INTERNATIONAL TELECOMMUNICATION UNION

4th Meeting of the Task Force for New Technologies and Rural Applications
ITU Headquarters, Geneva 28 June 2002

Document FG7-TF DOC 4

28 June 2002
Original : English

Project Guidelines
Wireless IP for Rural Connectivity

This short document contains four sections:

a) Project Concept for Wireless IP pilot project network
b) Objectives of the Pilots
c) Expected Outcomes
d) Partner Obligations and Commitments

In addition, it contains five annex documents. The first and second delve more concretely into specific components of an ITU wireless IP pilot project (Annex A) and the process of project authorization and implementation (Annex B as FG7-DOC 5). The third annex provides definitions of rural landscapes (Annex C). The paper also contains two technical annexes, the first provides more detailed information on wireless IP technology (Annex D*), while the second provides technical illustrations of a typical network (Annex E*).

1. PROJECT CONCEPT :

Since the formative work of the Maitland Commission in 1984[1], the ITU has been working in cooperation with national governments, international organisations, the private sector and NGOs to enhance universal access to ICTs – particularly in rural and remote areas. From the Valetta Action Plan (VAP- 1998] to the Istanbul Action Plan (IAP-2002), policy statements and recommendations[2] have confirmed the need to promote basic telecommunication, broadcasting and the Internet as tools for development in rural and remote areas.

The WTDC 1998 established a Focus Group (FG7) to study new technologies for rural applications. Their final report, *New Technologies for Rural Applications* evaluates new technologies suitable for rural landscapes, ranging from radio to VSAT and wireless packet based IP systems. It confirms the need to further study the benefits of a robust telecom network combining low-cost, wireless access technologies with packet-based networks for the possible delivery of multimedia applications in rural and remote areas

Consequently, it proposes to study this new technology by evaluating a number of wireless access infrastructure initiatives in rural areas. The aim of this study is to evaluate its applicability to the rural environment from technological, financial, economic and social perspectives.

---

* Documents can be requested from ITU Secretariat
[1] Independent Commission for World-Wide Telecommunications Development, *The Missing Link* Geneva, ITU: 1984.
[2] World Telecommunications Development Conference 2002, Recommendation [Com 4-9] 11 Rev. 1, Telecommunications in Rural, Isolated or Poorly Served Areas.

In order to ensure the implementation of the report's commendations, a special Task Force has been established and is currently Chaired by Mr. Y. Kawasumi of Japan Telecom. The current target is to invite five project proposals from rural communities worldwide in order to implement and/or evaluate wireless IP technology applications as an input to the World Summit on the Information Society to be held in Geneva December 2003. These projects are to be sustained by project partners as a vital source of rural ICTS and development. Ideally, these projects should complement existing multilateral, regional ICT projects or networks. For more information on the work of the Task Force and related rural connectivity issues, please consult **www.itu.int/ITU-D/fg7**.

2. Objectives :

More than 2.5 billion people – over 40% of the planet's population – live in rural and remote areas of developing countries. Of the small fraction that has any access to telecommunications, radio broadcasts and voice telephony have traditionally been the main services provided. Today, a wide variety of new telecommunication applications such as e-mail, e-commerce, tele-education, tele-health, and tele-medicine, among others, have made access to interactive multimedia services as important for rural and remote communities as voice connectivity alone. Since each rural district or community requires a different mix of voice, text, image, video and audio communications to best meet its needs, today's telecommunication network operators must be able to support a wide range of services, applications and bandwidth levels at a reasonable cost.

To accommodate these new applications, the focus of new network construction around the world is shifting rapidly from conventional PSTN to IP-based technologies. It is important that developing countries, and rural areas in particularly, not be sidelined during this process.

In the report, *New Technologies for Rural Applications,* it was found that there are an increasing number of technologies that are available to meet multimedia applications at a reasonable cost to rural network operators. Emerging packet-based wireless access technologies, such as IMT-2000 and wireless routers, are being designed to deliver a wide range of traffic types more efficiently and inexpensively than traditional wired and cellular telephony networks.

2.1 Specific Objectives

The specific objectives of the pilot projects on Wireless IP are:

a. To provide easy access to data and voice services where needed in rural areas and hence to:

- Increase access to education facilities;
- Increase access to medical information;
- Stimulate the development and growth of local businesses; and
- Develop ICT skills among the local population.

b. To test the suitability of packet-based wireless access infrastructure for delivering multimedia applications such as long distance education, telemedicine, local business development, and so forth, in rural areas

c. To serve as a case study for administrations in developing countries looking to implement IP technology.

An ideal test site to meet such criterion and to suit the parameters of wireless IP technology currently available on the market would be a cluster of five to ten communities separated by a distance of between five and fifty kms. By providing access to an existing national or regional ICT hub, products and services can be easily exchanged worldwide.

3.OUTCOMES

The objectives of the project have been designed to produce the following outcomes:

Establishment/Extension of an existing network or telecentre with packet-based, wireless access technology that will initially provide the following services:

- Data communication services for simple applications in the following fields:
  - Telemedicine (exchange of medical records, statistics, epidemic surveillance data, transmission of X-rays and EKG test data, consultations with specialists through e-mail, etc.);
  - Education and research (access to electronically stored libraries, training material and research papers and, possibly, trial courses for teachers, based on existing material, adapted as required;
  - Trade information services (access to databases with market information, contacts with suppliers and customers through e-mail, etc.);
  - Government and community information services.
- Voice services (depends on the regulatory environment).
- User training and support in use of IT and communication facilities;

It is also possible that given the location and the need for applications the following additional services may be provided:

- Interactive distance learning courses in relevant subjects, using multimedia and video conferencing facilities;
- Advanced telemedicine applications (in the hospital), such as remote diagnoses using interactive video besides transmission of X-rays, EKG, EEGs, and, possibly, Ultrasound and MRI; and
- Low-cost access to e-mail and data networks.

4. Partner obligations and commitment:

In order to study wireless IP applications, three scenarios are envisaged. The first involves an existing public or private wireless initiative, the second involves the extension of an existing rural project via wireless IP and the third is a project proposal for a rural wireless system including any required applications.

A. Working with existing Wireless Projects

The first, more straightforward approach is to receive an invitation from governmental or private sector players to evaluate an existing packet-based wireless IP project in a rural or remote area of the developing world. In this case, the ITU would work together with these partners to conduct an evaluation including financial, economic, technological and social strengths and weaknesses of this new technology.

B. Extending Rural networks using wireless LAN

In the second approach, the ITU would ask to be invited to participate in an existing ICT project in a rural or remote area that could benefit from the inclusion of wireless IP technology, such as a telecentre or e-application project, among others. This could provide value added to an existing project by extending it into more rural or remote areas.

C. Project Proposal for Wireless IP /applications

In the final scenario, the ITU invites a project proposal from national, regional or international public or private partners to test a wireless IP system in a rural or remote area. The most important element the project, therefore, is to identify a main partner or configuration of local, national or regional project sponsors to take the lead in selecting a site and confirming local involvement in the project in terms of manpower, facilities and resources.

Estimate costs of a five to ten community-based wireless router network, as determined in the final report, average around 130, 000 CHF (See Annex C). As a result, a project document, must include a solid role by local and national partners in order to attract necessary national or international funds to support the proposal. Once interest has been determined, a short project proposal document can be submitted to the Director of the BDT for technical evaluation and commitment evaluation. This project proposal document must include as a minimum:

1. Overview of Project
2. Proposed Project Partners
3. Proposed Project Site
4. Proposed Applications and Benefits to local users
5. Partner Commitment (manpower, facilities, resources]

Regardless of the scenario used, all proposals will be reviewed by Task Force members and the ITU. They will then be circulated for revisions and any additional funding will be solicited. Potential funding sources include: National Universal Service Funds, Co-financing with UN agencies, private sector contributions, private investment, ITU Telecom Surplus Fund applications as well as other multilateral or national sources. In addition, the proposal has been made to solicit voluntary contributions or regular funds through the ITU/BDT for this purpose. Once financing and the project criterion have been authorized, the project implementation and evaluation phase can begin. At this time, project teams can be formulated, experts can be sent for any required consultations and appropriate supplier selection criterion will be followed.

The local partners are expected to provide the following:

- counterpart task force team;
- assistance to the BDT staff in conducting field survey;

- installation support activities (necessary training will be offered by the ITU or by vendors);
- establish distance education/healthcare and e-government mechanism in the community in association with appropriate centre; and
- power supply (power consumption for wireless router: It should be noted that the wireless router is designed to work with wind and/or solar energy.

Local and national partners are also required to participate, with the ITU and an external expert with inputs for the formal project evaluation, which will take place at six month, twelve month and later intervals. The interim evaluation of each Wireless IP project will be included in a short document and recommendations to be published for the World Summit on the Information Society to be held in Geneva in December 2003.

For more information, please contact:

ITU-D Director: Mr. H. I. Toure
ITU Regional Representative
Task Force Chair: Mr. Y. Kawasumi [yasuhiko.kawasumi@japan-telecom.co.jp]
ITU Contact Point for the Task Force: Dr. P. Murphy Ives [paula.Murphy@itu.int]

ANNEX: Why Wireless IP?

From the rapid rise in the market, the growing importance of wireless IP technology is clear. Each quarter the market witnesses new technological breakthroughs and an increasing downward trend in cost. In order to bridge the digital divide, multimedia communications is indispensable. Thus, semi-broad band and PC terminals are integral to building the infrastructure. With the increasing privatization of the telecoms industry worldwide, many economically under-developed regions, particularly in rural and remote areas, remain outside the scope of the public infrastructure. For this reasons, initiatives to achieve universal service can capitalize upon newer wireless technology in rural zones. Additional advantages of this technology include ICT access, including possibilities for multimedia and Voice over IP applications, community involvement, job and skills creation, low entry investment with the possibility for expansion and revenue generation, ease of replicability as well as ease to relocate to other desired zones. In light of the above arguments, wireless technology would seem preferable to wire solutions for rural and remote areas.

Wireless Access Technology

Wireless refers to telecommunication in which electromagnetic waves, rather than wires, carry a signal over the communication path. According to *Whatis.com*, wireless infrastructure can broadly be divided into 4 categories: Portable Wireless, Mobile Wireless, Fixed Wireless or Infrared Wireless.

Wireless technology is rapidly evolving and is currently viewed as one of the most important tools to reduce the digital divide. Wireless infrastructure provides faster roll out times, lower maintenance costs, and greater network flexibility. Through case studies and research, the report identified 10 types of wireless access systems, illustrating existing and emerging access options for rural communities. These include:

1. IMT-2000

Commercial IMT-200 systems have been put into operation beginning in the autumn of 2001 in Japan, and are expected at the beginning of 2003 in Europe and with much of America following in 2003. However, a number of factors make it unlikely that IMT-2000 technologies will be deployed in rural areas of developing countries before 2005.

2. Wireless Routers

A router is a device, or in some cases, software in a computer, that determines the next network point to which a packet should be forwarded toward its destination. The router is connected to at least two networks and decides which way to send each information packet based on its current understanding of the state of the networks it is connected to. A router creates or maintains a table of the available routes and their conditions and uses this information along with distance and cost algorithms to determine the best route for a given packet.

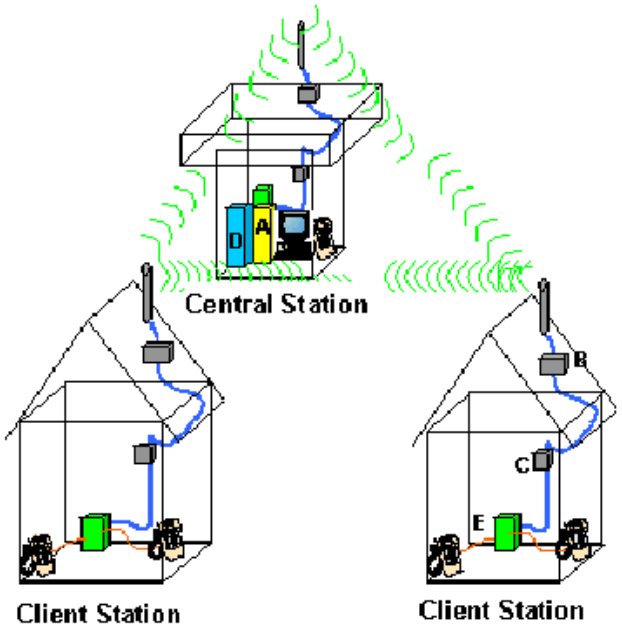
It is technologically possible, using available products, to establish an access network in rural and remote areas using routing technology (as opposed to circuit-based technology).

Router-based local access networks using TCP/IP in the network and transport layers (OSI layers 3 and 4) can be interconnected with the public switched telephone network using gateways that comply with ITU-T Recommendation H.323.Real-time voice calls can be transmitted at any quality over closed router networks with the use of voice over IP (VoIP) software. The quality of service can be maintained on a properly configured and managed network because traffic is controlled from the subscriber to the PSTN gateway by a single service provider. In this way, a router-based access network using IP is more analogous to a local area network (LAN) than to the global Internet. When combined with wireless technology in the local loop, such a network may provide an affordable solution for rural areas, particularly when the primary services delivered over the network will employ multimedia.

Example: A Wireless IP Phone System for Rural Applications

The wireless IP phone system is based on the integration of two products: a wireless router and an IP Phone. The system consists of multiple Client Stations managed and monitored by computers located at a Centre Station as illustrated below.

Minimum configuration of a wireless IP phone system



System Components:

Wireless Router

	Symbol	Number (X)*
SNMP Server	A	[1 (1)]
Antenna		1 (3)
Main Unit	B	1 (3)
I/F Cable		1 (3)
Junction Unit	C	1 (3)
AC Adapter		1 (3)
10Base-T Cable		1 (3)

IP Phone

	Symbol	Number (X)*
Management Server	D	1 (1)
Gateway (2ch)	E	1 (3)
Telephone handset(2W)		2 (5)

*(X) = minimum number of units required to form a network.

At the Client Station, the wireless router equipment consists of an antenna, a main unit, a junction unit, and interconnection cables. An IP phone gateway (GW) is connected to the router equipment using a 10 Base-T interface. The gateway contains two ports, each of which connects a standard telephone set.

The main Centre Station houses a management server for the IP phone network and an SNMP server to monitor the wireless router network. As with a PC-based local area network, an SNMP server is required for each unit system (comparable to a closed LAN). However, the IP phone management server has the capacity to serve a large number of unit systems and more than one is unlikely to be needed. Therefore local Centre Stations can be established at appropriate client sites, such as public office buildings, to house local SNMP servers. A client site is used in order to make the full set of wireless routers available to support customer lines.

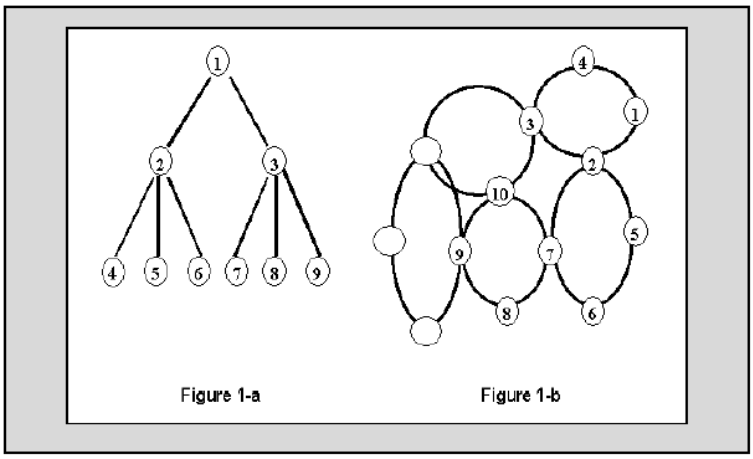
Since the network system is based on IP technology, normal PCs and other electronic devices that use TCP/IP can easily be operated on the network. With these devices, the network can provide the community with multimedia communication services including data, video, audio and image transmission as well as open or closed broadcasts. These multimedia functions may be used to enable rural access to distance education, health information services, and e-commerce, as well as telephony.

Some manufacturers have designed their wireless IP phone for usage in the 2.4 GHz band allocated to the ISM (Industrial, Science and Medical) service.

Flat Connectivity

In general, wireless LAN systems form hierarchical connectivity among nodes as shown in the figure below.

Hierarchical vs. Flat Connectivity



In contrast, the wireless router, which functions as a receive/transmit terminal as well as a repeater, creates a LAN system with flat connectivity, as in Figure 1-b. In Figure 1-a, for example, there is only one path between nodes 1 and 8, namely 1–3–8. In Figure 1-b, there are several paths between nodes 1 and 8, such as 1–2–7–8, 1–4–3–10–9–8, and so on. The network in Figure 1-b shows greater resiliency, more flexible node locations, and better traffic distribution than the network in Figure 1-a. This flexibility is crucial in a rural wireless system, particularly where the radio conditions are unstable.

Wireless Coverage

The wireless router provides circular coverage with a radius from 5 to 50 km when configured in compliance with certain regulations on frequency use and maximum transmission power (this is dependent on country regulations). In general, if higher power is allowed the wireless reach can be much longer.

Depending on the location of the client and the geographical conditions of the area, users may select the most suitable types of antennas to achieve the desired coverage.

Unit System

In this specific example, we assume that in a closed LAN, a maximum of 100 slots are available for registration of the wireless routers. In practice, however, the number of routers in a closed LAN depends on various factors including traffic volumes, traffic types,

traffic profile, and the locations where routers are set. In the case of IP phone use, it is generally recommended that the number of client routers be no more than 20 in order to maintain communication quality. Thus, a system of 20 client routers (supporting up to 40 client handsets) can be regarded as a unit system for expansion of the network.

PSTN Interconnection

The wireless IP phone system can be easily interconnected with public networks through the use of a transit gateway (TGW) installed at the local exchange. All necessary signal conversions, including PSTN signaling, are performed at the TGW. The transit gateway gives rural communities the means to communicate with the outside world, in addition to its own community members, when connection to the PSTN or another network is available.

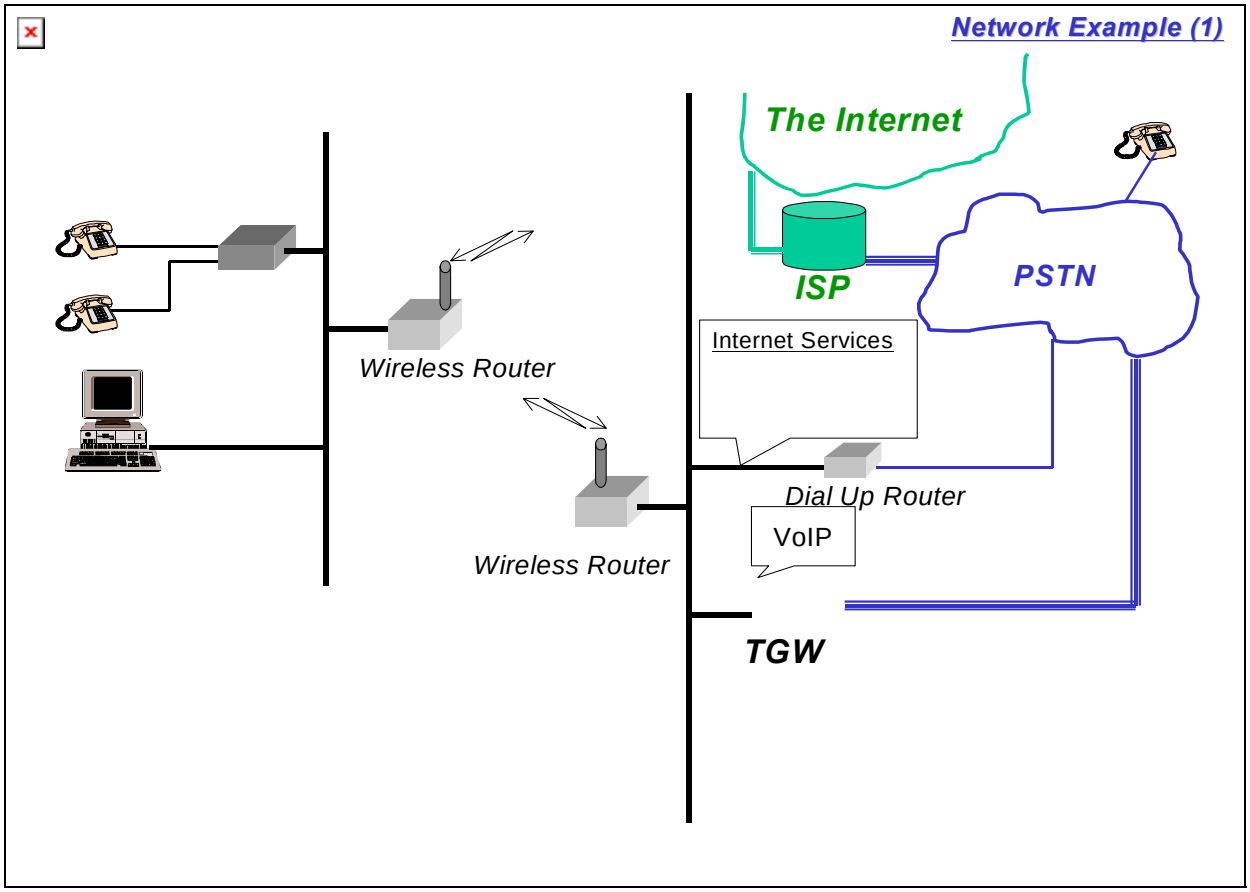
Essential Data for the Wireless Router System Described Above:

Wireless Router		
Modulation	Direct Spread Spectrum	
Frequency	2.4GHz (2.483/2.485GHz)	
Data Speed	2Mbit/s	
Base Band Modulation	DQPSK	
Transmission Power	10mW/MHz or less	
Transmission Distance	5km (depends on environmental conditions)	
Networking Protocol	TCP/IP	
Routing Protocol	RIPv2	
DHCP Server Function	Yes	
Interface	10 Base-T (RJ-45 Normal)	
Power Requirements	AC 100V/DC12V 1A	
Size & Weight	Main unit 216x145x100mm 2kg Junction unit 117x32x100mm 0.13kg	
Antenna		
Frequency	2.471GHz ~ 2.497GHz	
Input Impedance	50Ω	
Gain	6dBi (Includes cable loss)	
VSWR	Not more than 1.5 in the band	
Connector	N-P	
Antenna Type	**Non-Directional**	**Directional**
Characteristics	Horizon: non-directional Vertical: HPBW 9°	Horizon: HPBW 65° Vertical: HPBW 60°
Temperature/Humidity	-10~+50°C, 20~95°C	-30~+60°C, 20~95°C
Size	1,000mm	120mm x 120mm
Weight	1kg	0.5kg

As of February 2001, about 2000 sets of RTB-2400 are in operation in about 150 different places in Japan. Okinawa, which is famous for its strong winds, has installed a wireless router which has not reported any problems to date.

Annex E

Technical Illustrations of Wireless IP network



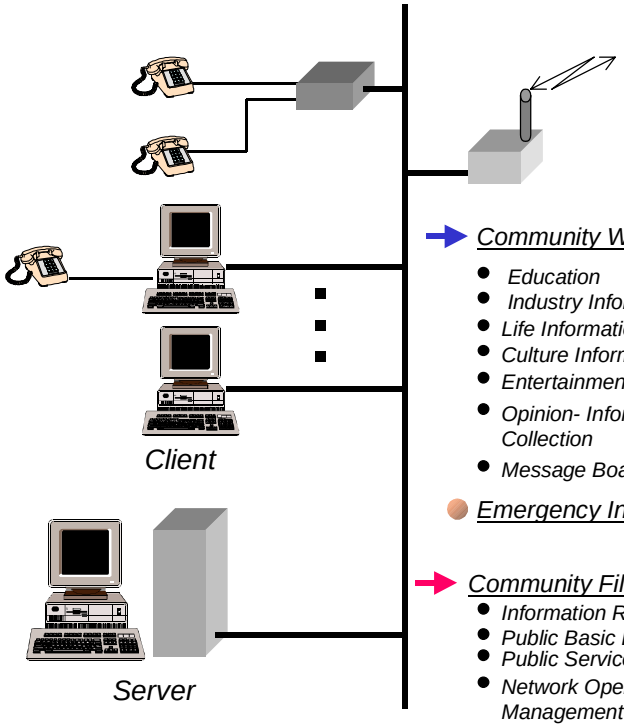
Network Example (2)

Clients PC

- Web Access
- post messages
- Real time communication
- File creation
- Data Submission

Local Community Server

- Community Web
- Community mail
- Community File



Community Web

- Education
- Industry Information
- Life Information
- Culture Information
- Entertainment
- Opinion- Information Collection
- Message Boards

Emergency Information

Community File

- Information Resource
- Public Basic Data
- Public Service Resource
- Network Operation & Management

Local Community Center

Annex A

Components of a Wireless IP Pilot Project for Rural Connectivity

1. Cost Considerations for a Wireless IP system :

The costs involved with a wireless router system will naturally vary according to location; population served, services offered, interconnection with the PSTN, and so forth. However, in order to obtain a general per-line costs for the system, the report considered a community that requires 200 telephone lines for voice communication. Five complete unit systems, each supplying up to 40 telephone lines, would be required.

In the planned pilot project, however, the concept of unit system and its expansions are not considered to give good model for evaluation. The scale of the pilot project model shall be minimized, as long as sufficient records and data are expected to be obtained. It also has functions from the beginning to serve multimedia applications and connections to PSTN. Costs shown below are estimated based on the basic model specially proposed in the pilot project and most recent equipment prices.

Basic Model

Assuming that a PSTN connection is made available at the local community (at telecentre for example).

Available Communication Tools:

(a) VoIP communication
Local community VoIP user can be connected to PSTN subscribers. The PSTN subscribers call numbers for Gateway (Transit Gateway) first and receive tone from the Gateway. They then call the extension number for the community specific VoIP user. From community network VoIP user, PSTN subscribers are directly called. Gate Keeper works for this calling number translation.

(b) Multimedia communication
Voice, picture, facsimile, video etc.(net-meeting) through local community network and Internet. Connection between local community network and Internet is done by PSTN if ISP is not available near the community. In this case Dial up router and modem may required.

(c) Internet services as electronic mail, web browsing, FTP, file downloading, telnet etc.

Configuration:

- 10 public spaces are selected from one rural community;
- on average, 3 personal computers, 2 VoIP terminal (handsets) and a set of peripheral package (printer, facsimile, scanner, digital camera (video/still), IP camera etc) will be supplied to each public space;
- community servers (mail/web/file etc) will be supplied to the community centre.

Equipment cost (FOB) plus basic installation fee:

(Based on the indicative figures provided to Focus Group 7)

Items	Set	Cost
Wireless Routers (antenna included)	10	32,000
VoIP Facilities (10 Gateways and 1 Gate Keeper)	10	49,000
PCs	30	25,000
Peripherals	10	8,000
Community servers(mail/web/file etc.)	1	4,000
Other network components (Router/modem to PSTN)	2	2,000
Total		120,000

Estimated budget costs including any required human resource costs :

Equipment	$120,000
Installation: 14 working days	$10,000
Expert: 5 working days	$3,000
Other	$1,000
Total	**$134,000**

2. Installation

The time and technical skills needed for installation and commissioning, and hence the cost, varies depending on local conditions and system configuration. The table below provides a summary checklist of installation requirements for the simplest applications. In cases where the IP phone network will be connected to the PSTN or another network, the installation of the system requires additional setup work for about 5 - 10 days.

The basic features described above show that system installation is relatively simple, requiring little heavy construction work, which is generally needed to prepare towers, masts or shelters with temperature control. Since the system consists of small components, it is relatively easy to transport and install. Therefore, under ideal conditions, it takes approximately one week to be put into operation.

Summary of Installation Requirements

Station	Installation Requirements
Client Station	· Antenna fixing and direction adjustment · IP Address registration · Calling/Called number registration · Cable works · Test and readjustment
Centre Station	· Antenna fixing and direction adjustment · IP Address registration (centre and all clients) · Calling/Called number registration (centre and all clients) · Charging/Billing Data input · Cable works · Over all test and readjustment

Once the installation environment is prepared, a unit system can be installed by two experts with an appropriate complement of local staff, as described below:

• Field study, site environment check and network design	3 days
• Installation and setup of Client Station equipment	6 - 7 days
• Installation and set up of Centre Station equipment	1 day
• Network establishment and testing	1 - 2 days

Since some installation activities are conducted in parallel, generally 7- 10 days are required to put a system into operation.

3. Suppliers of Wireless IP Technology

Although this technology has been developed primarily in Japan and the USA, at present there are over thirty commercial suppliers of wireless IP technology worldwide. One of the indirect objectives of this initiative is to encourage these firms to expand into rural and remote markets of the developing world to facilitate rural connectivity. Increased demand and supply of these technologies should encourage a downward trend on prices and an improved range of services for rural users. Finally, because this technology is relatively simple in configuration, it is hoped that local and national users and suppliers can play a key role in project sustainability and replicability into other rural zones.

4. Operation & Maintenance

All of the Client Stations on the network are monitored at the Centre Station. The parameters of the wireless routers can be reset from the Centre Station as well. If the TGW experiences problems, the Centre Station is signaled. As long as the network works properly, no routine maintenance work is required.

The Client Stations are identical and easy to add or remove from the network, which makes it possible to restructure networks easily and quickly.

5. Project Site Selection

The selection of each project site will be based around the following issues:

a) Physical Environment

- The presence of rural or remote areas.
- The presence of telecom-related infrastructure elements (in the situation where electricity is not readily available, the wireless router is designed to work with solar-powered energy or wind energy).

b) General Context

- An existing or on-going ICT project
- A favorable regulatory environment (for example, whether the regulatory situation allows Voice over IP)
- An identified demand (existing or potential) for telephone service, as well as multimedia applications such as long-distance education, tele-medicine, environment monitoring, and so forth.
- The socioeconomic impact of the pilot project on the rural community (the pilot projects should be developed to have the widest developmental impact, including support for education, health, small business development, governance and poverty reduction).

Annex B

Definitions of Rural or Remote Areas

Rural or remote areas exhibit more than one of the following characteristics:

- Scarcity or absence of public facilities such as reliable electric supply, water, access roads, and regular transport;
- Scarcity of technical personnel;
- Difficult topographical conditions which render the construction of wire telecommunication networks costly that make critical demands on equipment;
- Severe climatic conditions that make critical demands on the equipment;
- Low level of economic activity, based mainly on agriculture, fishing, handicrafts etc;
- Low per capita income;
- Underdeveloped social infrastructures;
- Low population density; and
- Very high calling rates per telephone line, reflecting the scarcity of telephone service and the fact that large numbers of people relay on a single telephone line.

Acknowledgements:

This document was prepared by the Task Force and its ITU contact points. Particular thanks to Mr.Y. Kawasumi of Japan Telecom and Mr. K. Sasaki, KDDI of the Task Force for their technical expertise.