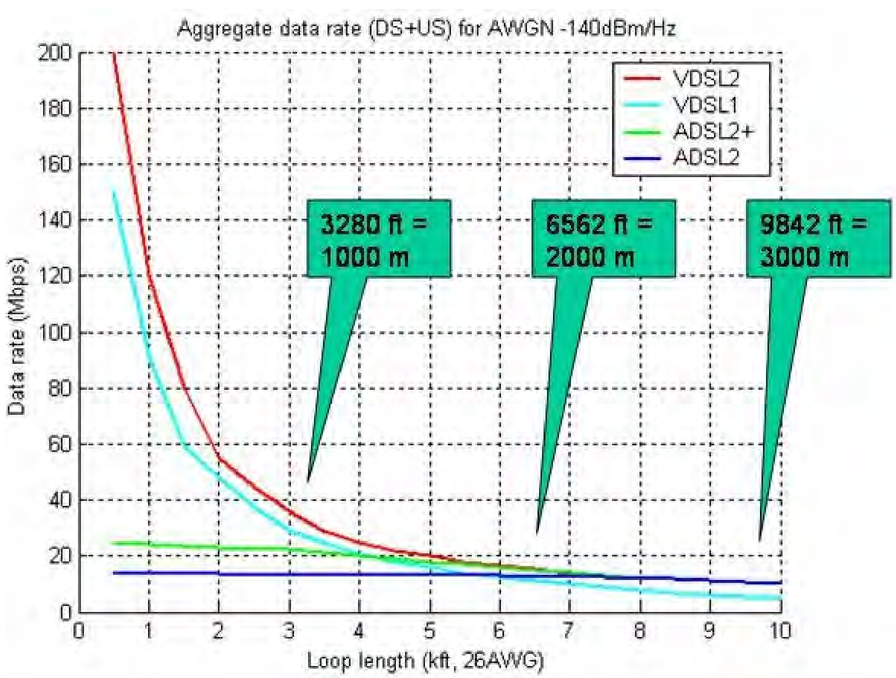
xDSL	Description	ITU Recommendation	Net data rate
SHDSL	Single-pair high-speed digital subscriber line	G.991.2	192 kbit/s to 2.312 Mbit/s
ADSL	Asymmetric digital subscriber line	G.992.1	1.5 to 6.1 Mbit/s downstream 16 to 640 kbit/s upstream
ADSL2	Asymmetric digital subscriber line	G.992.3	up to 8 Mbit/s downstream up to 800 kbit/s upstream
ADSL2+	Asymmetric digital subscriber line 2+	G.992.5	up to 16 Mbit/s downstream up to 800 Mbit/s upstream
VDSL2	Very high-speed digital subscriber line 2	G.993.2	up to 100 Mbit/s downstream up to 100 Mbit/s upstream

Source: ITU

Source: ITU

The throughput capacity of DSL depends of the length of the access loop as is shown in figure N° 6.

Figure N° 3: Data rate vs. loop length



Source: DSL Forum

DSL is used mainly in areas where a wire telephone connection exists, such as urban and sub urban areas. The deployment of DSL in such areas is easy, cost effective and considerably cheaper than other technologies.

6.1.2. Coaxial (ex. DOCSIS and HFC) and fibre optic cable systems

Coaxial cable systems, when built with Data over Cable Service Interface Specification (DOCSIS), can support downstream speeds of up to 30 Mbps and upstream speeds of 3 Mbps. Building networks with DOCSIS gives the usually unidirectional cable TV networks bidirectional capability.

Fibre optic cable systems can support speeds in the terabit per second (Tbps) range. They allow for better quality than coaxial cable because there is no crosstalk, no electromagnetic or radio interference, and they are less expensive to maintain.

In rural areas of many countries, there are small cable operators who can potentially offer a good alternative to providing broadband Internet access and telephony; however, interconnection requirements and regulatory impediments in some countries often make it too difficult and costly for them to provide the service legally[28].

6.2. Wireless

6.2.1. Mobile communication

According to the ITU-infoDev ICT Regulation Toolkit "*The development of mobile technologies and services in the last two decades has had massive implications on the ICT landscape. Mobile technologies enable mobility and flexibility in the use of ICT services. While these technologies have primarily been driven by voice telephony but in their development, they embrace the whole portfolio of converged services, particularly when it comes to wireless standards and the new generation mobile technologies*"[29].

[28] Many of them are already interconnected illegally, through fix-lines.
[29] http://www.ictregulationtoolkit.org/en/Section.1870.html

Second Generation

GSM (Global System for Mobile Communications) is the most popular standard for mobile telephony in the world. Since both the signalling and speech channels are digital, it has been easy to adapt this second generation (2G) mobile system to data communications (3G).

The ubiquity of the GSM standard has been an advantage to both consumers and operators who can buy equipment from any of the many vendors. The standard also offers short message service (SMS), a low-cost alternative to voice calls, which is now supported by all other mobile standards. In addition, newer versions of the standard are backward-compatible with the original GSM phones. Release '97 of the standard added packet data capabilities through General Packet Radio Service (GPRS) and Release '99 introduced higher speed data transmission using Enhanced Data Rates for GSM Evolution (EDGE). EDGE supports data speeds up to 236.8 Kbps with end-to-end latency of less than 150 msec.

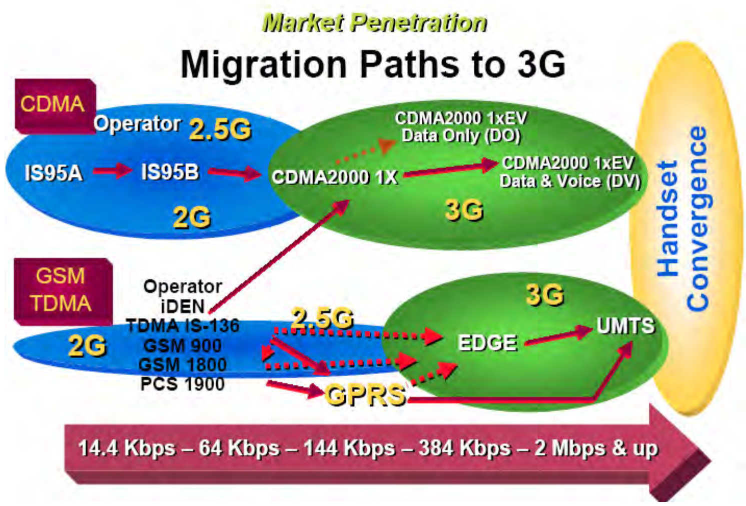
GSM operates mainly on 900 and 1800 frequency bands. In North and South America it operates also in the 850 and 1900 MHz bands.

CDMA (Code Division Multiple Access) is a spread spectrum technology with a special coding scheme (where each transmitter is assigned a code) to allow multiple users to be multiplexed over the same physical channel. CDMA (IS-95A) or CDMAOne is the second generation (2G) version of CDMA. The so-called 2.5 G version, CDMA (IS-95B), offers speeds up to 64 Kbps.

CDMA operates in the 450 MHz, 700 MHz, 800 MHz, 850 MHz 900 MHz, 1700 MHz, 1800 MHz, and 1900 MHz frequency bands.

CDMA has evolved through several steps to its third generation (3G) data only (CDMA 1x EV-DO) and data and voice (CDMA 1x EV-DV) versions. Figure N°7 shows the migration paths for CDMA and GSM to 3rd Generation mobile technologies.

Figure N° 4: GSM and CDMA Migration Paths to 3G³



Source: Stern and Townsend (2007)

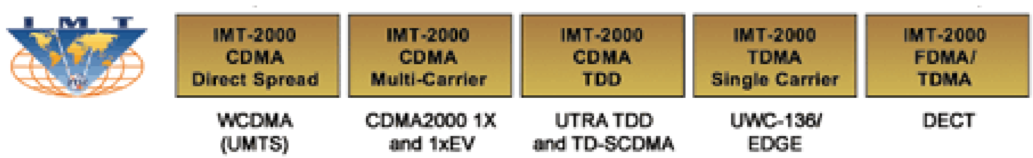
Third Generation (3G) and IMT-2000

Third Generation (3G) is used to describe mobile services which provide advanced voice communications and high-speed data connectivity, including access to the Internet, mobile data applications and multimedia content. The International Telecommunication Union (ITU), working with industry standards bodies from around the world, has defined the technical requirements and standards as well as the use of spectrum for 3G systems under the IMT-2000 (International Mobile Telecommunications-2000) program, which, inter alia, requires that IMT-2000 (3G) deliver improved system capacity and spectrum efficiency over 2G systems and that it support data services at minimum transmission rates of 144 kbps in mobile (outdoor) and 2 Mbps in fixed (indoor) environments.

Based on these requirements, the ITU in 1999 approved five radio interface standards for IMT-2000[30]. Three of the five, W-CDMA, CDMA2000[31], and TD-SCDMA are based on CDMA (figure N° 8). In October 2007, ITU added the WiMAX air interface specification as the 6th IMT-2000 technology and modified the general naming conventions for IMT technologies: 3G technologies continue to be known as “IMT-2000”; 4G technologies will be known as “IMT-Advanced”, and collectively, all of the 3G and 4G technologies will be known as simply “IMT”.

[30] ITU-R Recommendation 1457.
[31] CDMA2000 is also known by its ITU name, IMT-2000 CDMA Multi-Carrier (MC).

Figure N° 5: IMT 2000 Terrestrial Radio Interfaces



Source: http://www.cdg.org/technology/3g.asp

W-CDMA and CDMA2000 are two 3rd Generation mobile standards which are being used in Dominican Republic and Peru.

W-CDMA (Wideband Code Division Multiple Access), designated by the ITU to be the main technical standard for 3rd Generation or UMTS mobile communications standard, supports transmission speeds of up to 384 kbps in an outdoor environment and up to 2 Mbps in a fixed indoor environment. It operates in the 850 MHz, 1900 MHz and 2100 MHz frequency bands.

Many GSM operators in Latin America are upgrading to W-CDMA-HSPA[32] which is becoming a very promising and cost effective way to provide broadband access in unserved areas with speeds up to 384 Kbps. In Dominican Republic, under the Rural Broadband Connectivity Project, more than 300 localities are being provided with broadband access via W-CDMA- HSPA.

CDMA2000 (Code Division Multiple Access 2000) or IMT-2000 CDMA MC is a hybrid 2.5G/3G CDMA standard used for digital radio, to transmit voice, data and signalling information (such as a the dialled telephone number) between mobile phones and cell sites. CDMA2000 designates a family of mobile standards that includes:

- CDMA 1x, which doubles the voice capacity of CDMAOne and delivers peak packet data speeds of 307 kbps in mobile environments;

- CDMA2000 1xEV-DO,which comes in the following versions:

[32] WCDMA-HSPA, High Speed Packet Access – an extension of WCDMA to provide high bandwidth and enhanced support for interactive, background and streaming services.

- CDMA2000 1xEV-DO Rel. 0 delivers peak data speeds of 2.4 Mbps and supports applications such as MP3 transfers and video conferencing;
- CDMA2000 1xEV-DO Rev. A increases peak rates on reverse and forward links to support a wide-variety of symmetric, delay-sensitive, real-time, and concurrent voice and broadband data applications; and
- CDMA2000 1xEV-DO Rev. B which provides integrated voice and simultaneous high-speed packet data multimedia services.

CDMA2000 1xEV-DO Rev. A and CDMA2000 1xEV-DO Rev. B are both backward compatible with CDMA2000 1x and CDMAOne. CDMA2000 supports data communication speeds ranging from 144 kbps to 2.4 Mbps.

There has been growing interest in using CDMA in the 450 MHz band, for rural, suburban and sparsely populated areas for both mobile and fixed applications. This is due to the relatively large cell sizes that are possible at this frequency, which makes deployment less expensive because fewer base stations are required to cover a given area as show in Table N° 3.

Table N° 3: Theoretical cell sizes that can be achieved using CDMA 2000 1x in the different frequency bands

Frequency band (MHz)	Cell Radius (Km)	Cell Area (Km^2)	Normalized Cell Count
450	48.9	7,521	1
850	29.4	2,712	2.8
1900	13.3	553	13.6
2100	10	312	24.1

Source: Response by Lucent Technologies to Questionnaire 2, usage of Lower Frequency Bands in the AP Region, 2nd Meeting of the APT Wireless Forum, Shenzen, PR China, September 5-8, 2005.

The single, largest hurdle to the development of CDMA 450 is commercial. The low number of handset options available, their higher price, and the fact that few offer multi-band capability, has been an impediment to growth of this standard. In addition, the development of innovative approaches to rural network design and marketing by the GSM operators has limited the market for CDMA 450. The International 450 Association[33] and a number of mobile operators have created an alliance to aggregate purchases in a bid to drive down costs of terminal equipment through bulk purchases and to nurture a market for entry-level devices.

In Peru, a small rural operator deployed the first commercial CDMA 450 network in Latin America in 2005 and has since February 2009 been deploying infrastructure for fixed broadband telephone access to more than 800 small communities across the country[34].

Table N° 4 indicates the year of its launch and the number of world-wide networks and subscribers for several mobile Internet and broadband access technologies.

Table N°4: Mobile internet and broadband access technologies

Technology	First commercial launch	Nb of networks 2Q2008	Nb of subscribers of mobile broadband networks 2Q2008	Data rates
CDMA 1x	1999	269 (+21*)	349 990 000 *(incl. CDMA 1 × EV-DO rev.0-B)*	153 kbit/s (Release 0) or 307 kbit/s (Release 1)
CDMA 1xEV-DO rev.0	2001	105 (+40*)	100 020 000	300-600 kbit/s
CDMA 1xEV-DO rev. A	2003			1.8 Mbit/s
CDMA 1xEV-DO rev. B	2005			< 4.9 Mbit/s
WCDMA	2001	182	302 840 000 (3Q2008) *(incl. HSPA)*	384 kbit/s
3G TD-SCDMA	2008	1	n/a	2-4.75 Mbit/s
HSDPA	2005	127 (+31*)	50 000 000	1.8-7.2 Mbit/s
HSUPA	2007	6 (+20*)		1.4-1.9 Mbit/s
WiMAX	2005	305	1 700 000	10-70 Mbit/s

Source: ITU, Trends in Telecommunication Reform 2008: Six Degrees of Sharing, based on data from CDMA Development Group, GSMA, UMTS Forum, GSA, WiMAX Forum, 3G Americas and other

6.2.2. Broadband wireless access (WiMAX, WiFi)

WIMAX (Worldwide Interoperability for Microwave Access) is a wireless broadband transmission standard for data, which can be used in a variety of ways including point-to-point links and portable Internet access. It does not need cables. WiMAX is based on IEEE standard 802.16 which

[33] http://www.450world.org/
[34] http://www.televiasperu.com/

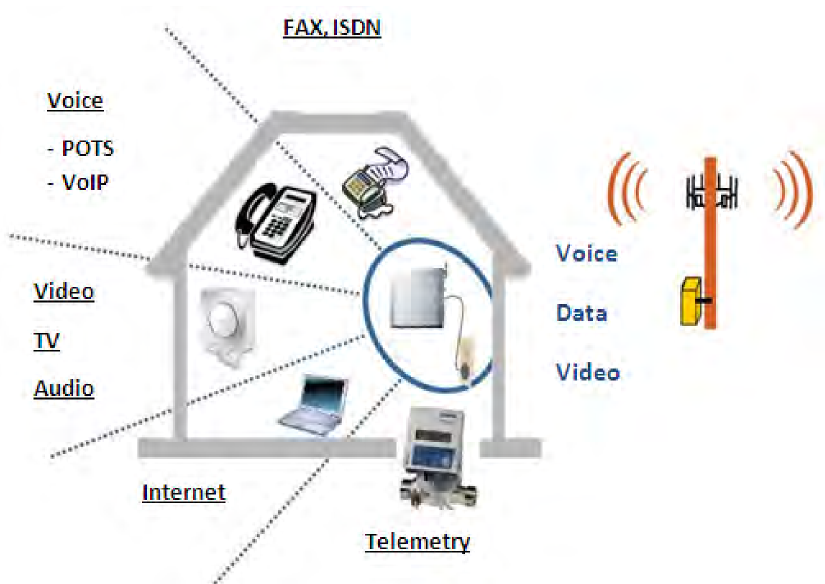
is also known as the Broadband Wireless Access (BWA) standard and provides up to 75 Mbps symmetric broadband links. It can be used as an alternative to cable and DSL for last mile wireless broadband access. See Figure N° 9.

IEEE standard 802.16-2004 or IEEE 802.16d, named after the IEEE working party that developed it, is frequently referred to as "fixed WiMAX" since it does not support mobility. IEEE 802.16e-2005, a modification of IEEE 802.16-2004, often referred to as IEEE 802.16e allows for mobility and is therefore referred to as "mobile WiMAX".

As mentioned earlier, in October 2007 the ITU Radiocommunication Conference decided to include WiMAX-derived technology in the framework of the IMT-2000 set of standards.

While there has been broad interest and enthusiasm for WiMAX technology and its potential, the business case for this standard and its ultimate success will be determined, as with other technologies, by market factors, including competition, demand, affordability of services, customer density, price and availability of end-user terminals[35]. The current main impediment for the wide use of this technology in rural areas remains the high cost of the end-user-terminals.

Figure N° 6: Actual uses of WiMAX technology



Source: WiMAX Aplicaciones y Servicios. Siemens. Jaime Martínez.

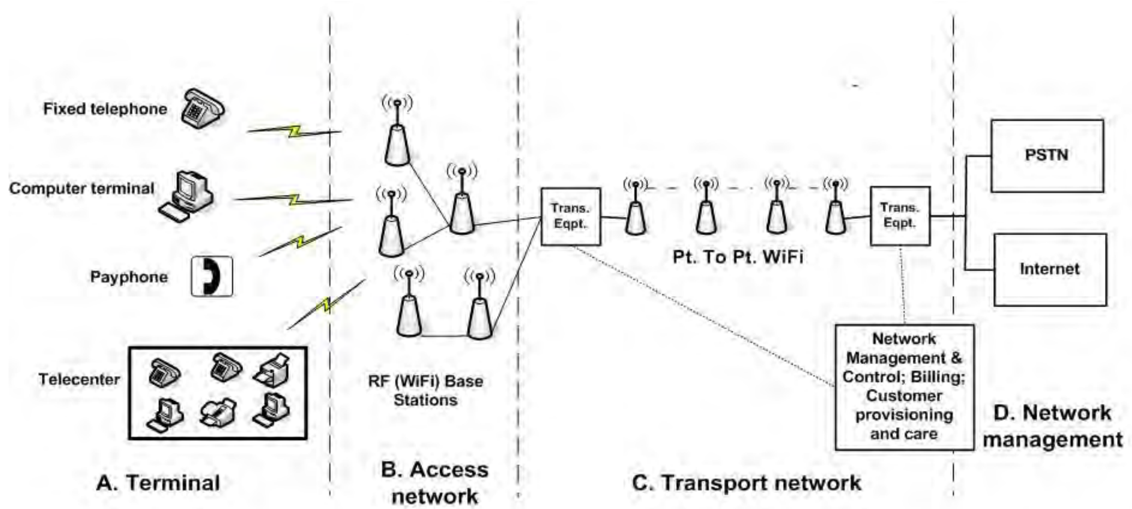
[35] See Annex 5 of Stern and Townsend, 2007.

Wi-Fi (Wireless Fidelity) is a Wireless Local Area Network (WLAN) technology and standard, which primarily provides short-range, wireless, high-speed data connections between mobile data devices (such as laptops, PDAs and telephones) and nearby Wi-Fi access points. There are several variations of the Wi-Fi standard, referred to as IEEE 802.11. The most common is IEEE 802.11b, which provides speeds up to 11 Mbps. IEEE 802.11g and IEEE 802.11a are faster versions of IEEE 802.11b with the former supporting speeds up to 52Mbps. Many IEEE 802.11g and IEEE 802.11a devices are backward-compatible with the original IEEE 802.11b.

Wi-Fi is a very good and cost effective solution for covering large areas in rural and unserved areas. Hot spots with amplifiers can easily cover ranges of up to 8 km. The low cost equipment and terminals make it affordable for low income populations. Non-mobile technologies such as Wi-Fi and wireless mesh networks built using Wi-Fi technology are well suited for small, local initiatives for which large and expensive centralized projects are not feasible. Typically, non-mobile technologies can support VoIP alternatives to 2G telephony.

Figure N° 10 illustrates a network that combines a Wi-Fi local access mesh network, with a point-to-point Wi-Fi transport link.

Figure N° 7: Access with a Wi-Fi mesh and Wi-Fi transport



Source: Stern and Townsend (2007)

Wi-Fi has been deployed with success in many universal access and service (UAS) projects in rural and remote areas to provide Internet points of presence. The main advantages, especially for developing countries, are[36]:

i. the availability of high data throughput rates (compared with many 3G technologies);
ii. its flexibility for small networks to develop outside of large centralized organizations;
iii. the use of radio frequencies that are exempt from licensing in many countries where Wi-Fi frequencies are intended to be used by equipment with very limited range and indoor applications, for which interference does not need to be controlled through licensing; and
iv. the possibilities of acquiring cheap standard equipment that is readily available and has been type approved for many countries.

Table N° 5 summarizes the basic specifications for various versions of the WiMAX and WiFi standards.

Table N°5: The basic specifications for various versions of the WiMAX and WiFi standards

Standard (technology)	Release date	Frequency Band(s)	Radio technology	Max net data rate	Max indoor range	Max outdoor range
IEEE 802.11 (WiFi)	1997	2.4 GHz	DSSS	2 Mbit/s	20m	100m
IEEE 802.11a (WiFi)	1999	5 GHz	OFDM	54 Mbit/s	35m	120m
IEEE 802.11b (WiFi)	1999	2.4 GHz	DSSS/CCK	11 Mbit/s	38m	140m
IEEE 802.11g (WiFi)	2003	2.4 GHz	OFDM, DSSS	54 Mbit/s	38m	140m
IEEE 802.11n (WiFi)	2009	2.4 GHz,5 GHz	OFDM, DSSS	600 Mbit/s	70m	250m
IEEE 802.16d (Fixed WiMax)	2004	2 – 11 GHz	OFDM	75 Mbit/s	variable	15-50km
IEEE 802.16e (Mobile WiMax)	2005	0.7 – 6 GHz	OFDM/ OFDMA	15 Mbit/s	variable	1.5-5km

Source: ITU

[36] See Annex 5 of Stern and Townsend, 2007.

6.2.3. Satellite

Very Small Aperture Terminals (VSAT) are the most common satellite communication systems used for voice and Internet applications in rural and remote areas; however, the high cost of the equipment and especially the space segment compared with terrestrial radio and wireless access networks limits VSAT applications to quite remote areas. VSATs have been used successfully for providing fixed public access to telephony and broadband Internet in remote areas in many countries. Many good examples can be found in Peru, Chile, Colombia, Brazil, the Dominican Republic, Mongolia, Nepal, South Africa and other countries.

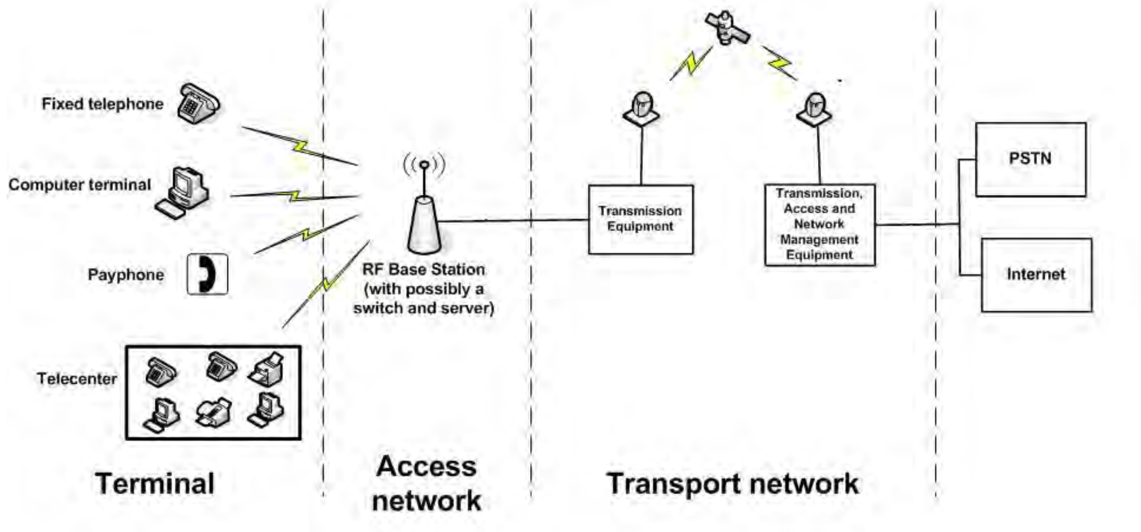
VSAT systems are sometimes also used as backbone networks for remote rural exchanges and mobile base stations (Picture N° 18).

Picture N° 18: VSAT transport network infrastructure in Puno, in the Peruvian highlands

Source: FITEL

Figure N° 11 shows a Broadband Wireless Access (BWA) with satellite transport.

Figure N° 8: Broadband Wireless Access (BWA) with satellite transport



Source: Stern and Townsend (2007)

6.2.4. End user equipment

Advances in technology as well as economies of scale are lowering the costs of terminals for broadband users of which there are basically two types: (i) terminals that allow the Internet connection at home known as CPE (Customer Premise Equipment) and (ii) terminals that allow the user to use the Internet and to navigate, also known as end user devices.

The cost of CPEs is fundamental to establishing the viability of a project. It can be the deciding factor in cases where, for example, the network can be built cost effectively.

Convergence and technological advances are merging previous distinctions between types of end user devices as illustrated by the range of different devices that are available today: (i) personal digital assistant (PDA); (ii) combined phones, video cameras and music players; (iii) internet-enabled mobile phones such as Blackberry or iPhone that enable e-mail and web-browsing among other wireless services; and, (iv) powerful handheld 3G end-user devices that offer “triple-play” services: i.e. telephony, Internet and IPTV and mobile TV, such as Palm computers, PlayStation portables, etc.

7. Use of geographical information systems (GIS) and Google Earth in planning rural telecommunications projects

7.1. What is GIS?

Geographical information systems (GIS) combine hardware, software and data to capture, manage, analyze and display all forms of geographically-referenced information. Users can create interactive queries, analyze spatial information and edit data and maps. GIS is a structured geographical database that makes worldwide geographic data available in two formats:

i. the Vector Model uses three geometric elements including points, lines or polylines and polygons, which correspond to discrete objects and therefore definite limits;

ii. the Raster (Matrix) Model divides a given space into regular cells where each cell represents a unique value. This model focuses on the properties of space rather than the accuracy of the location.

GIS allows simultaneous spatial analysis of different layers of information representing census information, elevation, road networks, hydrographical data, infrastructure and telecommunications network elements and project information, etc.

7.2. Benefits of using GIS in planning rural telecommunications projects

GIS can be used in planning telecommunications projects to facilitate the decision-making process, including deciding where to put base stations and repeaters for a wireless project to optimize the design and coverage footprint and, ultimately, the best location for the project.

The decision-making process, which requires that data be collected, processed, and analyzed before the results can be presented and decisions can be taken, is facilitated by the fact that information from the different layers mentioned above gives an almost exact determination of the best coverage areas for deploying the project.

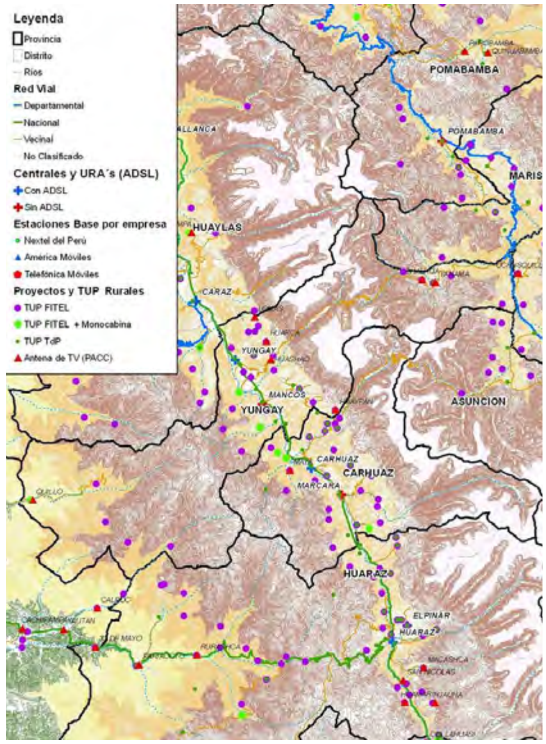
Gathering geo-referenced data such as geographical, demographic, economic and infrastructure information is, however, the most difficult task when using GIS and, if it has to be done manually, an extremely laborious task. However, in many cases there are already existing databases that can be used (government resources, national statistical offices, local authorities resources, etc.) in telecommunications projects.

GIS has been used extensively since 2001 in Peru where there are many organizations involved in gathering the required input. OSIPTEL, the telecommunications regulator, has been one of the lead users of GIS for elaborating telecommunications projects and even for calculating the walking distances to public telephones taking into account the hills and valleys that any potential user would have to cross to gain access to a telephone. In Dominican Republic, GIS is not as widely used as in Peru, even though there are several applications that do use them.

For example in the case of Peru, figure N° 12 below shows the political divisions in the country (black lines), the road network (blue and green lines) and rivers (dotted blue lines). The colored dots represent the location of FITEL[37] and other publicly financed public phones and public Internet centers.

[37] FITEL (Fondo de Inversión en Telecomunicaciones) is Peru's Universal Access Fund.

Figure N° 9: Use of GIS in Peru

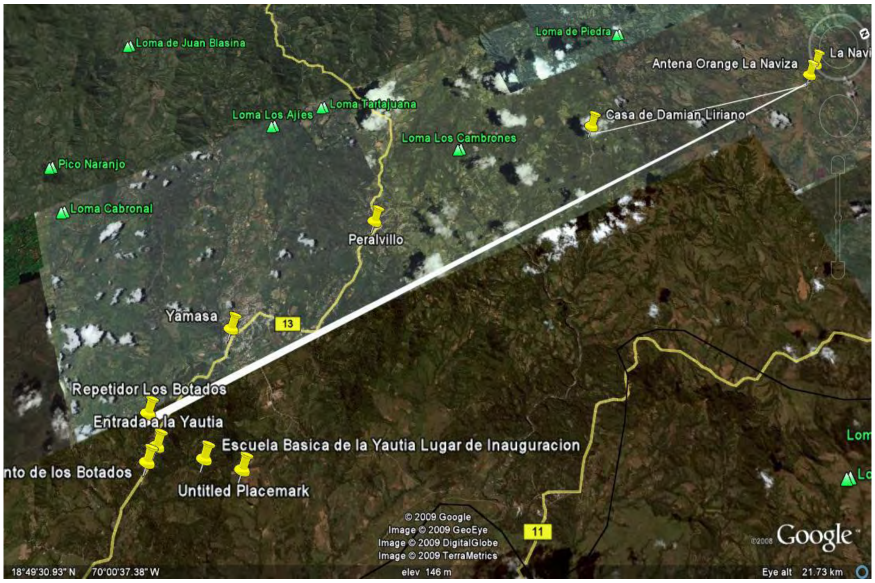


Source: FITEL

7.3. Google Earth

The Google Earth application, among many others currently available, **i**s a powerful tool that can be used for analyzing and planning telecommunications projects. It costs nothing to use in its basic version and allows data of locations from GIS to be imported. With Google Earth it is easy to determine where the best place is to build a telecommunications network to suit a specific purpose. Depending on the degree of resolution of the Google Earth image, it is possible to identify individual houses, roads and even see existing elevations. Google Earth can provide a very good first approximation of distances and help the design engineer determine whether there is line-of-sight between any two specific points (figure N^{o} 13). It is an ideal, first step tool for planning the required network infrastructure and coverage.

Figure N° 10: Creating lines-of-sight for wireless links between specific points in the Dominican Republic rural areas

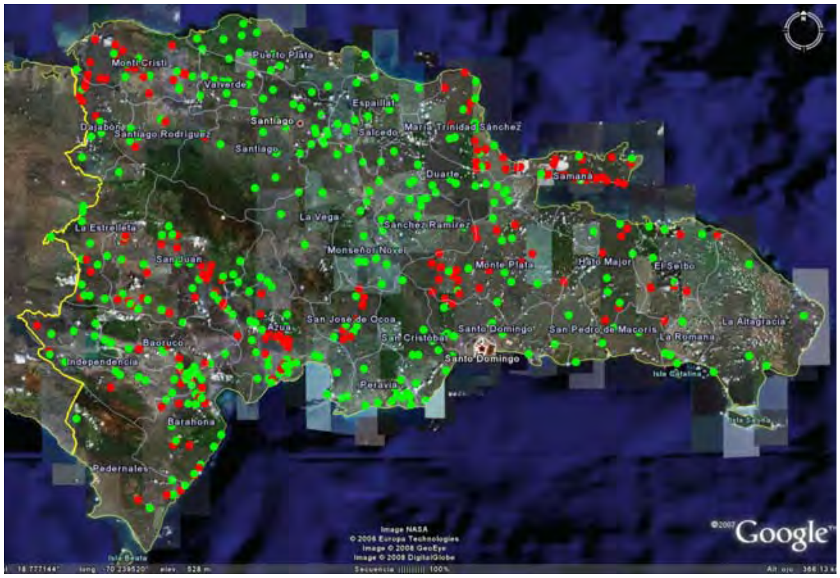


Source: Google Earth, Edwin San Román

Google Earth was used in the Dominican Republic in both the *Los Botados* pilot project and the *Rural Broadband Connectivity Project* from the development stage through to the infrastructure design stage, including the design of the transmission system and to determine coverage. In both cases the technical team designated by INDOTEL first obtained the coordinates of all localities to be covered and then overlaid these coordinates on a Google Earth image of the target area giving a view of location clusters which were within line-of-sight for wireless links. This allowed them to determine the best places for interconnections, taking into account existing transmission infrastructure.

Figure N° 14 shows the distribution of local governments (green dots) and localities (red dots) for the whole of the Dominican Republic.

Figure N° 11: Rural Broadband Connectivity Project in the Dominican Republic



Source: Google Earth, Edwin San Román

PART IV: PRACTICAL MATTERS TO CONSIDER AND STEPS THAT NEED TO BE UNDERTAKEN IN DEVELOPING AND IMPLEMENTING A RURAL BROADBAND PROJECT

8. Developing a rural broadband project

The development and implementation of a rural broadband connectivity project requires first that the administrative and legal underpinnings for the project, the nature of the licence to be awarded and the contract to be signed are well understood. It also requires that a number of practical steps be undertaken to complete the project successfully, including assessing demand, running an economic model to determine the maximum subsidy to be offered, the tender procedure, project supervision, development of dedicated web pages, awareness raising and capacity building.

Since broadband access allows not only Internet but also other services to be delivered, it is recommended that the provision of residential telephone[38] services be included as a requirement of the project. This enhances the potential for its sustainability because of the higher profit margins that can be derived from this service in comparison to those generated by Internet alone.

8.1. Administrative matters and legal basis

Before the bidding and contracting procedures for such a project can begin, the regulator or policy maker must ensure that the required legal and regulatory framework and administrative rules are in place before the infrastructure can be built and operated and determine the type of services to be provided.

In the Dominican Republic this framework and these rules are set out in the following documents:

- the General Telecommunications Law (No.153-98),
- the Law on Procurement and Contracts for Goods and Services, Construction and Concessions of the State (Law No. 340-06),

[38] Residential telephony can be provided using VoIP or any other suitable technology

- Telecommunications Universal Service Fund Regulations, and regulations on concessions, registrations and special licenses to provide telecommunications services.

In addition the social policy on universal service and the Universal Service Fund's 2007-2009 biennial budget were taken into account before the Rural Broadband Connectivity Project was started.

8.2. Nature of the licences and issues related to spectrum

Another issue concerns the nature of the licenses that will be awarded to the successful bidder(s) to operate the networks, to use certain frequencies, and to provide services. Ideally the selected operator should first be able to provide all services in the region covered by the project and then nationally under a global licence upon fulfilment of the project requirements and objectives. This is important, especially for potential new entrants, since it gives them an incentive to enter the market. Existing operators and service providers can have their existing licences modified to reflect the additional rights and obligations they have been given.

From the outset, the regulator must have a clear picture of the frequencies that can be assigned and how these are to be treated. Depending on the circumstances, the licenses and authorizations can be free or operators may be asked to pay for them.

In the Dominican Republic, INDOTEL decided that, if the successful bidder was a new entrant, it would automatically receive the necessary operating licence(s) once it had demonstrated that it met all the requirements. If it was an existing operator, its licence was to be modified automatically to reflect the added rights and obligations related to the *Rural Broadband Connectivity Project*.

With respect to spectrum, it was decided that potential bidders were to specify their requirements during the consultation phase of the project and, if successful, they would be awarded the required frequencies along with their operating licence without any additional charge. However, the successful bidder was to use these frequencies only in the coverage area of the project until completion of the project and confirmation by INDOTEL that all of the project requirements and objectives had been met. Thereafter, the company was to obtain the right to use the same frequencies in the whole country. This was designed to be an effective incentive for the successful bidders to finalize their projects according to the specifications and within the time frame prescribed.

8.3. Demand analysis

Like their counterparts in the cities, people in rural areas want to communicate with family and friends and access information of all sorts for entertainment, work, capacity building, general knowledge and many other purposes. Communication is a vital part of their daily social, political, formative and economic activities. This creates an identifiable demand for telecommunications services.

Demand studies are used in developing telecommunications projects to determine:

(i) the level of demand for different telecommunications services at determined prices, that the general population in rural areas can afford;

(ii) the minimum level of investment and operating costs needed to satisfy the demand, so that there will not be high tariffs or investment deficits that could raise tariffs; and

(iii) the potential rates of return on investments, a vital indicator for operators wanting to invest and operate in rural areas;

In addition, for rural access projects demand studies help:

(iv) determine the level of subsidies required to incite investors to invest in rural telecommunications projects which are otherwise not viable without subsidies; and

(v) set policies and incentives that facilitate access for operator to rural areas.

Even though demand for basic telecommunications services is predictable to a certain extent and can be measured *ex ante*, the demand for services, such as broadband, is harder to measure because of the lack of information on usage in unserved and underserved areas. Nevertheless, comparisons can be made with localities with similar characteristics that have been connected.

8.3.1 Normal method for determining demand in rural areas

There are four basic steps in determining demand in rural areas:.

1. Collect and analyze secondary data[39] and information such as demographics, the economic situation of households and individuals, geography, traffic and tariffs.

2. Collect, compile and analyze primary micro-economic data on individual customers, households, companies, institutions, and others by means of questionnaires, interviews and other information gathering tools[40].

3. Use econometric modelling techniques to determine the demand functions, establish the accuracy of the estimates, and calculate elasticity and other parameters needed to quantify demand. These techniques are used for each type of service, each geographic area, each period of time, for incoming and outgoing calls, payment types, and for different socioeconomic levels[41].

4. Evaluate and present the results, including an assessment of their relevance for the aspirations and objectives of the companies and/or institutions that required the demand estimates.

Although reliable, this method for determining demand is generally long, difficult and expensive, especially in a competitive sector where participants are reluctant to make commercially sensitive data, such as traffic flows on their networks, available to others, including the regulator.

[39] Secondary data is data previously collected by organizations such as national statistic or information agencies, census, etc. Primary data is data collected for the purposes of the rural broadband project; as such it has a special component on ICT-related information.
[40] For more information, see www.ictregulationtoolkit.org/en/Section.3335.html
[41] For more information, see www.ictregulationtoolkit.org/en/Section.3341.html

Rural as opposed to urban projects are characterized by the number of obstacles to obtaining reliable demand estimates including the lack of secondary data, the difficulties and higher costs of obtaining primary data, the scarcity of traffic data, and questionable results of demand assessments for telecommunication services from rural areas. To overcome these obstacles, the regulator in the Dominican Republic, following the example set earlier by his Peruvian counterpart used a practical, less complex and quicker approximation or proxy to determine demand a method described below, which can be used in countries where there are already some telecommunications networks in rural areas, which is the case in many countries in the world.

8.3.2 Approximation method used in Peru and in the Dominican Republic

Following are the six basic steps in the approximation method used in Peru and the Dominican Republic to determine demand:

1. Select and determine the precise location of all rural communities in the country. In Peru OSIPTEL[42] did this using the most advanced Geographic Information Systems (GIS) techniques available at the time[43]. This required a substantial amount of information to be gathered including: demographics, number of households, availability of electricity (especially for the Internet services), accessibility to the road network, etc.

2. Using the information obtained in Step 1, identify the communities with and without telecommunication services and designate those which are to get broadband and residential fixed lines.

3. Obtain and introduce all historical information on traffic available from rural communities with telecommunication services (e.g. public telephones) into the GIS model.

4. Obtain the per capita traffic by dividing the total traffic by the total population for a representative community. For Internet access services the indicator to be used is the population of the representative community divided by the number of cyber cafés in the

[42] OSIPTEL is the national regulator of Peru
[43]Arc GIS tool from ESRI. See http://www.esri.com/

localities that already have Internet service and the number of households that have residential Internet connections.

5. Apply the traffic structure[44] and the daily traffic per person in the community with access to the nearby unserved community. This gives a good estimate of daily traffic figures for both outgoing and incoming local, national long distance, international long distance and mobile calls. The daily traffic multiplied by the population of the targeted community and by 365 days constitutes the estimated annual demand for each service in this community.

6. For Internet access, apply the number of inhabitants per cyber café in the community with access to obtain the number of inhabitants per cyber café in the nearby community without access. With this data it is then possible to determine the number of cyber cafés per community and the bandwidth required.

In Peru, this analysis indicated that on average there is one cyber café for every 300 people in rural areas and 1 for every 500 nationally. In the Dominican Republic, a conservative estimate of 1 cyber café for every 1000 persons was made.

8.4. The economic model

8.4.1. Method used in Peru and in the Dominican Republic

Once demand has been assessed, an economic model is applied to determine the maximum amount of subsidy that can be made available. For this type of project this can simply be a cash flow analysis to determine the net present value (NPV) and the internal rate of return (IRR) of the project[45]. It requires the traffic data which is obtained from the demand study. Once demand is assessed, the total number of communities and, hence, the total traffic and number of Internet cafés to be included in the project can be determined.

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[44] The traffic structure is the distribution of traffic of incoming and outgoing calls for each of local fixed line calls, mobile calls and long distance calls.
[45] The ICT regulation toolkit elaborates on the quantitative socio-economic analysis using net present value (NPV) and the internal rate of return. See: http://www.ictregulationtoolkit.org/en/Section.3349.html

he next step is to get an estimate for interconnection charges, capital expenditure (CAPEX), operational expenses (OPEX) and profit margins. Finally, the average Return on Equity (ROE)[46] , a standard industry measure which has the advantage that it takes into account the special characteristics of the country, can be estimated. ROE can serve as approximation for the cost of capital since it describes the level of profitability required for telecommunications companies to be willing to provide telecommunications services.

In the Dominican Republic this analysis was carried out separately for each of the three types of services being considered: residential telephones, the Internet cafés and public call centres.

8.4.2. Determining the amount of the subsidy

Once the ROE has been determined, a simulation of the rural operator's or service provider's revenues and expenses is done by applying prices and costs to the forecasted level and distribution of traffic. The cash flow over a specific period of time and net present value (NPV) are then calculated.

A negative NPV means that the project is not profitable. To get companies to invest the rate of return of a project has to be equal or greater than what can be achieved elsewhere. This happens when the NPV is equal to zero or, in other words, when the IRR equals the discount rate. Therefore, a subsidy that makes NPV equal to zero has to be offered to make the rural project attractive for current operators and potential new entrants[47].

In the Dominican Republic the cash flow figures were determined separately for each of the three types of services mentioned. First revenues were calculated for each and then the cost including CAPEX, OPEX and maintenance was subtracted from the total revenue to give net revenue for each service. Cash flow was determined over the five-year period that the company is required to provide the services under its contract with INDOTEL. Finally, cash flow and NPV were determined

[46] The ROE is an indicator of profitability. It is determined by dividing net income for the past twelve months by owners' equity. The result is shown as a percentage and it is interpreted as a measure of the net income that a firm is able to earn as a percent of stockholders' investment.
[47] For more information, see www.ictregulationtoolkit.org/en/Section.3347.html

on a yearly basis[48]. The amount of subsidy required to make NPV zero was the maximum amount offered.

8.4.3. Other considerations

Given that the inputs into the demand study, including historical data, are obtained from neighbouring communities, the subsidy obtained is not likely to be exact. However, this is not important since the method described in sections 8.4.1 and 8.4.2 should result in a good approximation of a maximum subsidy, an amount likely to be underbid if the tender is carried out in a fair, non-discriminatory and transparent way.

In the Dominican Republic the financial assessment of the project was carried out over a five-year period which was to be imposed on the successful bidder. The five-year period was chosen because of the rapid evolution of technology and falling prices that require essential telecommunications equipment to be replaced every 4 or 5 years. Since prices in the future tend to be lower than current prices, calculating the cash flow using actual prices over a longer period may lead to a higher minimum subsidy than if a five-year period is used.

Another very important consideration results from the experiences gained with earlier rural public telephone projects in Peru, the Dominican Republic and elsewhere where an increasing number of unserved and underserved areas are being connected through rapidly expanding mobile networks and mobile telephones, which are becoming substitutes for fixed line connections and even for public telephones.

As a result, traffic from public telephones has fallen considerably. This has decreased the income of suppliers and made the projects less sustainable.

An earlier rural broadband project, the Agrarian Information System (SIA) Project in the Chancay-Hural Valley north of Lima, Peru built in 2005, is a case in point[49]. Here the introduction of a 3G mobile network that also offers broadband Internet access is becoming a substitute for the fix

[48] Because the cash flow analysis was carried out on an annual basis.

[49] http://access.apc.org/images/6/61/Community_Projects_Case_Study-_Huaral_valley_agrarian_ information _ system.doc

wireless infrastructure deployed only three years earlier. This raises the question about cost: if providing broadband services through the 3G operators is lower than the cost of providing these same services over the fix wireless line network.

For these reasons, it is important that the life of rural access projects be spread over five years. The contract should be flexible and allow for its renewal to allow for new technical, commercial and economic conditions unforeseen at the start of the project.

The objective should be to maintain the subsidy only where competition is not providing services on a commercial basis with comparable quality and prices.

8.5. Minimum subsidy auctions

Subsidies are used when the market alone is not enough to support network deployment and service delivery and where policy concerns justify public funding or redistribution of resources. A particular type of subsidy, known as a output based aid (OBA) subsidy, is often used in the telecommunications sector and, in particular, in conjunction with universal access and service projects[50]. OBA-type subsidies are intended to support investments, for example, in rural areas where the cost of construction and service provision combined with limited revenue potential makes the project commercially unfeasible. A key requirement for a one-time OBA-type subsidy is that it results in the establishment of an operation and service provision that should ultimately be self-sustaining and commercially viable.

In recent years minimum subsidy auctions have often been used in the telecommunications sector in conjunction with the economic model discussed in section 8.4 to select operators and service providers to implement universal access and service projects.

[50] OBA programs pay subsidies over a period of time, based on meeting pre-defined performance or continuous service milestones. While many OBA programs use minimum subsidy tenders, OBA projects can also be awarded and allocated using other criteria. See Executive Summary of Stern and Townsend, 2007 (http://www.regulatel.org/SU_Peter_31_08_07/Ab.Summary_v.9.PAS.pdf) and also ICT Regulation Toolkit, Module 3: Authorization of Telecommunication/ICT Services, at: www.ictregulationtoolkit.org/en/Section.507.html.

Such auctions are sometimes used in conjunction with OBA programs in which the payment of subsidies is tied to the successful bidder's meeting pre-defined performance criteria, such as the installation of a certain number of rural telephones in given areas[51].

The terms of reference of the project and auction have to clearly indicate the maximum amount of subsidy which was determined using the economic method described in sections 8.4.2 and 8.4.3 above. Competing bidders for the project will ask for amounts equal to or below this maximum, underlining the importance of having the economic model prepared with much caution and getting the right input data. Bidders will need to know how much room for manoeuvre they have when determining the amount of subsidy they will need to make their operation profitable and to what extent they can underbid their competitors to win the project.

8.6. The tender procedure (transparency and non discrimination in the evaluation of offers)

Once all the tender documents have been prepared and approved, they should be published, preferably on both the regulator's and government's web sites, and in at least three newspapers with national coverage to make sure that potential investors from home and abroad are informed about the project. It is also important that this publication be accompanied by a realistic timetable which gives interested parties enough time to assess the project, do the necessary technical evaluations and prepare the bid document.

In the Dominican Republic the time allowed for the whole process was five months. Bidders were given 60 calendar days after being prequalified to prepare their technical and economic offers (Table N° 6).

[51] See reference 3.

Table N° 6: Actual timetable for the Rural Broadband Connectivity Project in the Dominican Republic

Stage		Date
1	Resolution 149-07 of INDOTEL's board approves the tender	23 Aug. 2007
2	Project and tender announced (First notice)	6 Sept. 2007
3	Project and tender announced (Final notice)	10 Sept. 2007
4	Potential bidders acquire tender documents	6 - 20 Sept. 2007
5	Questions submitted by potential bidders on matters related to Envelope # 1[52]	up to 22 Oct. 2007
6	Answers provided by INDOTEL on questions submitted on matters related to Envelope # 1	up to 26 Oct. 2007
7	Submission of Envelope # 1	30 Oct. 2007
8	Envelope # 1 prequalification results announced	5 Nov. 2007
9	Questions submitted by potential bidders on matters related to envelopes # 2[53] and #3[54]	up to 20 Dec. 2007
10	Answers provided by INDOTEL on questions submitted on matters related to envelopes # 2 and #3	up to 26 Dec. 2007
11	Submission of by bidders envelopes # 2 and #3	3 Jan. 2008
12	Evaluation of bids received	up to 14 Jan. 2008
13	Envelope # 2 results announced	14 Jan. 2008
14	Opening of Envelope # 3 and announcement of winning bidder	17 Jan. 2008

Source: INDOTEL

Transparency of the tender process from start to finish is fundamental to ensure that there are a large number of bidders and a good competitive process. All bidders without exception should have access to exactly the same information at the same time. Any changes or new information must be immediately published on the relevant authority's web site and sent in writing to all those who acquired the tender document.

Bids should be evaluated by a team composed of engineers, economists and lawyers of the entity responsible for the tender if it has qualified personnel and/or specially contracted experts, so that bids are evaluated strictly in accordance with the terms of reference and other conditions of the tender. This may avoid accusations of favouritism or the use of veto powers by any evaluator, which must not and cannot be part of the process.

[52] Envelope #1 contained administrative information of the bidders.
[53] Envelope #2 contained the technical offer.
[54] Envelope #3 contained the economic offer.

The evaluation process has to be completely impartial, and technical aspects have to take priority. The project has to be awarded to the bid that requests the minimum subsidy amount and at the same time satisfies all technical and legal requirements specified in the tender documents.

8.7. The contract

The contract is a legal document signed by the chosen operator and the entity responsible for developing the concept for the project, conducting the tender, and supervising its implementation. Inter alia, it commits the operator that has been awarded the project to building and operating the agreed network and providing the agreed services and it commits the responsible entity to honour the amount of subsidies offered, supervise the deployment and operation of the infrastructure, and penalize the selected operator, if required. The contract has to clearly define all the terms used in the document and the objectives of the project. It has to state the general conditions and the guarantees, the obligations of each party, the deliverable documents, the spectrum assigned as part of the project, allowable tariffs, conditions of interconnection, penalties in cases of failure to execute the project, contractual deadlines, the arrangements for supervising the project during implementation and operation, causes for rescinding the contract, validity of the contract and other relevant matters.

8.7.1. Payment method for subsidies

There are different ways of paying out subsidies. The most common is a phased approach whereby, say, the initial 20% to 40% is paid out on contract signature; the second, 20% to 40%, once the infrastructure has been completely deployed and the final portion, in regular instalments every six months over a given period of time.

In the Dominican Republic it was decided pay 20% on contract signature, 40% on completion of installations and 40% in six month instalments over a period of five years.

All of these payments must be backed up during the deployment phase by letters of credit guaranteeing the successful completion and operation of the project. These letters are not required after the infrastructure has been completely deployed. Only confirmation that the services are being provided adequately and according to the conditions in the terms of reference and the contract are usually required. Failure to do so should result in payments being stopped.

8.8. Supervising the implementation of the project

Project implementation must be carefully supervised by the entity responsible for the project and tender, since this is the only legal guarantee that the network and facilities will be deployed properly according to specifications and in the agreed timeframe. This requires a team, the size of which depends on the scope of the project, but composed of at least three people (as was the case with the *Rural Broadband Connectivity Project* in the Dominican Republic): a team leader responsible for organization, planning and follow up of the project; a telecommunications engineer to confirm that the specified installations are deployed in each locality; and an administrator to deal with all the administrative issues of the contract. Where the size of the project requires more people, it might be necessary to contract people from outside or even outsource some of the work.

The first duty of the team in the Dominican Republic's *Rural Broadband Connectivity Project* was to visit each locality as soon as the contactor advised it that the project was ready-for-service. All installations were checked for conformity with specifications, including Internet up and downlink speeds, quality of voice on residential telephones and tariffs for telephone calls. The team also checked the training and the awareness raising programs that were being provided. Given the large number of installation that came on stream in a very short time, it was necessary for INDOTEL to temporarily increase the number of staff carrying out field supervision work by training additional technical and administrative personnel to support the base team.

8.9. Creation of dedicated websites for the communities to be served

The Internet allows each community and its residents to connect to the Information Society, to access information, generate local content, and give the rest of the world access to the community and thereby the possibility to interact with the community. This requires individuals who can create and develop local content on the community's website with information on the geographic location, how to reach it, tourist attractions, locally produced goods and the names and information about the local authorities. The task of creating a dedicated website should not be underestimated because it will be presenting the community to the rest of the world. It has to be designed so that information can be easily and frequently updated. The objective of the exercise should be not only to develop the local content but also to train the local community in computers and Internet use and to encourage local organizations to create content related specifically to these organizations.

It is highly recommended that there be in the contract with the operator or service provider selected to carry out the project an obligation that requires it to promote and assist in the creation of appropriate and relevant web content for each locality where broadband access is going to be provided.

In the Dominican Republic the company that was awarded the project had an obligation to create a web site with the sort of information described above for each of the 508 communities in the project service area (Figure N° 15). The company also had to train local people to maintain and update the website.

Figure N° 12: Web page of the Rural Broadband Connectivity Project

Source: Claro - Codetel

8.10. Raising awareness among the local population

Raising awareness among the local population is determinant for the success of the project. It is important for the community to know about the services they will be provided with and how they will be able to access and use them. The usual way of doing this is through a publicity campaign which targets the youth of the community, since they are the ones who are most up to date with technological developments and the most inclined to use them.

For the *Rural Broadband Connectivity Project* INDOTEL decided to take the awareness raising campaign directly to high schools. The strategy was to first create awareness and interest among the younger people who understood the new technology and who in turn were to serve as conduits in raising awareness and understanding of the new technologies and services among their parents, grandparents and other adults. This awareness raising campaign for the *Los Botados* pilot took place during the deployment phase of the project as shown in Picture N° 19.

Picture N° 19: Training course in informatics in a CCI

Source: Edwin San Román

8.11. Capacity-building to ensure sustainability of the project

Capacity building and training of the local population is essential in ensuring the sustainability of the project. People in the community have to understand the importance and potential of broadband Internet as well as of the services and applications that it can deliver. Otherwise they will never adopt it. People have to be trained to become customers of the service and thereby ensure the project's sustainability.

In the Dominican Republic the establishment of more than 867 CCIs was accompanied by an important training objective. Many hundreds of people had already received computer related training in the CCIs and were ready to use Internet the day their communities were connected to broadband access. As a result, in many places where broadband is now being provided demand could not be met due to insufficient installed capacity. Consequently, the operator has been forced to expand capacity.

Once young people discover the potential and benefits of broadband they soon find ways to get a computer (which may sometimes be second-hand) and get connected. This gave INDOTEL the idea to start a new and very ambitious project called Juventec and which uses an e-learning platform to train people in assembling, maintaining and repairing computers, in Java and webpage programming, and entrepreneurship. Figure N° 16 illustrates the Juventec webpage.

Figure N° 13: Juventec Web Page

Source: www.juventec.org.do

9. Other innovative funding mechanisms

Universal access and service funds are not the only mechanisms to fund projects which bring telecommunications networks and provide services to rural, unserved and underserved areas. They were not the only mechanisms used in the Dominican Republic or Peru to achieve similar results. Other mechanisms discussed in this section included public-private partnerships, private initiatives and private-private partnerships [55]. Which one is best in a given situation depends on particular circumstances; however, whichever the regulator or other entity responsible for achieving universal access and services chooses, it is important to ensure that the desired results are achievable.

9.1. Public-private partnerships

Public-private partnership projects are ones in which the public sector, in the case of the Dominican Republic and Peru, the regulator, takes on the leadership role for the project and contracts a private operator to bring telecommunications services to a specific rural area. After first carrying out a study of the communities to be served, the regulator should contact the local authorities to discuss the project and to solicit their involvement.

Once they have reached an agreement, the regulator (or public sector entity) should contact operators who could potentially implement the project and provide the required services in the community. The regulator could propose a formula to the operator whereby the project implementation costs for a given community would be shared among the local authority, the regulator (through a Universal Access Fund, for example) and the operator.

This was the case in the *Los Botados* rural broadband pilot project where the local authority agreed to provide the land and built a supporting structure for the tower and antenna and has been providing site security. INDOTEL provided the towers and terminal equipment and the operator, VIVA, provided the radio link, the broadband hotspot equipment and Internet service as detailed in section 5.4.

[55] Other financing initiatives are also mention in chapter IV of Stern and Townsend, 2007.

Picture N° 20: Internet connection in a house in Los Botados

Source: Edwin San Román

9.2. Private initiatives

Purely private initiatives may also be used in communities where there is demand but no services are being provided by any operator. The job of the regulator in this situation is to show operators that there is demand for telecommunications services and then put them in contact with the local authorities, so that together they can work out the details of a project which will satisfy the demand and result in the installation of a network and the provision of desired telecommunications services in the community.

This is what happened, for example, in the community of *Hato Damas* in the province of *San Cristobal* where INDOTEL contacted a small telecommunications operator called Estrelatel and explained that the community had practically no access to any telecommunications services in spite of there being a significant demand for such services.

Estrelatel visited the community, contacted the local authorities and after undertaking its own evaluation became interested in building a network and providing services. After securing support of the local authorities, it built the network and is currently providing broadband access and other services. Here the operator deployed a copper local loop for fixed-lines and wireless local loop for broadband access.

Picture N° 21: Home phone installation in Hato Damas

Source: Edwin San Román

9.3. Private-private partnerships

Private-private partnerships can work where there are large private (and in some cases publicly owned) enterprises other than telecommunications companies in the vicinity of the community to be served in sectors such as mining, petroleum, and agribusiness. These enterprises usually have social responsibility programs which include, among others, the financing of some local infrastructure programs, education and health initiatives.

Here the role of the regulator is to persuade these companies to include the deployment of broadband networks in their social responsibility programs for the neighbouring communities and show them how this can promote their social and economic development. The regulator should also indicate how their support for such a project can enhance their image in these communities especially where company's activities may be having a negative impact.

Once the enterprise has agreed to be involved, the next step is for the regulator to contact a telecommunications operator that may be interested in building a network and providing services, give it the information needed for achieving the objectives of the project and, of course, put the operator in touch with the enterprise.

This type of partnership was created in the Dominican Republic for the implementation of a rural telecommunications project in *Las Salinas de Puerto Hermoso*, with Ciramar, a shipyard company located nearby and with Estrelatel, a small telecommunications company. Here, Ciramar financed a large part of the project.

Picture N° 22: Installations at Ciramar

Source: Edwin San Román

10. Sustainability

Building a network is the easy part of a rural broadband project. It is the long term technical and economic sustainability that is critical and fundamental. For sustainability to be achieved, the operator, who built the network and provides the services, has to be able to cover its costs and make a profit. If it does so, it will be encouraged to not only continue to operate and maintain the service but even expand it.

The regulator or policy maker responsible for the project must be aware of this when determining and setting tariffs, which should be based on costs and allow for a profit because otherwise the operator will have no incentive to build the network, maintain the services and or to expand it. Asymmetric interconnection rates, where more is paid to terminate calls in rural areas than in the cities, reflecting the generally higher costs in the former, can help ensure the sustainability of rural telecommunications projects[56].

During the development phase of the *Rural Broadband Connectivity Project* INDOTEL did a comprehensive study of tariffs for similar services among different operators in the country, applied these to the economic model for the project, and then chose those that met the relevant criteria of covering costs and allowing for a profit margin.

The results were presented along with the overall project to the potential bidders with special emphasis on the proposed tariffs derived from the model. The operators provided their comments and suggestions and some of these were incorporated into the project. Tariffs derived in this way and prescribed for the operators receiving subsidies reflected commercial market realities.

It is commonly argued that tariffs in rural areas should be lower than in the cities because people in rural areas have less income than those in the cities. However, one should not overlook the main goal and objective of these projects which is long term sustainability rather than just the implementation and operation of a network and the provision of services for a limited time period. A better solution is to provide direct subsidies to individual subscribers and institutions that are not able to afford the tariffs required to achieve sustainability.

[56] For more information on asymmetric interconnection rates and other regulatory strategies to facilitate universal access and service, see: www.ictregulationtoolkit.org/en/Section.3212.html.

PART V: CONCLUSIONS AND RECOMMENDATIONS

11. Challenges and lessons learned

The following are challenges and lessons learnt in the development of rural broadband projects including from the ones in the Dominican Republic and Peru which have been referred to in this course and paper:

- It is essential that political support exist at all levels (national and local) for such a project to be successful. This was lacking in Peru whereas it was the driving force behind the project in the Dominican Republic.

- Local operators may underestimate demand, willingness to pay for telecommunications services and technological knowledge in the use of computers in rural areas. This was true in Peru and the Dominican Republic where operators whose networks covered the more populated areas found it difficult to think in terms of the technological and marketing requirements of infrastructure projects in rural areas.

- The regulator has to review the continuity and quality requirements for rural areas and modify them if necessary because providing telecommunications services in these areas with the same quality as in the cities can be very expensive.

- Instability and lack of a reliable electricity supply is a major problem for rural telecommunications projects and can add significantly to the overall cost of a project. Fluctuations of the energy supply are dangerous and often cause damage to the equipment resulting in expensive repairs and loss of service. This is an important factor to keep in mind when dimensioning the network and equipment.

- It is very important to become familiar with the social and economic situations of the targeted communities as well as their idiosyncrasies. Misunderstandings with local populations can often cause unnecessary delays in project implementation.

- The regulator and/or Universal Access Fund administrator has to be very active in promoting the development of networks and the provision of telecommunications services in unserved and underserved areas. Pilot projects are a very useful way of demonstrating to operators and other potential investors that it is possible to provide the services at costs which are lower than they may have envisaged and that there is definitely a market and willingness to pay for these.

- There are many clever and very creative people in rural communities who are already providing some forms of telephone and Internet services to others in the community. The project has to embrace their experiences and encourage them to get involved in the planning and implementation of the project in hand.

- In the absence of reliable data for estimating demand and given the high cost of conducting surveys, the regulator and/or fund administrator should consider various types of approximations (or proxies) for estimating demand when developing and designing rural broadband projects.

- Getting the large telecommunications operators to participate in tenders for rural broadband projects is often a big challenge because of they do not see such projects as viable. In this case, the regulator and/or Fund administrator has an important role to play in convincing them of the real benefits of such projects, not only for the communities affected but also for the operators themselves.

- Small broadcast cable operators in rural areas can be very good and cost effective broadband network and service providers; however, often high interconnection costs with existing networks present a barrier for them. The regulator has a role to play in bringing down these barriers.

12. Conclusions and best practice guidelines

A number of important conclusions can be drawn from the Peruvian and Dominican experiences in developing, planning and implementing rural broadband projects:

- There should be no barriers to the implementation of rural broadband connectivity projects when national policy supports such projects and when the regulator is committed to promoting them and providing its resources and facilities to demonstrate their viability and help in their realization.

- It is important for the regulator to share its vision of rural broadband projects with telecommunications operators and service providers in the country. The industry must be kept informed continuously and involved in the development of the policies for rural broadband projects and the plans for implementing projects to achieve the objectives of these policies. The views and opinions of network operators and service providers, who are potential partners in realizing these projects, have to be taken into account at all stages in the process.

- Offering available spectrum as part of the tender can serve as a useful incentive to get operators to participate in the process for awarding rural broadband licences. This has the added benefit of reducing the amount of subsidy that is requested in the minimum subsidy tenders.

- Rural areas are full of young people who are anxious to embrace the arrival of broadband and all the services that broadband can deliver.

- Given the particularities of the telecommunications sector, official public approval processes should treat projects in this sector differently from other public infrastructure projects in order to avoid unnecessary delays in implementation.

ANNEX 1: OTHER SUCCESSFUL EXPERIENCES: THE PERUVIAN RURAL BROADBAND CONNECTIVITY PROJECT

There are several good examples of the successful implementation of large rural broadband projects in Peru, where the regulator, by 2003, had already financed the installation of more than 7,000 public telephones throughout the country. OSIPTEL, the regulator, decided to implement a national rural broadband connectivity project through its Universal Access Fund (FITEL). The initial phase of this new project had as its main objective to provide broadband access to more than 3 000 localities in the country and signalled the start of a new era in rural telecommunications in Peru.

OSIPTEL had the project prepared and ready for implementation by late 2004; however, because of changes in the Peruvian legislation, the project had to go through a lengthy national public investment approval process which treats all such infrastructure projects equally, whether they pertain to road construction, sanitation, education or telecommunications.

There are no exceptions for telecommunication projects and the bureaucratic process failed to take into account of the very rapid evolution of technology in this sector and the fact that the project was to be financed from the Universal Access Fund and not from the national treasury or loans contracted by the state. Under the approval process OSIPTEL had to demonstrate basically the same social and economic benefits that it had already confirmed in preparing the project in the first place. Nothing changed in the approach but two valuable years were lost in the approval process.

There is an important lesson to be learned for governments and policy makers here. Telecommunications cannot be treated in the same way as other sectors, which may be just as important to the economic and social development of a country but which do not evolve as rapidly as telecommunications.

The goal of the project was to extend existing broadband networks beyond the cities that already had such networks to as many locations in the surrounding areas as could be covered by terrestrial links with a maximum of up to three repeaters. These networks were to offer broadband Internet and associated services. OSIPTEL had carried out a demand study similar to the one described in section 8.3.2. The project divided the country into six areas or sub-projects with a total of 3,000 localities to be provided with broadband access. A telecommunications company bidding for a subsidy was eligible to be awarded up to three sub-projects, each of them of between 500 and 700 localities and 0.4 million and 0.5 million people covered.

The bidding process started at the end of 2006 after all approvals had finally been obtained. There were bidders for all sub-projects and when the tender was completed in 2007, two companies ended up sharing the six sub-projects between them; however, only one, Rural Telecom[57], met all the requirements and signed a contract for 3 sub-projects. Rural Telecom's plans were to connect 1,928 towns by the end of 2009 and, as of January 2009, 669 of these had already been connected.

The Peruvian experience was very much taken into account in developing and implementing the *Rural Broadband Connectivity Project* in the Dominican Republic. The parameters for the evaluation were modified in accordance with the socio-economic and legal aspects of the country. Thanks to the lessons learned in Peru it was possible in the Dominican Republic to prepare the project, conduct the tender, and start implementation of the project in just over a year.

The experiences of Peru and the Dominican Republic with very similar types of projects show that when the political will exists and the necessary legislation is in place to develop, tender and implement such rural telecommunication projects, they can be brought on stream in a very short time. In Peru, the delay of more than two years was a result of excessive and unnecessary bureaucracy. It had nothing to do with any technological, commercial, financing or other barriers.

[57] http://www.ruraltelecom.com.pe/

Picture N° 23: Finding ways for communicating in Arroyo Dulce, in the south of the country

Source: Edwin San Román