International Telecommunication Union

QUESTION 10-2/2

Final Report

ITU-D STUDY GROUP 2 4th STUDY PERIOD (2006-2010)

QUESTION 10-2/2:

Telecommunications for rural and remote areas

THE STUDY GROUPS OF ITU-D

In accordance with Resolution 2 (Doha, 2006), WTDC-06 maintained two study groups and determined the Questions to be studied by them. The working procedures to be followed by the study groups are defined in Resolution 1 (Doha, 2006) adopted by WTDC-06. For the period 2006-2010, Study Group 1 was entrusted with the study of nine Questions in the field of telecommunication development strategies and policies. Study Group 2 was entrusted with the study of ten Questions in the field of development and management of telecommunication services and networks and ICT applications.

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1 General

The challenge for the telecommunication development of rural and remote areas of developing countries and particularly least developed countries goes back to Independent Commission for World-Wide Telecommunications Development chaired by Sir Donald Maitland established in 1983 on the occasion of United Nation's "World Communications Year". The commission's report known as "The Missing Link" identified the gap between "haves" and "have nots" of communication means and set the goal that by the early part of 21st century "virtually the whole of humankind should be brought within easy reach of a telephone and of all the benefits this can bring".

In later days, the technology shifted from analogue to digital rapidly since mid-1990s which lead to the digital era for new services and applications but caused the "digital divide". While the goal set by the Missing Link Report was deemed realistic, ITU Secretary General announced the new goal in his opening speech at TELECOM 99 to bring internet style services to all human kind within the first decade of new millennium and apply all the new technologies and impulses so that the gap in connectivity to the internet could be reduced. The new goal was confirmed by Geneva Plan of Action 2003 and Tunis Agenda for Information Society 2005 to provide equitable access to information and knowledge for all at affordable cost by 2015.

Whereas, the World Telecommunication Development Conference (WTDC-94, Buenos Aires) under new convention and constitution since Kyoto Plenipot-94 set the Question 4/2: "Communication for rural and remote areas". The question was maintained at each Conference: WTDC-98 (Valletta), WTDC'02 (Istanbul), WTDC'06 (Doha) until today. In the mean time, Topic 7 "study various mechanisms by which to promote the development of new telecommunication technologies for rural applications" was agreed at WTDC-98 to be conducted by Focus Group to finish the work within a year. The report of the focus group on Topic 7 was accomplished and published by the ITU as entitled "new technologies for rural applications". The emergence of low cost technologies such as various wireless technologies for the last one mile extension and TCP/IP internet technology to be applied to the infrastructure for rural and remote areas were identified by the report. The study of new technologies for the rural applications is succeeded by the Rapporteur's group on the question of "communications for rural and remote areas".

The Question 10-2/2 (2006-2010) on "telecommunications for rural and remote areas" is now set at WTDC-06 (Doha) to study the issues in response to Res.46; "to achieve the goal of digital inclusion, enabling universal, sustainable, ubiquitous and affordable access to ICTs for all, including disadvantaged, marginalized and vulnerable groups and indigenous peoples, and to facilitate accessibility of ICTs for all, in the framework of access to information and knowledge". The Rapporteur's Group is mandated to study the issues in rural and remote area such as absence of telecommunication infrastructure, the relative high cost of telecommunication infrastructure, cost of physical access and equipment installation, low level of awareness for ICT and lack of energy sources, which were commonly reported in the case studies to date.

The Rapporteur's group conducted the global survey and analysis on rural communications, collection of case studies since study period for 2002-2006 until present study period for 2006-2010. Contributions were submitted based on the experiences and knowledge of the Member States and sector members on the issues. On-line discussion has been conducted among the registered members on ITU-D web site on the agreed topics related to the Question. The results of these activities are compiled in this report and guideline.

This report is aimed to respond to the Question 10-2/2 on "telecommunications for rural and remote areas based on the activities of the rapporteur's group for this study period of 2006-2010. The guidelines for the telecommunications development and the consolidated recommendation of this study cycle and past study cycles are given in the companion contribution Doc. 2/211 as outset of activities of this group.

2 Defining rural and remote areas

General features of rural and remote areas may be summarised as follows:

- Lack of basic infrastructure (telecommunications infrastructure, electricity, access road, water supply, sewer system etc; difficult living conditions)
- Low geographical population density (small village populations, in sparsely populated communities that are geographically separated from one another)
- Low economic activities, low per capita income, lack of disposable income and relative poverty of rural population
- High degrees of illiteracy
- Lack of information and social administrative services
- Marginalized group (women, children and elderly people, disables) are left in the areas.
- Difficult geographical and environmental conditions (mountainous, isolated by water, harsh climate etc.)
- Others

These difficult living conditions for the residents of rural and remote areas are accelerating the rapid migration of population to urban areas according to the UN statistics recently disclosed (See Fig 1). However, more than half of world population is still living in the rural and remote areas of developing countries and least developed countries. As the result of migration of workable population to urban areas, children and young people under 16 years old, elderly people over 50 years old, women, marginalized group of people are left in the rural and remote areas according to the analysis of global survey conducted by the Rapporteur's Group in 2004. Whereas, urbanization will be the potential cause of social problem of poverty in the major cities of the developing countries resulting from the declining job opportunities and shortage of food supply, etc.

The cross point of rural/urban population will be 2012-2013 according to the Fig. 1 below. The ICT is expected to contribute to the vitalization and improvement of quality of life of rural and remote areas by providing valuable services for the residents, and finally to suppress the migration of population or to stimulate adverse migration in the future. There will be the way to solve the problem of poverty – Millennium Development Goal- by ICT.

Figure 1: World Urbanization Prospects (The 2007 Revision Population Database, United Nations Population Division)

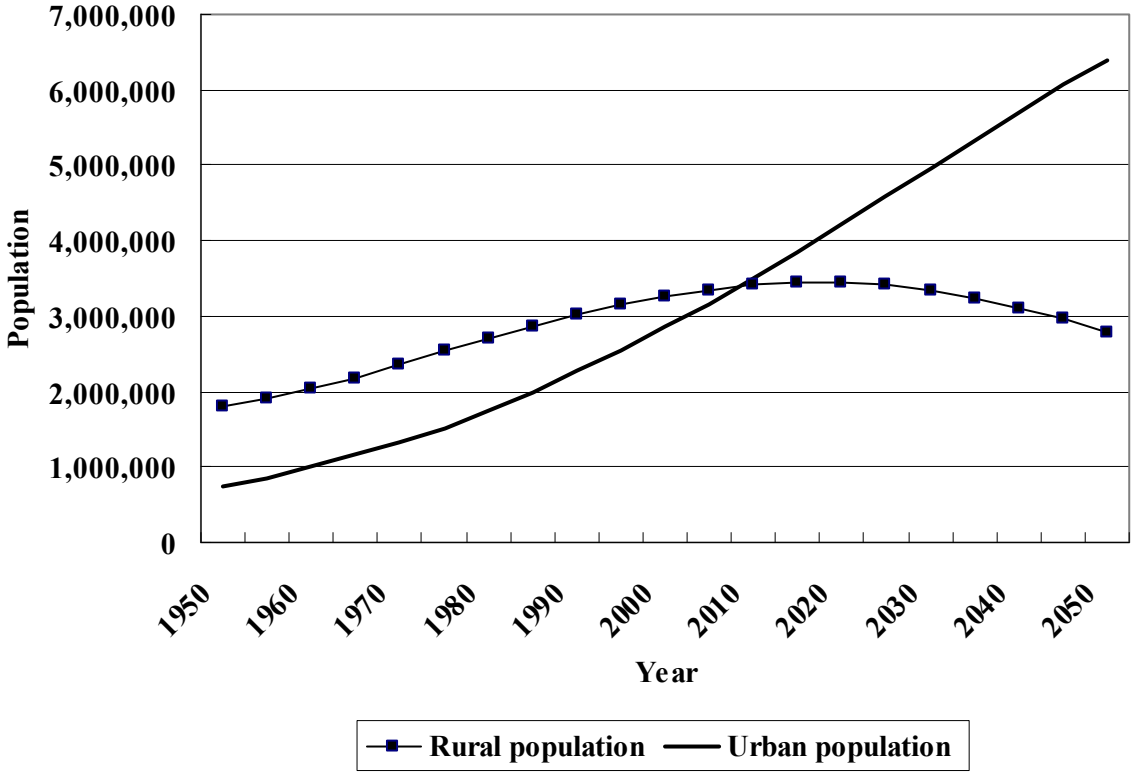
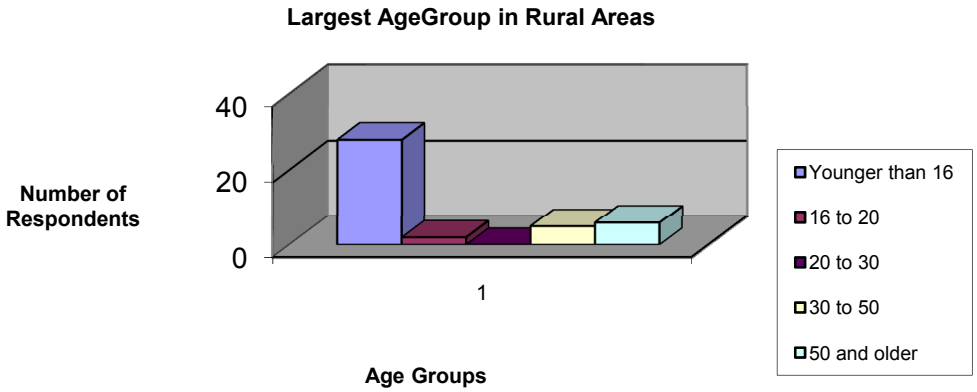


Figure 2: Age groups in rural area



3 Providing connectivity

Many case studies collected by the rapporteur's group and the contributions to the group indicate that Multipurpose Communication Telecenter (MCT) approach as well as Community Access Center (CAC), and Public Call Office (PCO) etc. are cost effective for providing connectivity to rural and remote areas for the following reasons;

1. Cost sharing of broadband communications facilities and customer premise equipments to provide services with affordable cost,
2. Maintenance and operation by the trained staff at the telecenters,
3. Easy provision of effective training at the telecenters,
4. The community owned telecenters may raise revenue through provision of services.
5. Connections may be extended to households from telecenters for potential individual users in the community,
6. Various multimedia services such as internet, teleteaching, health consultation, video conference, contents delivery, community bulletin board, remittance, mobile phone may be developed associated with telecenters,
7. Schools, post offices, health posts may be used for telecenters
8. Easy to get subsidy from local or central government to telecenters

4 Assessment of technologies for infrastructure development

(Q10-2/2 Step 1: Identification of the full range of potential techniques and solutions)

4.1 General

Recent trend is the provision of multimedia services for MCT, CAC at the community centers of rural and remote areas, which will require broadband connectivity to and from rural and remote areas. Requirements for broadband for rural and remote areas are not defined yet in ITU-D, however e-discussion group of RGQ10-2/2 debated the definition and it was suggested that the definition provided by Telecommunication Regulation Authority of India (TRAI) as of September 2007, was worth to consider, i.e.; "An `always-on' data connection that is able to support interactive services including internet access and has the capability of the minimum download speed of 256 kilo bits per second (kbps) to an individual subscriber from the Point of Presence (POP) of the service provider intending to provide broadband service where multiple such individual broadband connections are aggregated and the subscriber is able to access these interactive services including the internet through this POP".

Emerging technology options deployed for the projects in the rural and remote areas to meet the needs of broadband connections are reported in the collected case studies and contributions during the study period, which are categorized by wired transmission media and wireless transmission media as in the following Table 4.1 & 4.2. Major transmission media deployed in the collected case studies are satellite, cable (including optic fiber) and WLAN/WLL (Fig. 4.1). The recent broadband wireless technology of WiMAX is expected to be widely deployed for rural projects for its advantages of cost/range/throughput. The wireless technology of CDMA is popular for mobile phone services and there is one case study deploying CDMA 450 for rural project. The wireless technology of WiFi is popular for its cost effectiveness for rural application for middle range and last one mile but the characteristics for throughput and range are rather limited. Satellite communication is suited to cover the rural areas of large size countries, widely spread islands countries with number of scattered outer islands, and mountainous countries with isolated communities scattered over non line of sight areas etc. However the cost of leasing satellite transponder can be high for sustaining the network (Operational expenditure: OPEX). Optic fiber cable is suitable for long range backhaul system as well as middle range system for its stable characteristics and extremely high transmission speed, however the cost of installation (Capital expenditure: CAPEX) is high for rural application. Therefore, in some situations the use of satellite services to provide backhaul offers a more cost effective solution.

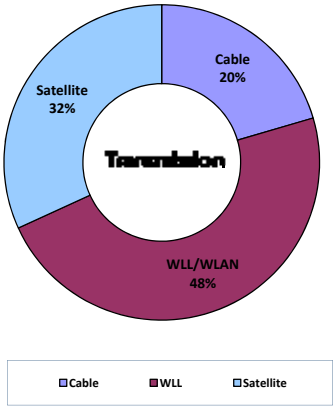
Table 4.1: Wired transmission technologies

Distance	Optic Fiber	Copper wire (ISDN/DSL)
Long range (Backhaul trunk line)	Single mode fiber (high construction cost)	Not applicable
Middle range (intermediate medium 20km plus or minus)	Single mode fiber (high construction cost)	Not applicable
Short range (Last mile; Access to customer's premises)	Multi-mode fiber (high speed)	n x Mbps (DSL) n x 64Kbps (ISDN)

Table 4.2: Wireless transmission technologies

Distance	Satellite	µ-Wave	WLAN & Cellular Systems (GSM, CDMA, W-CDMA, WiMAX, etc.)
Long range (Backhaul trunk line)	High cost/Delay Usable NLOS	High cost for construction and maintenance	Not applicable
Middle range (Intermediate medium plus minus 20km)	Not applicable	ditto	WLL, Mobile systems (including IMT)
Short range (Last mile; access to customer's premises)	Not applicable	Not applicable	WiFi， Mobile system, Femtcells

Figure 4.1: Transmission media deployed in case studies collected by ITU-D



4.2 Satellite Internet Access Technologies and Solution:

Today, satellite is increasingly chosen as an internet and broadband access solution. Because data can be transmitted and received directly via satellite, there is no need for a telephone or any type of landline connection. Satellite-based services offer many advantages, particularly for remote and rural areas, such as:

- ubiquitous coverage to all corners of the globe;
- cost-effective and easy-to-install solutions, even for remote and rural areas;
- no infrastructure investment required;
- sustains large end-user populations;
- capable of large network deployments;
- fixed and mobile applications; and
- reliable and redundant services for emergencies affecting terrestrial infrastructure.

Given their unique regional and global coverage, satellites are able to deliver immediate internet and broadband connectivity using existing satellite resources and infrastructures. This gives the flexibility and capacity to extend the service footprint based on market demand, instantly and easily covering rural areas. Importantly, particularly for developing regions, end-user and community connectivity is possible without huge capital investments or extensive build-out programs. Once a satellite system is operational, connectivity can be further extended to user locations with easy-to-deploy and install terminals. As users increase, economies of scale enable cheaper equipment, making satellite an even more competitive solution. Moreover, high-density, small-dish services, which can be enabled by higher pfd (power flux density) levels, offer the opportunity for even more cost-effective connectivity.

4.2.1 Extending Local Wireless Connectivity via Satellite:

For bridging the global digital divide, there are few more promising Internet connectivity technologies today than WiFi. WiFi enables users to connect to the Internet wirelessly while located in a connection “hot spot,” the area covered by a wireless Internet access point. Within the past few years, satellites have been instrumental in bringing high-speed Internet to users located in areas where broadband infrastructure such as DSL or cable cannot reach.

The combination of a satellite VSAT connection to the Internet plus WiFi for local access by multiple users can provide the lower per-subscriber costs that the market requires, particularly in rural and remote areas.

The satellite connection brings the Internet stream to the village, and the WiFi access point extends that connectivity to the home, school, and public building. Users share either equipment and connection costs through subscription or other joint payment plans.

The keys factors to reducing costs are:

- *Use low cost equipment* – Off the shelf, open standard equipment leverages mass production. Integrating satellite equipment that is based on widely-accepted global standards dramatically reduces equipment cost.
- *Maximize Subscribers per Gateway* – A larger pool of subscribers reduces the equipment cost per subscriber. A larger subscriber base is also more efficient in sharing a single connection. The key issue is to extend the range of standard WiFi equipment to allow a single VSAT to service an entire village.

The combination of VSAT + Wireless is one of the best solutions for many rural applications. Rural populations tend to be clustered in or around villages with most of the populations within a range of 1 to 5 km. A single VSAT can provide service to an entire village using a wireless local loop solution for the last mile connection. Wireless has the added advantage of spanning rivers or other obstacles and provides a more reliable connection when cable theft is a problem.

One possible solution involves an integrated system of a VSAT, a wireless local loop base station and a solar power system all mounted on a 10 meter post. Such a solution is easy to install, helps overcome obstructions from buildings, and is very secure.

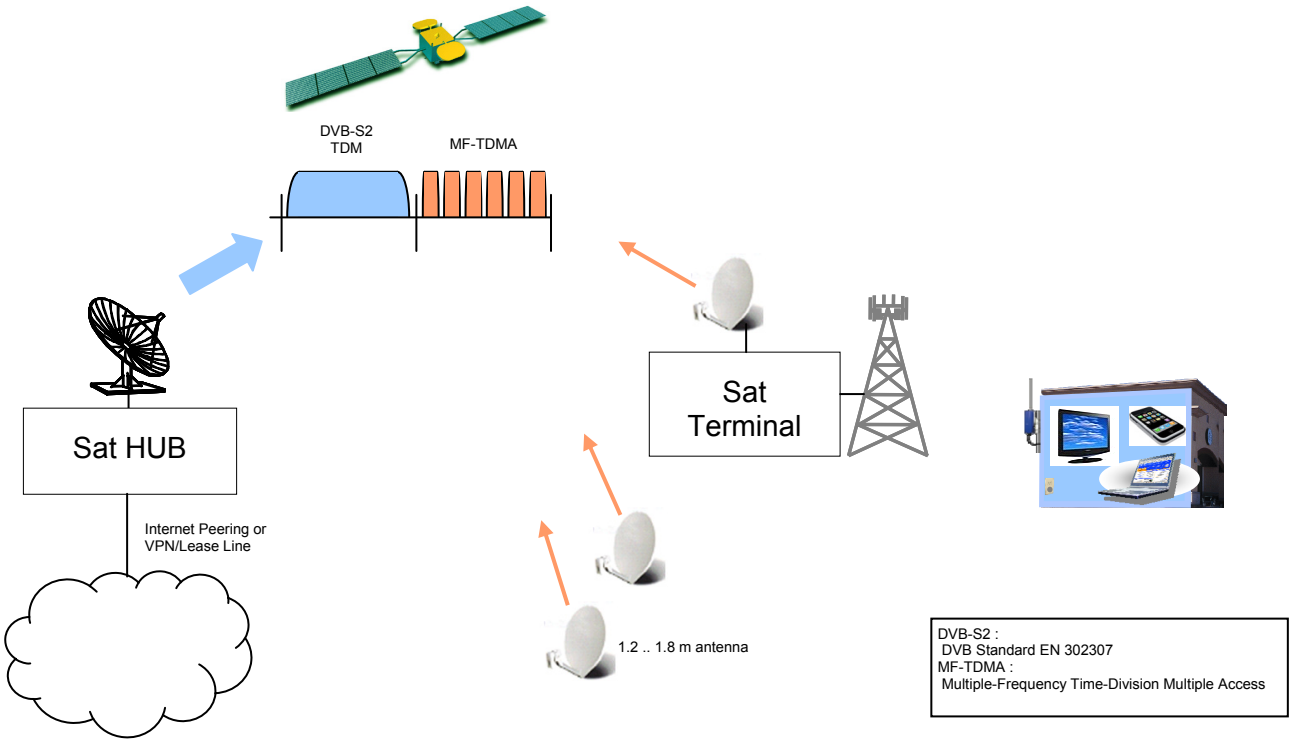
4.2.2 Satellite Backhaul Solutions:

Satellite-based backhaul has played an increasingly important role in extending the reach and coverage of mobile telephony networks throughout the globe, particularly in developing markets. Advancements in technologies have led to more cost-effective and robust satellite solutions, making them an integral component of mobile network deployment. As governments seek to ensure connectivity for all citizens, satellite backhaul will continue to play a role in providing connectivity to regions where fiber or terrestrial-based technologies alone are not an economically viable solution.

Using satellite backhaul to extend broadband services offers benefits in terms of coverage, cost, security and redundancy. Geostationary Earth Orbit (GEO) satellites can provide backhaul services for a large region with only a minimum expenditure on infrastructure. Satellite backhaul solutions enable operators to position base stations where they would provide the most benefit to citizens, with little reference to the location of terrestrial infrastructure.

The use of satellite backhaul also provides redundancy of connectivity. Damage to the fiber backbone network could lead to terrestrial base stations being cut off from key networks, while the extra diversity that satellite backhaul provides will ensure that connectivity remains un-interrupted, even if there is serious damage to terrestrial infrastructure.

Figure 4.2: Example of Satellite Backhauling Network



4.3 WiMAX solution:

WiMAX (World Interoperability for Microwave Access) is based on IEEE 802.16 standards. WiMAX standards have been developed for fixed, nomadic and mobile applications. WiMAX offers a combination of both broadband and mobility.

On 18th October 2007, responding to the demands of ITU Members to address the continuously growing wireless marketplace, ITU took a decision of global importance to include WiMAX technology in IMT-2000 Family. WiMAX is the first all IP and OFDMA based IMT-2000 standard. This agreement paves the way for the deployment of a range of voice, data, and multimedia services to both stationary and mobile devices. It opened the door to wireless Internet, catering to demand in both urban and rural markets.

OFDMA based WiMAX technology provides high data rate capability and excellent support for new features such as advanced antenna technologies to maximize coverage and the number of users supported by the network. A key advantage of WiMAX is to deliver higher bandwidth efficiency and therefore higher data rates. Adaptive modulation also increases link reliability for carrier-class operation and the possibility to keep higher order modulation at wider distance extend full capacity over longer distances. The technology behind WiMAX has been optimized to provide non-line-of-sight (NLoS) coverage. NLoS advantages are coverage of wider areas, better predictability of coverage and lower cost as it means fewer base stations and backhaul, simpler RF planning, shorter towers and faster CPE install times. Thanks to techniques such as diversity, space-time coding, and Automatic Retransmission Request (ARQ), NLoS coverage is increased.

WiMAX enables true broadband speeds over full IP based wireless networks at a cost point to enable mass market adoption. WiMAX has the ability to deliver true broadband speeds and help make the vision of pervasive connectivity a reality. Currently there are more than 475 commercial WiMAX networks around the world, deployed both in urban and rural areas.

WiMAX as an advanced broadband wireless technology can be applied simultaneously in both developed and developing countries providing an excellent opportunity to address the digital divide that blights many Countries (including developed Countries) today.

The challenge is bringing broadband and internet access to individuals and businesses in rural areas and many countries are looking for all IP based economical, fast applicable, broadband technologies. There is clearly a need for a wireless broadband IP-based network that has a similar quality of service as wireline DSL, Cable type services but with the added advantage of mobility. While many individual and business customers now have the luxury of high-speed broadband access at their fingertips, it's still a service that's concentrated in urban, high-density areas. Current infrastructures – typically offered by DSL or cable providers – result in limited coverage. To extend service to new, less-populated markets, providers must often engineer entirely new infrastructures from the ground up. This, in turn, drives up service pricing, slowing adoption in these areas. Even under ideal circumstances, telecommunications companies require several months to install new T1/E1 lines and other enterprise-level data connections.

WiMAX provides high throughput broadband connections over long distances – eliminates the need for physical "last-mile" connections from service providers to end customers. Mobile WiMAX technology can also provide a ubiquitous connection to extend high speed access beyond the home or office, making this an even more attractive option for servicing whole towns or villages.

WiMAX offers the potential to do much more than just extend the power and reach of existing networks. It supports a range of uses for communities around the globe that may have not had access to internet service. WiMAX enables everything from basic high-speed access for homes to Internet telephony, business connectivity, and support for schools and government offices.

Table 4.3: Deployments by region

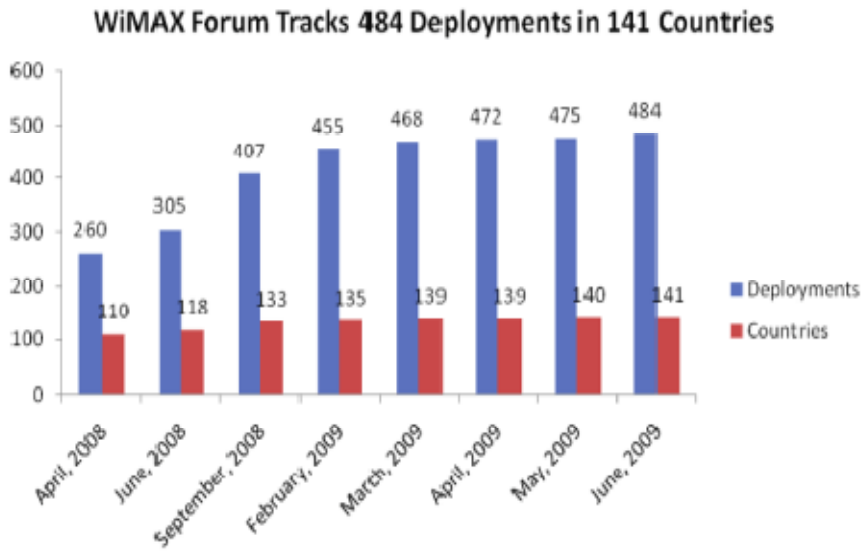
Africa	100
Asia-Pacific	76
CALA	97
Eastern Europe	77
Middle East	18
North America (USA/Canada)	48
Western Europe	68

Table 4.4: Deployments by frequency

2.3 GHz Deployments*	29
2.5 GHz Deployments*	63
3.3 GHz Deployments*	9
3.5 GHz Deployments*	240
5+ GHz Deployments*	20

**Note:* *In above table total deployment by Frequency may not add up to total deployments tracked. The missing deployments' statuses are unknown, and will be confirmed and updated.*

Figure 4.3: Deployments in countries



4.4 Other options

KDDI's proposal (Application of Femto-cell wireless technology for rural and remote areas)

KDDI proposed femto-cell technology for the last mile access solution in rural and remote areas by Doc. 2/94-E and Doc. 2/232. Base stations deploying the femto-cell technology are now components in an existing cellular system, which are originally developed to extend coverage areas inside buildings or underground areas where are tend to be "dead spots" from a normal base station. The outstanding features of the femto base stations are from a half to one forth in size compared with the conventional pico-cell stations (the order of A4 or A3 size paper),their cost as low as US$ 200 – 1,000/station and their power consumption is low which is essential requirement for application in rural and remote areas.

Views of R.O. Korea (technologies for rural communications development)

9. Most desirable and cost-beneficial connectivity for sufficiently large markets is fibre-optics. Current technological development enables less market size for is fibre-optic cable deployment. First generation cable is being retired due to excess capacity in the marketplace. Redeployment of such cable may be an affordable opportunity for small market. Papua New Guinea is using retired cables, especially first-generation fibre-optic cables, to redeploy parts. Such an approach could connect many other remote/rural and SIDS to existing cables for perhaps about US$3 - US$5 million per country on average.

10. Remote/rural and small islands may be amendable to new forms of wireless networking such as WiFi, wireless LAN, WiMax, or WiBro. WiMax can reportedly serve an area of up to about 10,000 square kilometers, which will form one fibre-optic or VSAT node. Though it should be noted that there are some trade-offs between coverage area, mobility and bandwidth in wireless networking, such approaches enable a single transmission node (satellite terminal or broadband cable) to cover larger dispersions of people.

	WiBro	WIFI	WiMAX	HSDPA
Origin	Mobile Phone	Wireless LAN	Wireless LAN	Mobile Phone
Frequency Bandwidth	2.3~2.4GHz	2~11GHz	2-11GHz	2GHz
Network	Broadband Wireless Network	Wireless LAN	Broadband Wireless Network	Broadband Wireless Network
Bandwidth per FA	10MHz	40MHz	1.5~28MHz	5MHz x 2
Mobility	Mobile Phone/Laptop Max 60km/h	PDA, Laptop	PDA, Laptop	Mobile Phone Max 300km/h
Transmission Speed	Download: 18.432Mbps Upload: 4.915Mbps	4-11Mbps	75Mbps	Download: 14.4Mbps Upload: 2Mbps
Coverage	1~1.5km(central) 3~5km(outskirt)	3.5~7km	1~2km(central) ~45km(outskirt)	4km

5 Migration of service platform from ISDN to IP based network

(Q10-2/2 Step 2: how the techniques identified above can be used to best deliver the range of services and applications)

Main service is migrating from voice service to multimedia services as observed in the analysis reports of collected case studies 2002-2006 and 2006-2007 (See Fig. 5.1). The main services are now internet style and provided over IP based platform deploying Wi-Fi (WLAN) for the community networks in the rural and remote areas (See Fig 5.2). Various multimedia services are provided over the IP based networks connecting rural communities with outer world or with each other. There are various applications developed to meet the regional needs and the environment of the communities and users in rural and remote areas of the developing countries.

Figure 5.1: Comparison of service applications provided in case studies 2002-06 and 2006-07

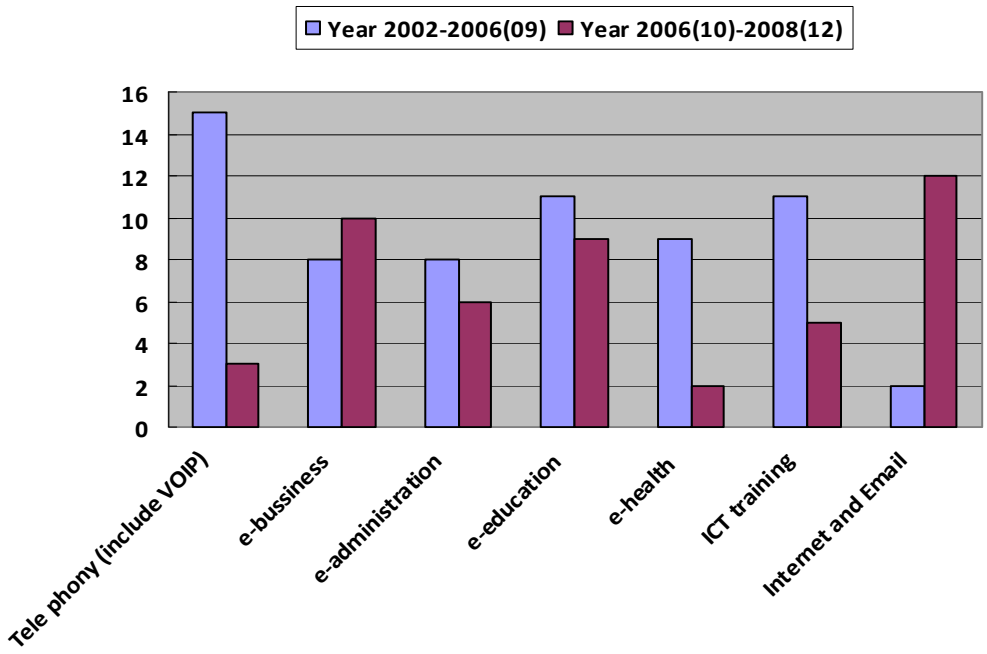
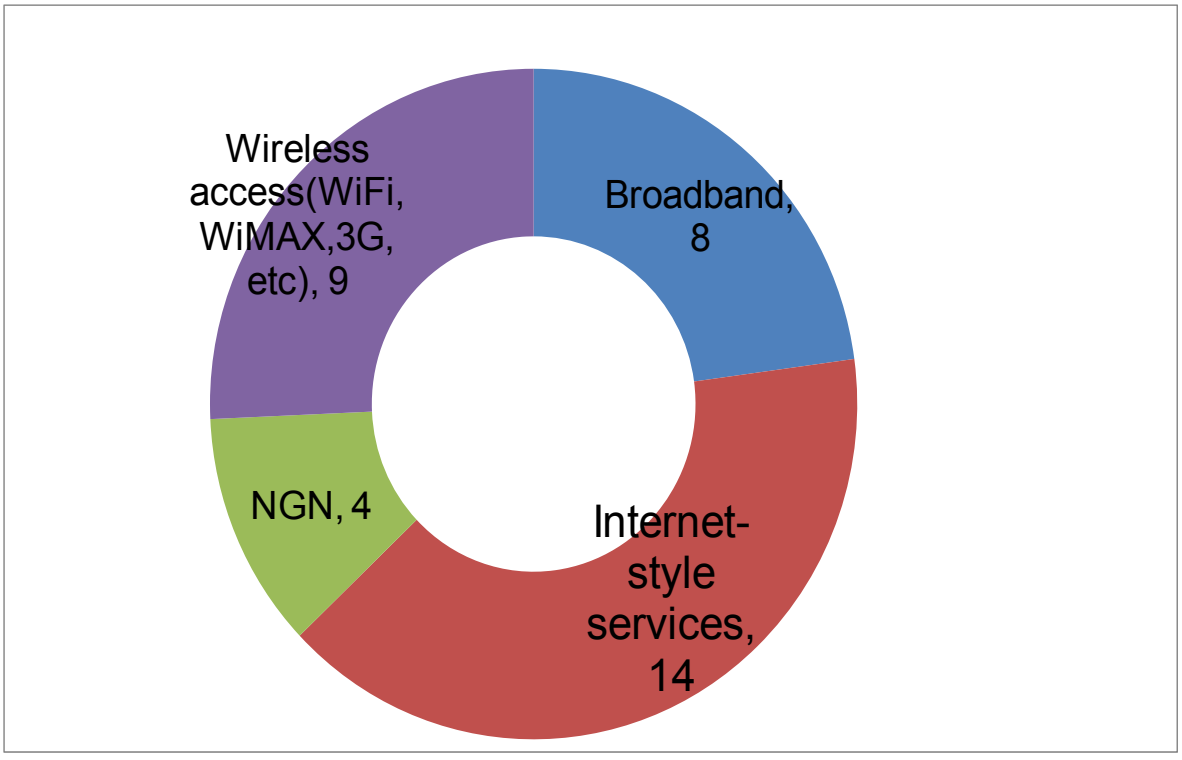


Figure 5.2: Trends of service platform observed in the analysis of case studies 2006-07



6 Service applications for rural and remote

(Q10-2/2 Step 3: assessment of the likely commercial viability or sustainability of the techniques and solutions)

There are various services to be offered by the IP based network to respond to the needs of rural communities. WSIS Plan of Action 2003 (C7) listed e-applications and the responsible UN Agencies, - however ITU is responsible for promotion and any assistance of all e-applications by developing infrastructure required for the applications.

- E-Learning UNESCO,UNIDO
- E-Health WHO
- E-Government UNDP
- E-Business WTO,UNCTAD,UPU
- E-Employment ILO
- E-Environment WHO,WMO,UNEP,UN-Habitat, ICAO
- E-Agriculture FAO
- E-Science UNESCO,UNCTAD

Apart from the list of e-applications as above, case studies present many practical applications implemented for the dwellers of rural villages.

E-education: Teleteaching will provide live classes using network cameras to address the shortages of qualified teachers. The classes will be interconnected between villages and urban schools or with foreign schools. Texts material will be transmitted via internet. E-learning may be useful means for the students of rural and remote areas or of the developing countries to receive the high quality education remotely, economically and internationally.

E-Health/Telemedicine: Health posts or health clinics in the remote villages will be interconnected with urban hospital to receive the consultation service, and second opinions healthcare services through audio-video conferencing.

Medical devices with internet interface will make possible the remote examination and treatment of patients by the regional central hospitals or central health clinics.

E-post: villagers of the rural and remote areas seldom sending and receiving letters to and from outside world because of lack of motorable access road or it will take time for delivery and pick-up. Therefore the post office in the remote villages will be connected via internet to overcome the difficulty. Post master may assist the villagers for reading and writing the letters at the post office.

E-post office may be internet kiosk as well.

E-agriculture: providing useful information such as weather, fertilizer, market prices, farm works for farmers via internet or on the community bulletin board.

E-administration: administrative information services for the villagers in the rural and remote areas from the urban administrative office for the community life.

Internet Access service: Available to community people, students, teachers, and tourists raising revenue. Community centers, school computer labs, internet kiosk, PCO and post office will be the access center. E-mails, web browsing service will also be available. Video conference service may be provided. Community people can place VoIP phone calls through internet

Community Discussion: Using an online discussion forum, villagers are able to engage in community discussions in local language or dialect.

E-commerce: teleshopping of commodity goods over internet, remittance service including between regions and cross border, and credit card transaction service for tourists.

E-business: Small scale enterprise will be launched such as manufacturing local products (paper making, textile weaving, arts and crafts) and selling products outside the community through internet for profit making.

Video and voice program streaming: video and/or voice program will be distributed or retrieved through the internet by remote villagers for quality of life, lifelong education and entertainment.

Environmental monitoring: enabling remote sensing or web camera for monitoring the glacier lake/river water level, for flood warning, monitoring the illegal act in the remote area or forest etc.

7 Successful practices providing ICT services for the benefits of rural population

(Q10-2/2 Step 4: Report on a range of case studies that clearly demonstrate how a range of techniques, based on new technology aimed at providing reduced capital and operating cost solutions and enhancing community participation, can maximize the benefits of telecommunication infrastructure in rural and remote areas.)

Rapporteur's Group on Q10-2/2 collected 19 case studies (2002-2006) and 20 case studies (2006-2010), which are posted on the ITU-D case library;

http://www.itu.int/ITU-D/study_groups/SGP_2006-2010/events/Case_Library/index.asp
(case studies collected 2006-2010)

http://www.itu.int/ITU-D/fg7/case_library/index.html
(case studies collected 2002-2006)

There are additional case studies received after the group completed analysis. The group also received the case studies submitted as contributions and not formatted acceding to the questionnaires. The Q10-2/2 rapporteur reviewed all those case studies to consider the successful practices implemented for provision of ICT services for the quality of life of rural population. Following case studies are considered to be typical model deploying technologies best suited for the regional needs and environment and deserved for the referenced models for other developing countries planning to replicate in the rural and remote areas of their countries.

7.1. Indonesian (Republic of) (CDMA450)

In the township of Way Kanan, Indonesia (Lampung province, in southern tip of Sumatra), a rural area with minimal telecommunications infrastructure, QUALCOMM International® along with its local partners have reached out to five of the poorest townships to increase teledensity and Internet penetration through the use of 3G wireless technology.

This project utilizes CDMA 1xEV-DO in the 450 MHz spectrum, ideal for providing extended coverage in rural and underserved areas, to offer wireless voice and high speed data.

i. Basic telephony: Implementation of CDMA450 "cellular kiosk" in each of the 59 villages within the 5 townships to give villagers access to telecommunications

ii. Broadband Access: Establishment of computer labs with Internet access via CDMA450 in each of the 5 provincial high schools

iii. E-education: The computer labs and broadband wireless access will serve to broaden IT skills and enhance educational opportunities for the youth in this area and grant them access to enhanced educational and e-learning resources.

iv. ICT Training: An integral part of this project is to ensure that these computer labs are useful to both the teachers and the students. To address the lab's usefulness, QUALCOMM teamed up with ICT Lampung, the Ministry of Education and Microsoft in order to implement a "train the trainer" program. To date, twenty teachers from the five high schools were provided with a week of training that covered the basic computer operations and computer based curriculum. Follow-up training will be held periodically to reinforce these skills

The partnership has equipped five high schools in Way Kanan each with a computer lab and provided broadband wireless access to broaden IT skills and enhance educational opportunities for the youth in this area. In addition, a cellular kiosk is being placed in each of the five townships' 59 villages to provide telecommunications access to citizens

In addition, QUALCOMM provided a 3G CDMA-based Community Access Point (CAP) in Pacitan, East Java. The CAP consists of a computer laboratory equipped with a CDMA2000® 1xEV-DO modem operating at 450 MHz (CDMA450) to provide high-speed Internet access to the public. More than 2,000 students and teachers in Pondok Tremas will be able to access information available worldwide via the Internet for use in education, research and training.

To date, 20 teachers from 5 high schools were provided with a week of training that covered the basic computer operations and computer based curriculum. Follow-up training will be held periodically to reinforce these skills

7.2. Cambodia (Kingdom of) (WiMAX)

The project was carried out in Cambodia (Least Developed Country) with the goal: "Pilot installation of e-Health and e-Education system connected from central Hospital to rural community in Kandal Province, Cambodia, using Wireless LAN System". This project was carried out in Angk Snoul district, which is one of the districts in Kandal Province, and made it possible for the local people to enjoy the multimedia Internet applications such as "Internet Access", "e-Mail", "e-Education", "Video-Conference / Remote Lecture" and "exchange of medical information" and it was confirmed that this project opened a lot of possibilities for the advancement of the community.

BreezeACCESS VL (Alvarion) was the wireless system used in this project, which was installed very easily. As its maximum transmission length is more than 20km, no repeater station was needed between the sites. That made Initial Investment Cost (CAPEX) low.

Operation and Maintenance is also very easy (usually maintenance free).

All we need for the wireless system as Running Cost (OPEX) is that for power consumption (around 30W/unit).

Figure 7.1: Basic system architecture

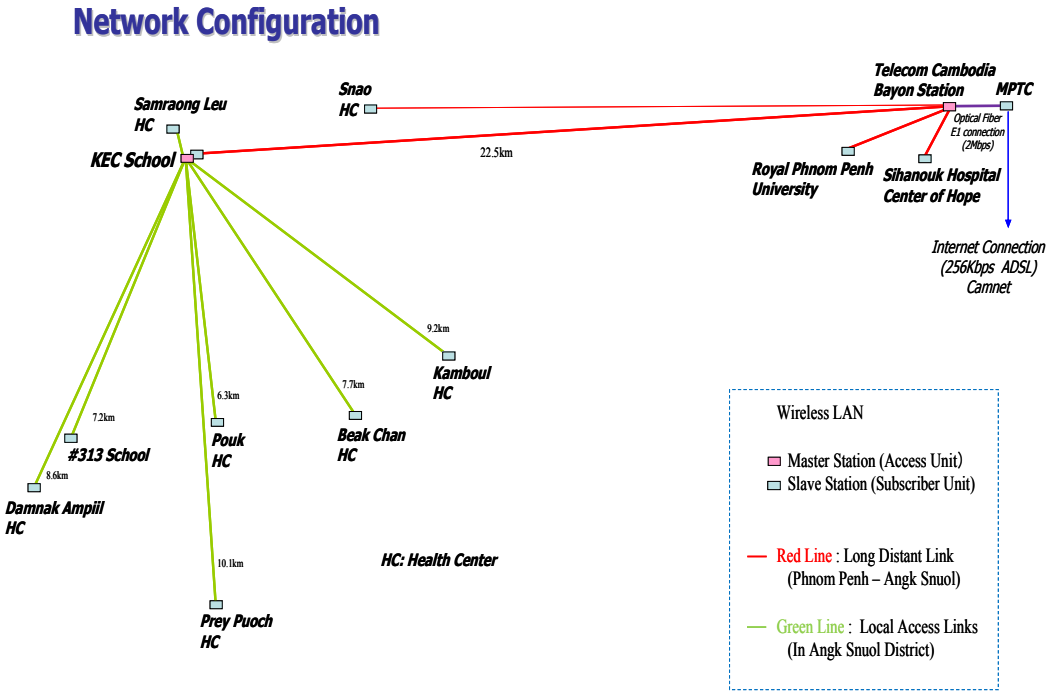
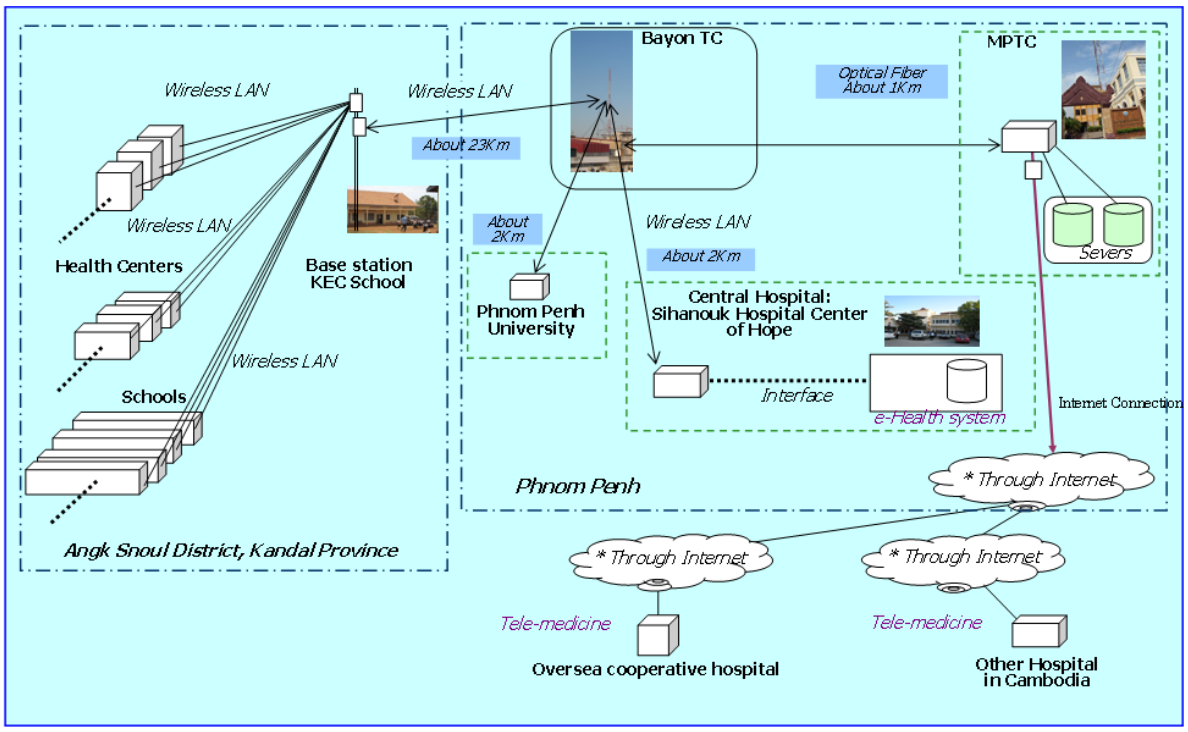


Figure 3.2: System overview of the project



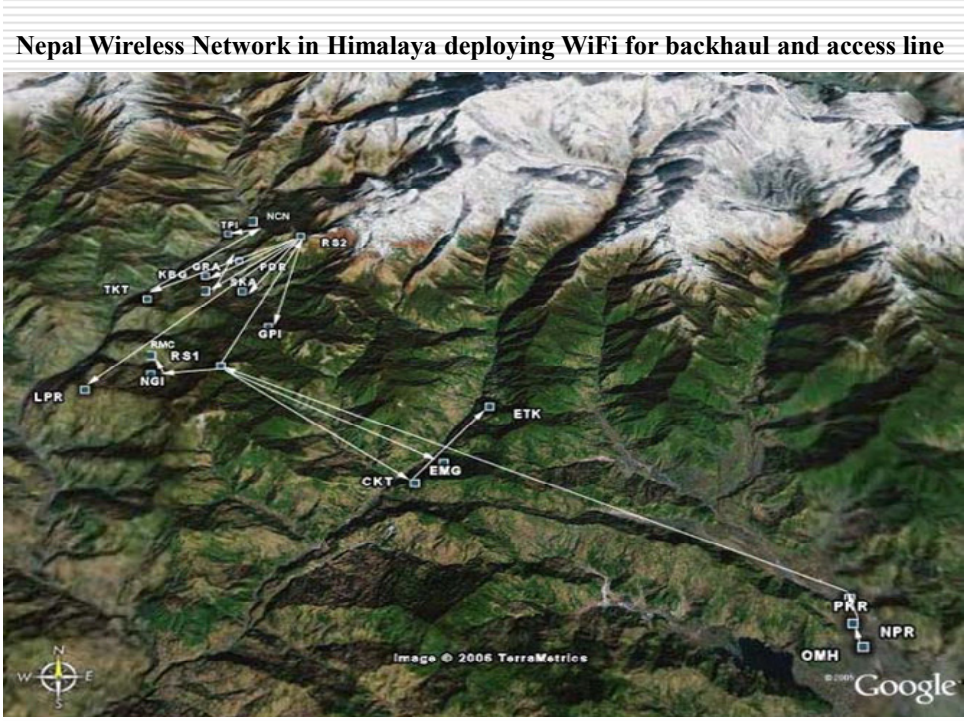
7.3. Nepal (Republic of) (Wi-Fi)

Nepal is one of 49 Least Developed Countries and a country with 83% occupied by mountains/hills and 17% plain belt. 15% of land is high mountains. It is very difficult to provide terrestrial mode of communications in this region. Nangi is a mountain village of 800 inhabitants in the mid-hills of western Nepal at 7300 feet elevation, near the Annapurna and Dhaulagiri ranges of the Himalayas. All of its people are farmers and no machinery or automated tools are available. Life in the village is very difficult.

A plan to empower villages using Internet in Nepal had started at a local level. The villagers decided to establish a connection that could assist in improving health care, agriculture, education local e-commerce, communication with the purpose of activating socio-economical aspects of the region in Nepal. The project has required several steps: first, getting electricity, then setting up a high school computer lab and, a few years later, developing a robust Wi-Fi network connecting villages and the Internet hub in Pokhara, a large city about 22 miles away from the nearest relay station.

The leader of the project in cooperation with the villagers have begun running a school with library, a nursery plant, a health clinic connected using telemedicine services using video link to the city hospital, a carpentry, paper-making industries, a camping grounds and lodges for trekkers (which includes e-mail capability), a fish farm and a yak farm etc. coordinated plan for a successful implementation. One of the most interesting aspects of this project is that once the villagers started communicating with each other about livestock, crops, health care and using the network for other useful subjects such as VoIP phone calls, and credit card transaction service for the tourists, they found that there was a niche that would generate other economic gains, and give some of the villagers a new way to use their skills. A handmade paper-manufacturing business has come to Nangi that has helped the women in the village to get some seasonal jobs. One of the villagers was sent to Kathmandu for training for health care and returned to train a cadre of others. The villagers also started jam making program from plums and juice making program from rhododendron flowers hoping to sell the products in the market. The villagers have built three community lodges for the tourists in the mountains and all the lodges are connected in the wireless network. That has made it easier for the lodge operators to communicate with themselves as well as with the tour operators.

Figure 7.3: WiFi Network Connecting Nepalese Himalayan Villages in Annapurna Region



7.4. Peru (Republic of) (WLL+Cable)

The Huaral Valley is located at 80 kilometers north of the capital Lima where most of the dwellers are farmers. A non-government organization called CEPES (Peruvian Centre for Social Studies) led the project supported by OSIPTEL (Supervisory Agency of Private Investment in Telecommunications). The project was backed by local institutions, the Education and Agriculture ministries, European development organizations. The communities with more than 13,000 inhabitants and 18,000 students in the region are the beneficiaries of the telecommunication infrastructure services. One of the key elements of the project is the agricultural information system, with its website on www.huaral.org, where farmers can find the prices for local products and information on topics ranging from plague prevention to the latest farming techniques. This system also helps the farmers to organize irrigation systems of farming villages of coastal areas of Peru that suffer from scarce water resources. Access to information and network also helped farmers to look beyond their own region by sharing and exchanging their experiences with others.

Main technical characteristics, installation and interconnection includes 14 telecenters two in city with ADSL link to national network, 12 interconnected through Wi-Fi equipment to Huaral and then the national network.

7.5. Spain (Kindom of) (Optic Fiber)

Asturias is a region in the north of Spain, with 1.15 million inhabitants in 0.49 million homes.

Only the large city within the municipality has broadband access in Spain, leaving most of the geography of the region with no broadband service. The Government of Asturias realized that the real problem was the lack or poor coverage of broadband access network, and invested in deploying a high quality, future proof broadband access network, open to all service operators. The basic technology chosen to activate the town was an optic fibre network. The selected areas for network deployment were 27 municipalities located along 3 coal mining valleys, where economy needs to be shifted from primary sector to secondary and tertiary. The area covered 33% of Asturias surface. The fibre network reaches all villages within the area with more than 1.000 inhabitants (minimum target village size for deployment). The homes passed by the network have been 31.000 with 100.000 inhabitants in total. Regional Government's objective was to avoid the digital divide, by creating a broadband infrastructure and stimulating competition to improve service quality and prices, and assuring a sustainable scenario. The Government of Asturias deployed, in each valley, the trunk and access networks from the interconnection point to the final fibre distributor. The Telecom operators are responsible to provision their own subscribers, being the services supported Broadcast TV, Video IP, Data, Internet Access and Telephony. It's a network open to all operators and service providers available for interconnection in a single point. Asturias made the necessary investments to deploy the network and also the end user gateways to be leased to the operators. The Public Infrastructure Operator takes care of network upgrades, gateways and systems, and the costs of managing the network. The subscriber provision costs are responsibility of the Operators and Service Providers. This attempt has opened up opportunities to improve the local economy and helped to promote social and local services. The case study state the need for Public Administrations to invest in access networks infrastructure, to address the digital divide and guarantee fair prices and service innovations in a true competition environment. "Open networks are the best and only future proof solution" this case study concludes.

7.6 Brazil (Federative Republic of) (Satellite + Access)

Anatel has certain legal instruments that allow the implementation of universal service targets: the General Plan of Universalization Targets (*PGMU)* and the Plans for Universalization Targets with resources from the Universal Service Fund.

Service provision in rural and remote areas: PGMU brought the target of implementing Service Telecommunication Posts (PST) in Cooperative Attendance Units located in rural areas. These Posts must make available a public telephone, a public internet access terminal and a fax machine. The installation of a PST occurs after a request from the legal representative of the cooperative, and must be activated by the Incumbent in up to 120 days, with no costs to the cooperatives or its associates. Another target that has enabled fixed telephony expansion is the target of service provision in all communities with more than 100 inhabitants. These communities must have at least one public telephone installed in a place that is accessible

24 hours per day, capable of originating and receiving local and national and international long distance calls. In the period between 2004 and 2007, with basis on the PGMU rules, 205 Indian villages, 13 archipelagos, 540 settlement projects and 209 remote and frontier areas were provided with public telephones.

Universal Service Fund - Fust : to provide services to the population unattended by private initiative, mainly to regions or services that are economically unattractive, such as education, health and security services, access of people with disabilities, libraries and remote regions. Resources for the fund come from donations, contributions of 1% over the gross turnover of telecommunications services, revenues from compensation, grants and telecommunication exploration, 50% of the resources of the Telecommunications Inspection Fund and budgetary endowments of the Annual Budget Law.

Plan for Universalization targets to provide service to areas with population under 100 (one hundred) inhabitants. This plan determines the provision of telecommunication service access, with at least one public phone, in these areas.

(Universal ICT service policy)

The majority of the Brazilian population lives in urban areas, and only 17% in rural areas. According to the Brazilian Internet Steering Committee (CGI.br), the penetration of computer and Internet access is 28% and 20%, respectively, in urban households, showing that even urban areas suffer from a significant digital divide. Nevertheless, the digital divide is larger in rural and remote areas, where only 8% of households own a computer and only 4% have Internet access.

Rural areas in Brazil comprise about 31.3 million people, approximately 17% of the 189.8 million Brazilians. The rural population represents a segment of society that is left out of the information society phenomenon and of the expansion of digital networks' infrastructure. The technological infrastructure associated with the use of Information and Communication Technologies (ICTs) in Brazil is still widely concentrated in urban areas of the country. Rural areas have little or no connectivity to the infrastructure of ICTs and the vast majority of households in these regions have no access to telecommunication and Internet services, which means that a considerable number of people living in rural areas is digitally excluded. Digital exclusion refers to the divide encountered between people, enterprises and geographic regions from different socioeconomic levels regarding access to ICT's, establishing two categories: that of those who have regular, effective access to ICTs; and that of those who have no access to such technologies. According to the Survey on the Use of Information and Communication Technologies in Brazil 2008, from the Internet Steering Committee (CGI.br), only 8% of rural households have computers, and only 4% of them have access to the Internet. Also, 58% of the people who claimed to access the Internet in rural areas declared that they did so from paid public Internet access centers, while only 26% of them have household access to the Internet.

The Brazilian Federal Government has been establishing specific programs to reduce the digital divide, relying on the effective contribution of the private sector and the civil society towards this process. In addition to making access to ICTs available, these programs aim to train citizens to use these technologies, enabling them to benefit from the possibilities offered by the information society and, consequently, ensuring their interaction with the various segments of society and with dynamic cultural content.

The digital inclusion of the population from rural and remote areas, especially in large countries - such as Brazil, relies on effective and guided government programs that feature a management model that is adequate to the reality of the country and to the participation of key stakeholders who can contribute with resources from the private sector, in return for governmental incentives, either in the form of tax reduction programs or by increasing the income generation potential of the private sector.

The first Telecenters, called Digital Houses, were opened in 2008. The goal is to match the number of Citizenship Territories by 2010, which by that time, should have reached 120. So far, 53 Digital Houses have been implemented, covering about 16 Brazilian States.

Internet access is made possible through GESAC (E-Government) antennae, that provide internet broadband access at a speed of 256 Kbps, that is five to ten times faster than dial–up connections. The connection is made by satellite technologies and also by other forms of connection, such as wireless technologies and ADSL, broadband telephone network. There is availability of services such as e-mail, office and virtual lab, hosting and Internet telephony or VoIP, allowing for receiving TV channels and radio over the Internet.

The rural telecommunications program, *Voz no Campo,* began in 2003 from a governmental initiative of the state of *Espírito Santo*, through the State Secretary of Agriculture, Supplies, Aquaculture and Fisheries, to establish partnerships with the municipal governments, the incumbents and local associations of farmers.

The program aims to provide farmers with modern telecommunication networks, enabling the transmission of voice and data and increasing the level of information of producers about the market. In addition, it aims to improve the living standards of rural families.

Between 2003 and 2006, the program benefited 164 (one hundred and sixty-four) rural communities and 66 (sixty-six) localities, with investments around R$ 21,355,091.00 (twenty one million, three hundred and fifty-five thousand and ninety *Reais* or approximately US$ 10,974,967.11, according to the conversion rate in June/2009), reaching approximately 150,000 (one hundred and fifty thousand) people in rural areas.

In order to make both collective and individual accesses to reach rural communities through the Program, extensions are being made of both cable networks (copper and fiber) and radio networks. In some cases, new telephone exchanges are also being implemented.

7.7. Lithuania I (Republic of) (WiMAX+WiFi)

The "Rural Internet Access Points" Project was started in 2003 upon initiative of the Government of Lithuania. The Project has got an overall funding support of 315 million Euro from the PHARE program of the European Union. The first stage of the Project has established 300 Rural Internet Access Points all over rural Lithuania, which included the provision of computers, furniture and Internet connection. The Internet access Centres were mostly established in regions where communication infrastructure is poor. The centers operate in most often visited institutions of rural areas: schools, libraries, community centers, culture houses, etc. They not only provide the access to computers and Internet but also give the possibility to print, copy, scan and fax. It should be noted that the Alliance "Window to the Future" (established by leading Lithuanian business in 2002) was the initiator of establishment of Public Internet Access Points (PIAP) in Lithuania. In 2002, the Alliance in cooperation with local governmental institutions established 75 PIAPs.

7.8. Lithuania II (Republic of) (Cable)

The project schedules the building of fiber-optical network infrastructure to all local administrations in the territories of rural local administration centers of Lithuania that do not have broadband internet connectivity. It will decrease the difference of availability of broadband internet services between rural and urban areas. The total length of this infrastructure will amount to 3 000 kilometers. The speed of the channels will initially reach no less than 100 Mbps. Optical channels will open up the possibilities of employing, to one's own needs, not only texts but sounds, images and video, with these possibilities being continuous, reliable and safe. The network is designed in such a way that its speed is subject to increase without involving considerable costs.

a. Indonesia I (Republic of) (Satellite + Cable)

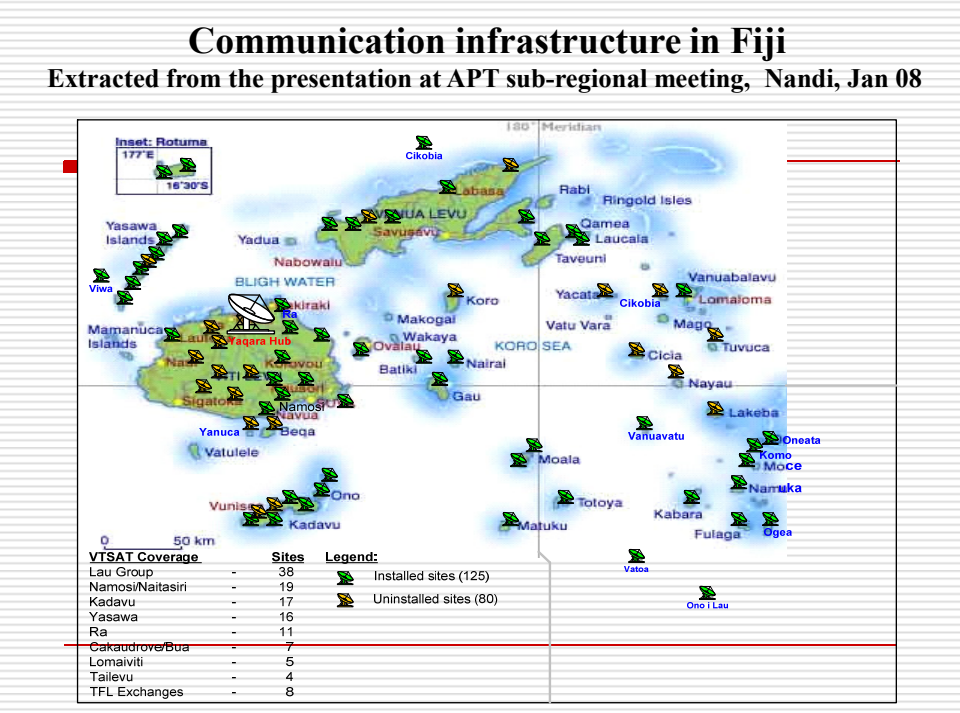
The project purpose was to provide telecommunication infrastructure for the local people in rural areas of Sumatera to encourage economic and social development through voice, fax, and internet services. NGN with soft switch over the wire-line contributed to offer rural people affordable services.

Project utilizes soft switch based NGN in conjunction with optical fiber, terrestrial IP Radio and VSAT in its network. Main technical characteristics: IP-Packet technology, MGCP/MEGACO protocols for MGs; trunk media gateway and signaling gateway for interworking, and access media gateway for POTS facilities.

7.9. Fiji Islands (Republic of the) (Satellite connection for outer Islands)

VSAT system is widely deployed in Fiji for connecting their outer islands. 125 sites are installed and the additional 80 sites are planned to be installed. Major islands are linked by microwave system and the CDMA system is also deployed for the mobile phone services on the main islands and their surrounding water or providing services to fishing boats.

Figure 7.4: VSAT systems for outer Islands deployed by Telecom Fiji Limited



7.10. Latin America and Caribbean (Satellite)

SES NEW SKIES provides support for Venezuela's INCE (National Institute for Educational Cooperation) by providing Internet connectivity via the DVB platform on NSS-806 to more than 150 educational training sites. In the Dominican Republic, over 500 rural sites have access to telephony services via a Ku-Band VSAT network on NSS-7 operated by Codetel, the country's largest telecommunications provider.

In Haiti, SES NEW SKIES is providing Internet connectivity to hospitals using the DVB platform on NSS-806. This connectivity links hospitals in Haiti to the Harvard Medical School in Boston and is used as a telemedicine tool for "real-time diagnosis". The organization behind the link is Partners-In-Health, a non-profit organization sponsored by the Bill & Melinda Gates Foundation and Harvard University, which aims to improve health services in communities worldwide. In 2008, a third hospital in Haiti was connected via our satellite.

7.11. Africa (Satellite connectivity for schools)

NEPAD (The New Partnership for African Development) is a Pan-African organization sponsored by the African Union that aims to combine public and private partners to address development issues in Africa. The NEPAD e-Africa Commission is responsible for ICT related projects. The NEPAD e-Schools Initiative has been established by the e-Africa Commission and aims to develop ICT skills in Africa by equipping all African primary and secondary schools with computers, networks and other equipment, and to connect them to the internet.

The first phase of the e-Schools initiative is the e-Schools Demonstration project which is being used to demonstrate the value of ICT to education and to gather support at various levels of government and industry. The Demonstration project encompasses 96 schools in 16 African countries. The project is being led by 5 consortia from private industry, lead by Microsoft, Cisco, AMD, Oracle and HP. Each consortium has partners providing various parts of the project including satellite or terrestrial internet, PCs, LANs and content. NEW SKIES is a member of the Cisco, AMD and Microsoft consortia, and SES NEW SKIES has inherited support of Oracle from SES ASTRA, another SES company.

NEW SKIES is supporting the NEPAD e-Schools Demo project by providing satellite capacity on the NSS-7 satellite and teleport services from the Washington Mediaport. SES NEW SKIES are working with two other partners, iDirect and Intersat Africa, and have committed to provide a total satellite solution for schools. iDirect is providing Virtual Network Operator (VNO) and VSAT equipment while Intersat Africa provides installation and operations.

7.12. Bangladesh (People's Republic of) (Challenge of LDC for rural connectivity by Optic Fiber and Wireless technologies)

Bangladesh is one of 49 Least Developed Countries (LDC) in the list of United Nations, which is situated in south-east Asia. Bangladeshi people are very keen towards new technologies and they try to adopt the new system quickly. Already the incumbent operator BTCL has launched the DSL service in Bangladesh to have rural broadband penetration. They are going to launch within next couple of years to have a well equipped telecommunication system for broadband penetration in the rural and remote areas.

The Bangladesh Telecommunication Regulatory Commission (BTRC) has published an infrastructure sharing guideline to have proper utilization and expansion procedures in telecom infrastructure in Bangladesh. The country will introduce FTTH by newer licensees. There is around 10% of coverage over optical fibres. Though there are 2(two) licensed operator to deploy the FTTH in Bangladesh, one is using optical network and the other will build nationwide optical network for their services. These operators have started rolling out their network setup. Three WiMAX operators are predicting to launch their services in the early 2010 but they are still developing their own network & infrastructure. On the other hand, almost 90% of the country is covered by GSM & CDMA. It is expected that the country deploys UMTS/WCDMA (3G) in early 2010. This country will be benefited by a rapid growth in wireless access techniques.

Bangladesh is planning to adopt wireless technologies for the rapid development of access infrastructure in the rural and remote areas. The WiMAX license is issued, which should be available in 2010 and implementation of 3G (UMTS+WCDMA) is in the similar timeline. The main competition will be on the WiMAX vs 3G. As WiMAX is launching earlier than 3G but the country has the widest coverage in GSM network. The competition between two technologies is tough for their deployment in rural and remote areas to challenge for broadband penetration. However the wireless technology is almost for sure to be taken into their consideration. Bangladesh will look forward to the developments in WiMAX & 3G field, and monitor the usage trend and international acceptance and will build the appropriate telecommunication infrastructure very soon. The country has fiber connectivity between metropolitan cities but the urban or rural areas still solely relying on microwave links to carry the data. The international access is still costly here. Bangladesh is looking forward for necessary supports to have infrastructure for rural & remote access system to facilitate the end user by making the service available in affordable price.

7.13. Niger (Republic of) (IP Mobile System for Broadband Service in Rural and Remote Areas)

Niger is also one of 49 LDCs in the list of the United Nations. An IP mobile system for broadband service in rural and remote areas of rural community of ABALA is on going in the country. The Republic of the Niger is a State in Sub-Saharan Africa with a vast surface area of 1 267 000 km^2 for the most part made up of steppe and desert. The State is entirely landlocked and its population lives very poorly from livestock breeding and the cultivation of some crops such as millet and ground nuts (see Fig 7.6)

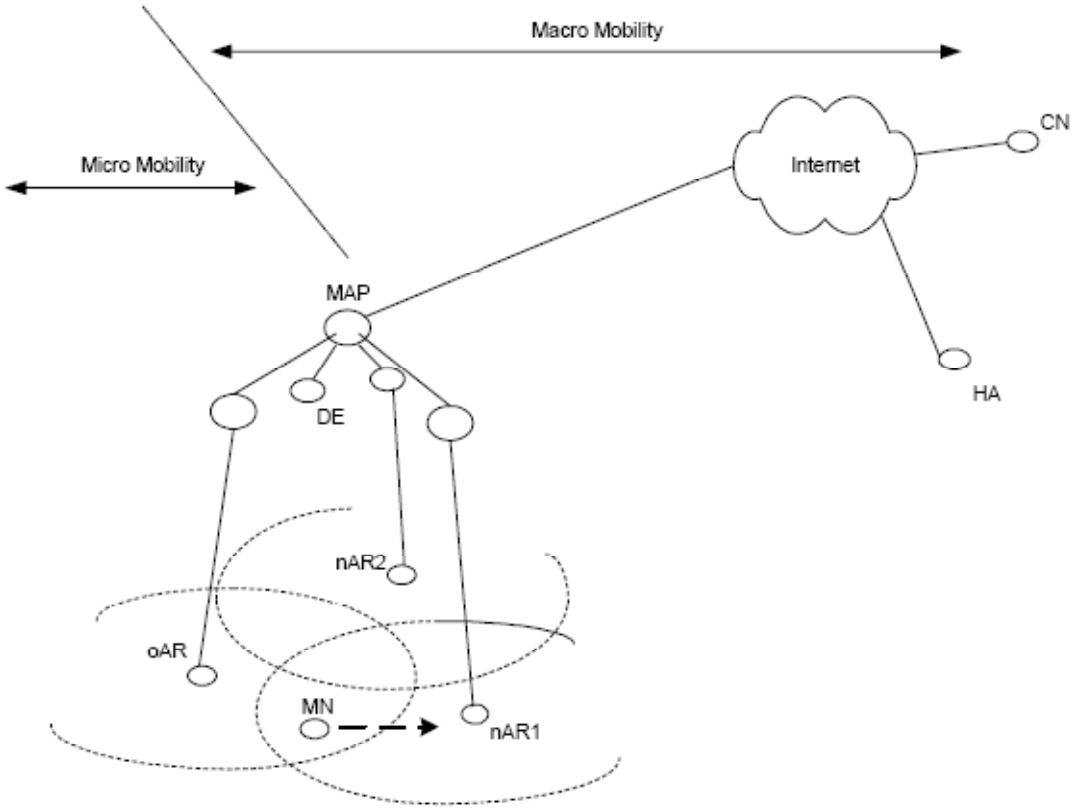
The Niger is currently divided up into eight administrative regions:

- The rural community of ABALA is situated in the Department of Filingué, Tillabery Region;
- The population was estimated at 66 492 in 2006;
- The population essentially comprises livestock breeders and farmers;
- The commune is not provided with any fixed or mobile telephone coverage by any operator;
- The road between ABALA and FILINGUE is a rural track, thus access is not easy;
- The distance between FILINGUE and ABALA is approximately 110 km;
- FILINGUE has telephone coverage, and therefore in order to send a message the journey has to be made from ABALA to FILINGUE, which is a problem for the low-income population (**see Fig 7.7**).

Technical solution proposed

They will use the routing scheme given in the figure 7.5 below:

Figure 7.5: Routing scheme



Legend and definitions:

- MAP – Mobility Anchor Point: is a router or set of routers that memorizes the Mobile Node (MN) links. The MAP intercepts all the packets sent to the MN, and routes them, having due regard to "tunnelling" with the Link Care of Address (LCoA)-type link addresses
- MN – Mobile Node: this is the user
- nAR – new Access Router
- oAR – old Access Router

Regarding the transmission systems, use has to be made of macro mobility in order to have a satellite link, and of a WiMAX-type fourth generation (4G) system for micro mobility, because combining this type of system with an intelligent radiation system will provide a coverage radius of only approximately 40 km line-of-sight from the base station.

Use is made of a WiMAX-type system, as it is extremely well suited to the kind of territory involved given the numerous services that can be developed with a high-rate system of this kind.

WiMAX will offer customers real high-rate Internet access and innovative telephone services. The technical connection of customers to the network will be by means of a WiMAX wireless high-rate link and an IP telephony professional gateway:

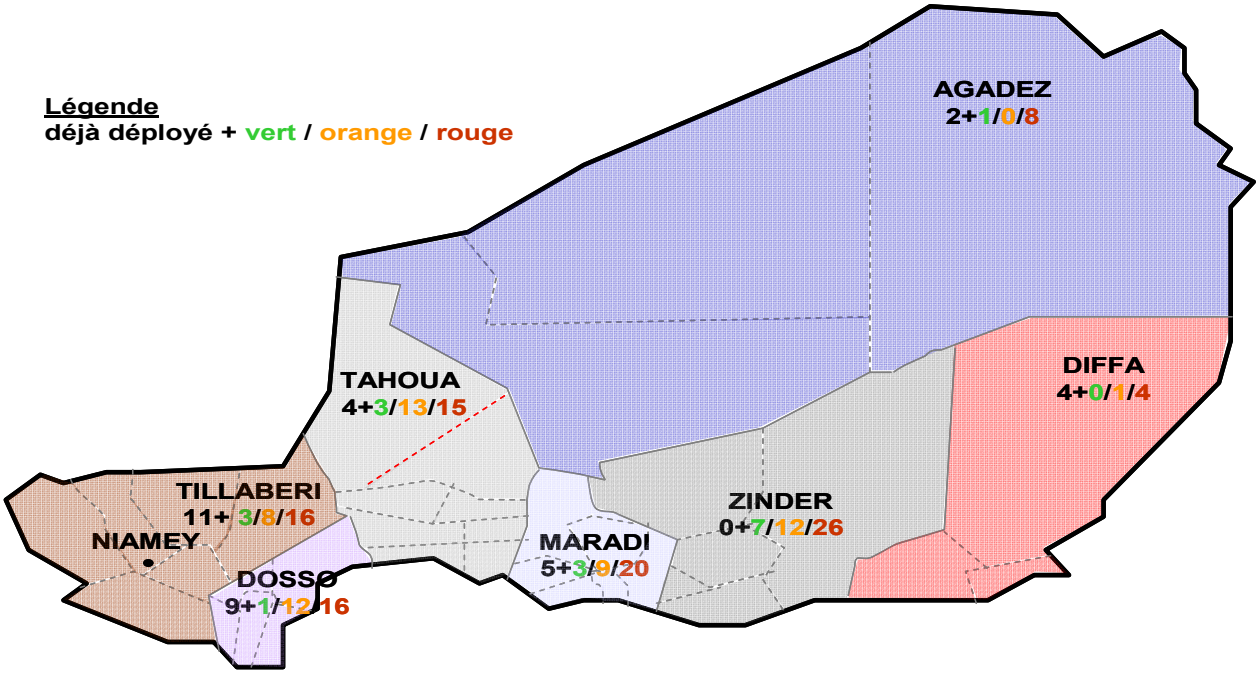
- for professionals: in addition to inter-site links, private networks, high-rate Internet access and IP telephony, the system will soon offer high valued-added advanced services (IP Centrex, teleconferencing, ASP application solutions particularly for SMEs,...);
- for private individuals: alongside its "double play" offer, the system will propose multimedia services on its WiMAX network, including offers of original, previously unpublished content.

In financial terms, construction of a WiMAX network requires **base stations, customer premises equipment (CPE)**, **high points** for the installation of the base stations, and the linking up of the stations to a collection network.

The cost of a base station is approximately 10 000 euros. The price of base stations has not fallen significantly in the last year, and they are to integrate new technologies in the short term, which will not be conducive to any price drop. Nevertheless, with the mobile WiMAX and extension of the market, prices will surely come down. The price must nevertheless be correlated with the required station density.

Figure 7.6: Terrain of the Niger

Figure 7.7: Networks already deployed



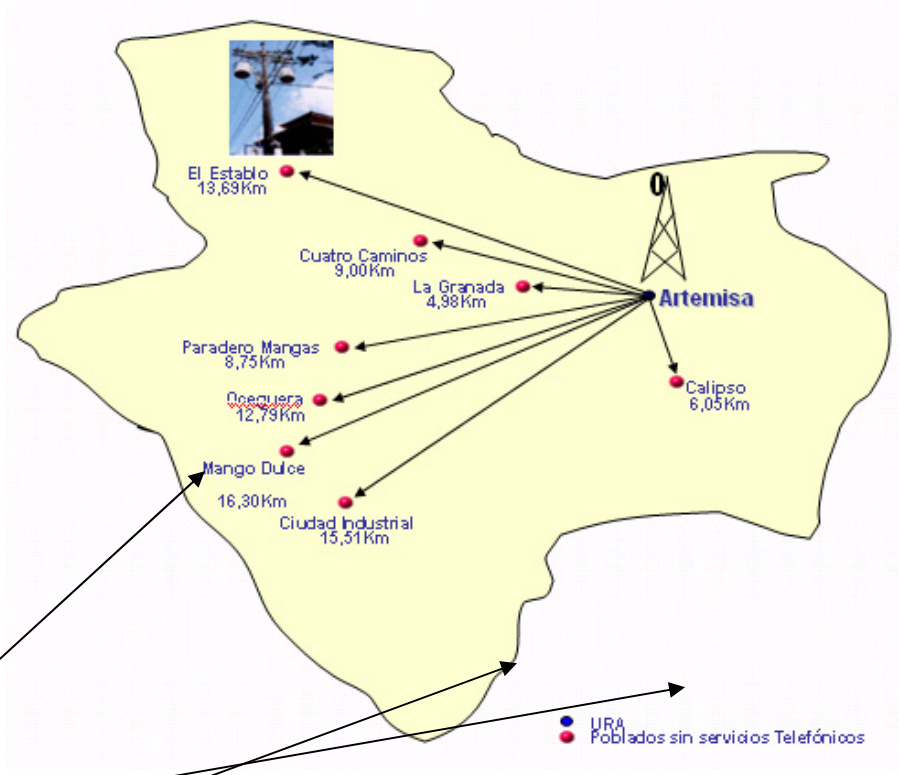
7.14. Cuba (Republic of) (WiMAX)

Cuba is one of 49 LDCs in the list of United Nations. With the objective to carry out test in rural areas on applications of WiMAX and PLC technologies and combination of both and some tests of compatibility were carried out in a village of Granada, during second week of March 2006.

This test consisted of proving VoIP in H.323 services over PLC using WiMAX for transporter which has been left in the Pilot test phase without concluding at the time.

Establishment of Granada, located at 4.98 Km of Artemisa, place with a Remote Subscriber Unit (RSU), together with a Node of Data transmission has been chosen. A general idea of territory with WiMAX coverage in the village of Artemisa is shown in detail in Figure 7.8 below.

Figure 7.8: Deployment of WiMAX in a Pilot Test of rural area in the village of Artemisa



Industrial city

Villages without telephone services

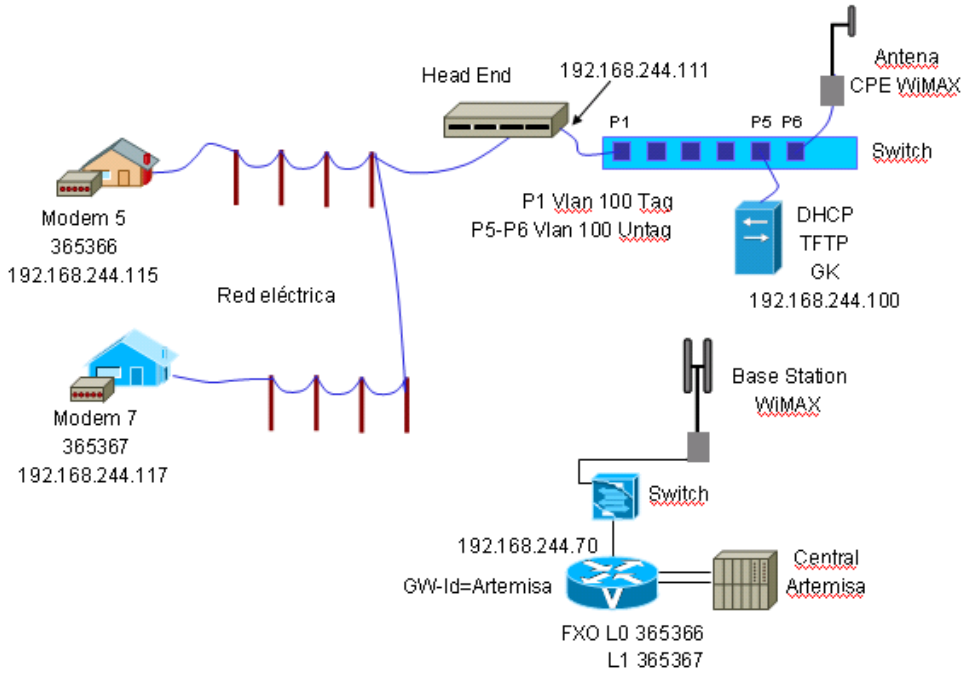
Remote Subscriber Unit (RSU)

Figure 7.9 below shows the tower where WiMAX Antenna has been located at Telephony Center of Artemisa and where RSU and Node of Data Transmission data are placed.

Figure 7.9: Tower in the Telephony Center of Artemisa where WiMAX Antenna has been placed

To pursue this test, a free Gatekeeper downloaded from the Internet has been used, like a router with XFO and XFS cards so that the service of VoIP placed over PLC and the WiMAX system behaved like prolonged loop of subscriber line using the Ethernet like by means of WiMAX for access, and PLC for LAN in a electric circuit of low tension of Establishment village of Granada covering an area around 300 meters.

Figure 7.10: Details on the installation of the Test WIMAX – PLC in the Establishment of Granada



It is important to say that the Head End equipment has been located inside of medical center together with the CPE of WiMAX, injecting PLC signal protected against the electrical attack, covering all houses connected electrically for transformer of medium and low tension which connect most of the houses of the establishment, this avoids the necessity of arranging a costly local telephone network for voice and data.

Figure 7.11 shows WiMAX antenna in the top floor of medical center office of a family where Head End is located, electrical wire of low-tension distribution in the mentioned establishment and a house of a user.

Figure 7.11: Medical Center (office) of a family from which WiMAX are received and has been injected PLC signal, energy lines and a house of a user

It is important to say that all installations and configurations of PLC equipments were carried out in less than 2 hours and were able to make phone calls among 3 telephones installed there.

These calls were invoiced for Remote Subscriber Unit (RSU) of Artemisa as it is shown in Figure7.10. They had numerations of this, reason why the combination WiMAX-PLC has served to increase the loop of lines for a distance of 4.58 km.

However, it is possible to emphasize that in those moments the Pilot of WiMAX were not prepared yet to use the VLANs, which required putting Switch layer 2 in Granada together with the Gatekeeper. It already surpassed this problem widely today and protocol 892.1p has been placed in WiMAX. Moreover we are able to place in PLC an IP telephone service without VLANs, of course it is only advisable with few subscribers.

This would facilitate having Switch layer 2 and Gatekeeper located in the Telephone Center of Artemisa providing services for all the establishments' population of the village.

It is considered that this has been a very positive experience. Firstly it allowed them to prepare in the adjustment of a Router with cards XFS and XFO as a Gateway, as well as in the adjustment of a free Gatekeeper of Internet for the work in our communication networks.

It is a new possibility of interconnection to evaluate economically in rural areas where demand to provide Voice and Access to broadband services to the villages without telephone infrastructure but having an electrical infrastructure, that by its capillarity (arrives at all sites or places) allows to offer these services to every place.

Nevertheless it should be reiterated that every place could take a specific solution to be economically viable and that therefore this is not the only viable alternative, also that demonstrates that the access technologies do not exclude another alternative.

7.15. Canada (WiMAX)

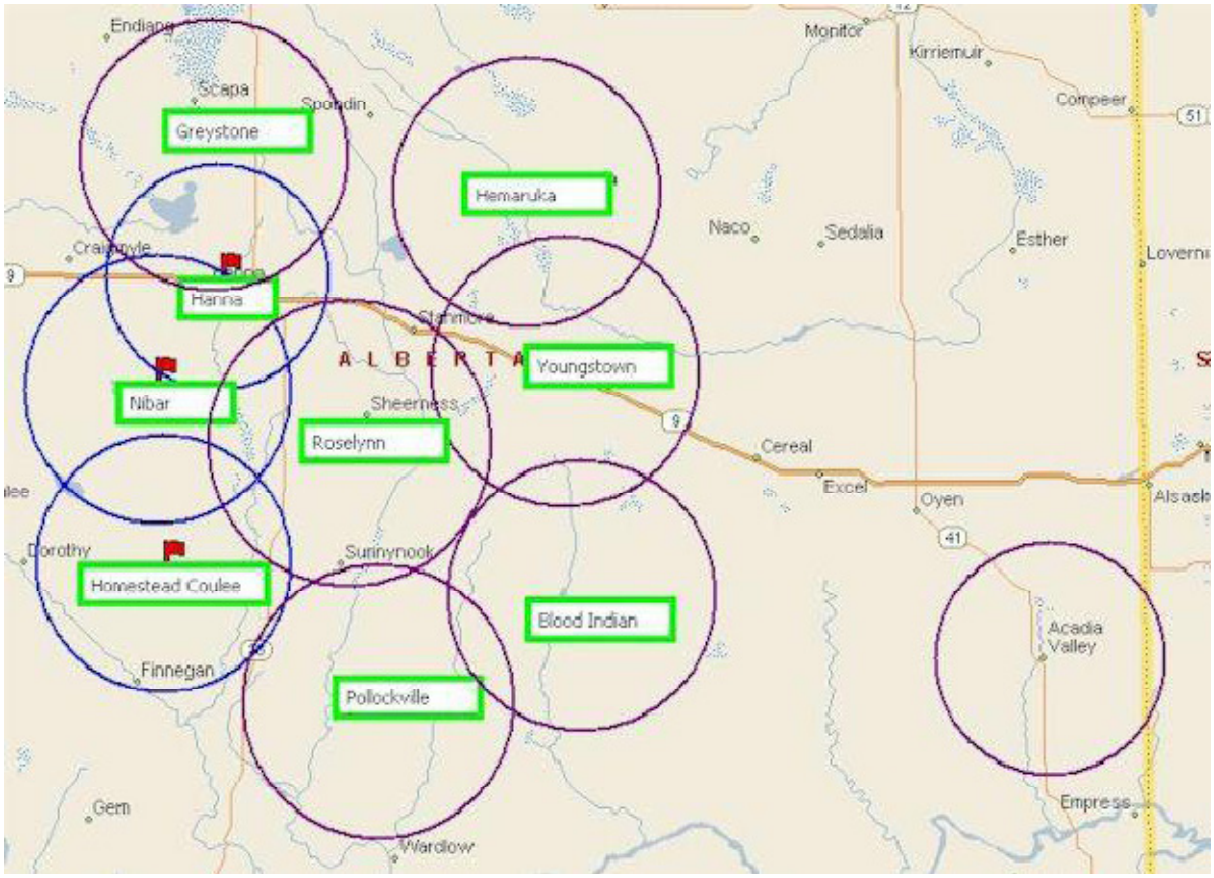
In December 2005, the Alberta Special Areas Board (SAB) selected Nortel to build a commercial broadband wireless access network in Alberta, Canada based on the WiMAX IEEE 802.16 standard.

The SAB collaborated with NETAGO Wireless, a newly formed wireless service provider in Canada, to bring wireless broadband services to rural Albertans spread throughout more than 21,000 square km in southeastern Alberta.

The new WiMAX network also extend the service area of the Alberta SuperNet Project, a provincial government initiative designed to bring affordable broadband services to approximately 4,200 government, health, library and educational facilities in 429 communities across Alberta.

The WiMAX network provides SAB residences and businesses with fixed broadband wireless access at data rates between 1-3 Mbps. The high-speed capabilities supports sophisticated broadband services such as email, high-speed Internet access, multimedia applications including streaming video and music, VoIP (Voice over IP) and other real-time business collaboration services. The network also supports video surveillance and remote telemetry.

Figure 7.12: Coverage area



7.16. Pakistan (WiMAX: Wateen Telecom)

Wateen Telecom is the Abu Dhabi Group's latest investment in Pakistan for providing solutions for bridging the digital divide.

Wateen Telecom has chosen its network solutions and vendors in accordance with international standards to provide world-class innovation that focuses on quality, reliability and scalability.

To effectively realize its vision, Wateen Telecom focuses on creating on Next Generation Network that is based on IP/MPLS and IMS (Integrated Multimedia Subsystem) solutions with multi-access services using fiber access and spectrum in the 3.5GHz band for WiMAX last mile access. To ensure quality and reliability, Wateen Telecom is building its own network to avoid third party reliance and to provide guaranteed Service Level Agreement (SLAs). This large-scale endeavor includes:

- Next Generation Network (NGN) Core
- IMS enabled converged multi-access network based on a layered architecture
- Robust LDI/Class 4 and Class 5 networks with all fundamental enabling technologies and a host of applications providing depth and breath of value added netwoks.
- End-to-end IP centric architecture including IP/MPLS core and edge networks for triple play services.
- Fixed and Wireless access networks.
- Metropolitan Access Network (MAN) with 96 pair G652/655 optical fiber.
- Ethernet rings in all major cities including fiber to the Curb (FTTC)

- National WiMAX cutting edge 4G broad band wireless connectivity
- Infrastructure (Optical Fiber Network and Tele-housing)
- Multi-terabite DWDM solution over national fully redundant ring architecture by long haul optic fiber network covering more than 5000km scalable 160 lambdas connecting all major cities in Pakistan and neighboring countries.
- Regional and international direct connectivity through optical fiber and VSAT links establishing Pakistan as a major communications hub.
- Tier 1 tele-housing and managed services based on international standards and premier Service Level Agreements (SLAs).

To facilitate WiMAX deployment Wateen Telecom has entered into agreement with Warid Telecom and other GSM operators to reuse existing GSM sites. This has reduced greatly the capital investment requirement and benefits Warteen Telecom as ell as the GSM operators since ongoing site operating expenses are shared. Wateen's WiMAX platform supports broad band internet (IP bandwidth and internet connectivity with offering 1 Mbps bit rate), Data-VPN (L1/L2), on line surveillance, gaming and video conferences, and Voice(basic telephony, enhanced telephony, IP centrex and video calling etc.).

7.17. China (Goverment Policy for rural communications development)

In the past five years, the Chinese Government launched the "village access project ", a total of more than 5 billion EURO investment for the 130,000 administrative villages and the villages to open a telephone service. At the same time, the "Eleventh Five-Year Plan" of information industry proposed the goal that every town should be connected with Internet to further improve the level of communication services in rural and remote areas. By the end of 2008, 97% of towns have already been connected with Internet and 95%of towns achieved broadband connections. In 2008, the Chinese Government and telecom operators have provided 431 towns and 12103 administrative villages with Internet connections. Since the construction of infrastructure has been made great progress, the Chinese government began to take further measures to enhance the communication services in rural areas and stimulate the rural economy through the provision of information-based services.

In April 2009, The Chinese government launched the "Information services to the countryside" project to promote information-based services in rural areas and narrow the digital divide. The key point of this project is focus on the construction of rural information service network and the development of agricultural related information services, in order to bring information contents, information services and information devices into the rural villages. According to the Chinese Government's plan, 10,000 towns will be covered by this project during 2009. The detail of this project includes setting up an integrated information service stations and an information content database in each town. It also includes an information service studio and online introduction of agricultural products for each village. The Chinese government has developed certain standards for the construction of integrated information service stations, including:

It must have a fixed place;

Information devices: with at least one computer, a telephone, and Internet access. Areas where conditions permit, can be equipped with televisions, set-top boxes, printers, projectors, digital cameras, touch-screen and other information devices;

At least one staff, part-time and full-time are both accepted;

Management systems, including security, equipment management, staff appraisal and other;

Integrated information service stations will provide a wide range of information technology services, including:

8 Social impacts on the rural communities

There are various social impacts on the lifestyle of communities in rural and remote areas. Some examples observed in the collected case studies are mentioned below.

- **Effectiveness**

  The users of ICT services in rural communities are mostly people with literacy. Those people are users of ICT services at community centres such as e-mails, information/news, telephone, chatting on the web, and reading materials by web browsing, etc. For the people with illiteracy including small children, measures are taken for their education and training how to use computers at the community centres in rural and remote areas. They share the computers and ICT infrastructure made available for the dwellers of isolated rural and remote areas. The school children, high school children in the rural villages are particularly benefited by the ICT services provided at the community centres. The effectiveness of provision of ICT services over the broadband connectivity is no doubt well aware by the rural community when they have the ICT and telecommunication services. They know that they had to spend much time to walk or to ride on the small boats from isolated community on land and sea to get access to ICT for the information/news of outer world or receiving/sending messages with the family or friends outside the community and they can eventually save time and money when they have ICT. The information of market price of their agricultural/fishery products obtained through the internet will bring more profit than when they have no such means. Thus in some way or other, villagers will be empowered by the ICT and their quality of life enriched.

- **Sustainability**

  In most of the cases, the projects are subsidized by the private/government funds or resources from international aid agencies for the building ICT infrastructure and associated facilities. The difficulties for sustaining the project are operation and maintenance (O&M) including recruitment or training of maintenance staffs at the site.

  In this regard the choice of equipment/facilities/software should always be important items from the planning stage. The costs for maintenance, operation of communication facilities, leasing facilities including communication charges or satellite transponder charges which are the significant part of the operational expenditure are not usually compensated by the project funds or by government subsidy. This will make the matter of project sustainability difficult. The implemented projects should be self sustainable by raising revenue to make both ends meet within the project as much as possible. In some collected case studies, the village development committee are formulated so that villagers may participate in the projects even modest amount of capital investment. The villagers will have the keen interest in the management of their community centres and operation and improvements for profit.

- **Human capacity building**

  The most of collected case studies have the human capacity building program in the projects for the community people including the women and young people so that they could fully utilize the services provided at the community centres. The human capacity building will be effective for the community people or villagers for making them potential users of services or giving them future job opportunity in the rural community or outside. Many projects stress the need of trainers' training for training community people. They train young high school or college students at urban or rural centres who could be core trainer of ICT technology and applications. They will be then dispatched to the rural centres for training rural community people and engage in the maintenance and operation for facilities of community centres.

  The core healthcare takers of the community health post are also trained at the urban hospital for basic healthcare knowledge and use of medicine. They will be assisted by the several supporters at the health posts. With the tele-consulting system over the broadband video conferencing network, healthcare taker may be assisted by the medical doctors of the urban hospital.

  Tele-teaching system is also planned or implemented by deploying video conference network to make it possible the highly qualified teacher at one core school may provide lessons to the several schools in the rural community thus sharing qualified teachers among the rural schools.

Human capacity building is the most important challenge for the success of rural communications development.

- **Cultural effect**

  ICT infrastructure once implemented in the rural and remote areas, the people may exchange information among the rural communities and outer world which will have the impact on their culture and life in various ways. Their traditional culture and life will have the opportunity to be exposed to the outer world over the internet. The most of the world population are still in the closed small world but they should have the equal opportunity to know the outer world or vice versa over the secured ICT network. There are some challenges for building digital library to save the traditional culture (art and dance, etc.) and written documents, etc. and to make it open for sharing globally.

9 Successful Telecenter Model

The telecenter model is more cost effective than providing ICT service to individual households for rural and remote areas. This method could make available infrastructure and facilities for the rural and remote areas to be shared by the dwellers in the community. There are many different models of telecenter deploying public facilities. Community participation for management of telecenters will be the key success factor where they may even participate in the capital investment to have the interest in the management of their own telecenters.

- School based telecenters

School computer labs and facilities may be made open to community people outside school hours and training should be offered to community people by the instructors or teachers with affordable costs or free of charge by the subsidization.

- E-post

Use of post office space and manpower may be rented to community telecenters for ICT services. This challenge is promoted by the collaboration between ITU and UPU (Universal Postal Union).

- E-health post

First aid for the villagers, consultation with doctors at urban hospitals via audio or video conferencing service may be provided at rural health posts combined with community telecenters with broadband connectivity.

- E-government

The space of local administrative office in rural and remote areas could be offered to the community telecenters which could share the broadband connectivity for e-government service between administrative office and telecenters.

- Agricultural telecenter

Agriculture and fishery information centres will have the important role in rural and remote which are dependent on the agrarian economy. Useful information for farmers and fishermen such as market prices, weather, assistances, etc. are demanded in such community. Telecenters services should be targeted for such population.

- Business telecenter (efficient to support local entrepreneurs)

10 Conclusion

To meet Principle 20.2 of the Geneva Declaration of Principle that information communication and infrastructure is an essential foundation for an inclusive Information Society, and also the Geneva Plan of Action that states to connect villages with ICT and establish community access points is an internationally agreed goal. The challenge set by the Millennium Development Declaration of United Nations “Eradication of extreme poverty and hunger is also the base line for rapporteur’s group on Question 10-2/2, striving for

the intensive study in accordance with its mandate set by the Doha Action Plan. Because of the rapidly growing urbanization of population from rural and remote areas of developing countries to the urban area or metropolitan cities the poverty of those people is the serious social problem in every developing country. With the aim that the provision of ICT connectivity and services for population of rural and remote areas would ameliorate this vicious circle the rapporteur's group has been striving for finding out solution and best practices to be recommended for the policy makers and practitioners of Member States, Sector members and international aid agencies/Institutes, etc. The following conclusions may be derived from the analysis of case studies collected and the contributions submitted by the members during 2002-2006 and 2006-2010 study cycles. Based on the studies by the rapporteur's group, the recommendation related to the Q10-2/2 is also derived and submitted for approval by WTDC-10.

- The ICT facilities provided for rural and remote areas of developing countries as well as developed areas or vice versa, thus reducing the mobility of population from rural to urban or metropolitan cities of developing countries as well as developed countries.
- There is no definite measure for the choice of technologies but to compare various technologies that could be best suited for each location (satellites, WLL/Wi-Fi/WiMAX, fibre or metal pair). Consideration of technical, economic and geographical aspects of the project is essential.
- Public private partnership scheme is the new methodology for raising funds for the rural project that has been often considered.
- Regulatory frameworks associated with USO, USF, frequency license, and service license, service competitiveness should be prepared in every country to adapt to the rapidly changing environment relating to new technologies, new services for the sound development of ICT in rural and remote areas.
- Providing benefit of ICT for all could be equal to social welfare to be provided by the country and also the basic human rights.
- Solutions for power supply for ICT facilities and infrastructure in the rural and remote areas are critical issue. Consideration of renewable energy sources such as wind power, solar power, and mini-hydro power, etc. should be stressed for the protection of global warming or from the environmental viewpoint.

11 Acronyms and abbreviations

ADSL	Asymmetric Digital Subscriber Line
ARQ	Automatic Retransmission Request
ASP	Application Service Provider
BTRC	Bangladesh Telecommunication Regulatory Commission
CAC	Community Access Centre
CAP	Community Access Point
CAPEX	Capital expenditure
CEPES	Peruvian Centre for Social Studies
CDMA	Code Division Multiple Access
CPE	Customer-premises equipment
DSL	Digital Subscriber Loop
DVB	Digital Video Broadcasting
EV-DO	Evolution-Data Optimized
FAO	Food and Agriculture Organization
FTTH	Fiber to the home
GEO	Geostationary Earth Orbit
GSM	Global System for Mobile Communications
ICAO	International Civil Aviation Organization
ICT	Information and Communication Technologies
IEEE	Institute of Electrical and Electronics Engineers
ILO	International Labour Organization
IMT-2000	International Mobile Telecommunication 2000

INCE	National Institute for Educational Cooperation
IP	Internet Protocol
ISDN	Integrated Services Digital Network
IT	Information Technology
ITU	International Telecommunication Union
LAN	Local Area Network
LC of A	Link Care of Address
LDC	Least Developed Countries
LOS	line-of-sight
MAP	Mobility Anchor Point
MG	Media Gateway
MGCP	Media Gateway Control Protocol
MCT	Multipurpose Community Telecentre
MN	Mobile Node
NEPAD	The New Partnership for African Development
NGN	Next Generation Networking
NLOS	non-line-of-sight, near-line-of-sight
PC	Personal Computer
PGMU	General Plan of Universalization Targets
PIAP	Public Internet Access Points
PLC	Power line communication
POTS	Plain Old Telephone Service
OFDM	Orthogonal Frequency Division Multiplex
OPEX	Operational expenditure
OSIPTEL	Supervisory Agency of Private Investment in Telecommunications
PCO	Public Call Office
POP	Point of Presence
PST	Service Telecommunication Posts
RF	Radio frequency
RSU	Remote Subscriber Unit
SME	Small Medium Enterprises
TCP	Transmission Control Protocol
TRAI	Telecommunication Regulation Authority of India
UMTS	Universal Mobile Telecommunications System
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
UPU	Universal Postal Union
USF	Universal Service Fund
USO	Universal Service Obligation
VLAN	Virtual LAN
VNO	Virtual Network Operator
VoIP	Voice over Internet Protocol
VSAT	Very Small Aperture Terminal (used with satellite systems)
WCDMA	Wideband Code Division Multiple Access
WHO	World Health Organization
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless LAN
WLL	Wireless Local Loop
WMO	World Meteorological Organization
WRAN	Wireless regional area network
WSIS	World Summit on the Information Society

WTDC World Telecommunication Development Conference
WTO World Trade Organization

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