Nepal Wireless Networking Project

Case Study and Evaluation Report

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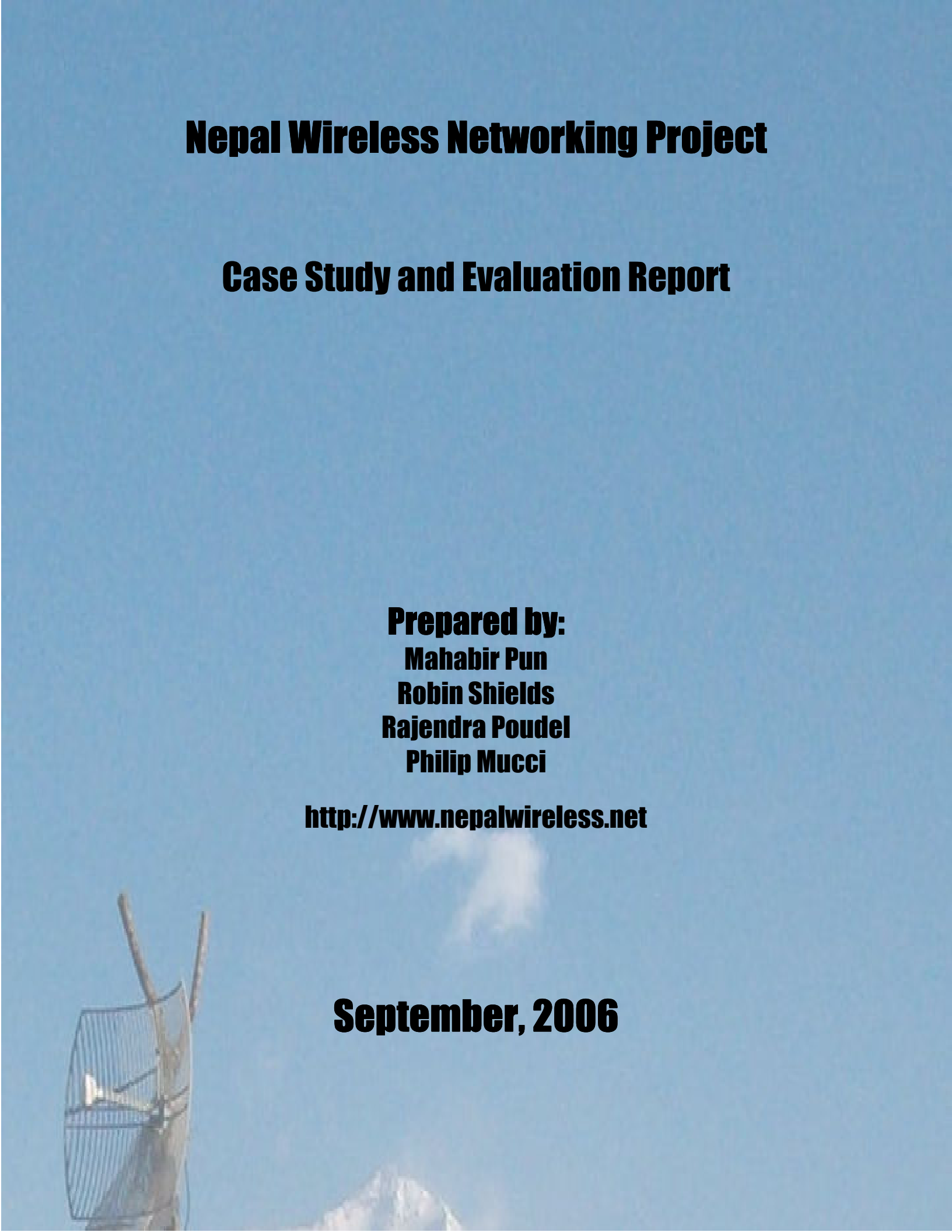
http://www.nepalwireless.net



September, 2006

Preface

Dear Readers,

Soon after I had learned to use email and Internet for the first time in 1996, I dreamed to connect Himanchal High School of Nangi, Nepal to the Internet. This was no small task that time because the school had no electricity, no phone line, and no computers. The only way to access the Internet for me was a full day's travel by walking five hours downhill and a four- hour bus ride to the nearest city called Pokhara. To make the long story short, I worked step-by-step with the villagers and a team of international volunteers to achieve this goal. We built a micro hydro generator in the village. I learned how to assemble computers from donated parts in wooden boxes. By 2003, we had set up a limited Internet connection using Wi-fi technology.

This project was formally started in 2003 as Nepal Wireless Networking Project to continue expanding the network throughout the area. Today, we have connected fourteen villages to the network and expanded our services to include telemedicine, distance education, and telephone service. We have come a long way since 1996, but we still have to go much further. We hope it will continue to prosper due to the improving political situation in Nepal.

Many thanks go to our international volunteers, who helped to bring donated equipment, set up the network, and taught villagers how to expand and maintain it by themselves. The project would have been just an unfulfilled dream of Himanchal Higher Secondary School had the international volunteers had not devoted their time and skills for the project. More recently, a team of local experts from Nepal has given a great deal of time and energy to the project, which has helped us to expand our network, gather research data, and offer new services.

We hope this report will help you to understand our project and see how it can lead to new forms of development in rural Nepal. We appreciate your interest and welcome your involvement, please do not hesitate to contact us with any questions.

Mahabir Pun
Nepal Wireless Team Leader

Khopra Relay Station

1. Introduction

Over the past few years a great deal of attention has been placed on issues of ICT access and the "digital divide" by development organizations and governments. While various conferences, resolutions, and commitments have taken place it is difficult to determine if any tangible progress has been made. The Nepal Wireless Networking Project has taken a serious look at the same issues, but it approached the problem from a grassroots perspective. Since 2002, it has been working to bridge the digital divide in Nepal by extending ICT access to rural areas through wireless technology.

However, the Nepal Wireless Networking Project was not started as a result of the policies and decisions made by international organizations or the Government of Nepal. It started with a dream, and the dream unexpectedly turned into a project in pursuit of finding ways to bring Internet and telephone at Himanchal Higher Secondary School, Myagdi district, Nepal. It took almost seven years to make the dream come true in a very unfavorable working situation in Nepal. Political conflict in the rural areas created a great deal of difficulty in setting up and running the network, while the autocratic rule of the king and restrictive trade regulations made acquiring the necessary technology extremely difficult. Regardless, the project successfully overcame these obstacles and set up a pilot wireless network in an area where no business dared

to go and brought the information technology for the benefit of the mountain population. The project now hopes that new government and the future government of Nepal will make laws to abolish all the obstacles and create new policies favorable to the development of wireless networks in Nepal.

1.1 Goals and Objectives

The long-term goal of Nepal Wireless Networking Project is to maximize the benefits of wireless technology for the rural population in mountainous areas in order to make their life a bit easier and more enjoyable. Specifically, the project aims to achieve the following goals, divided into four main goal areas:

- **Communication:** To increase communication facilities in the mountainous areas by providing telephone services to the villagers through an Internet phone system (VoIP), to make available and spread the use of email, and help villagers to discuss by setting up Nepali language bulletin boards for community discussion.

- **Education:** To increase educational opportunities in the community by creating a live tele-teaching program that overcomes the shortage of qualified teachers in the rural areas and by providing e-learning materials to students through the Intranet.

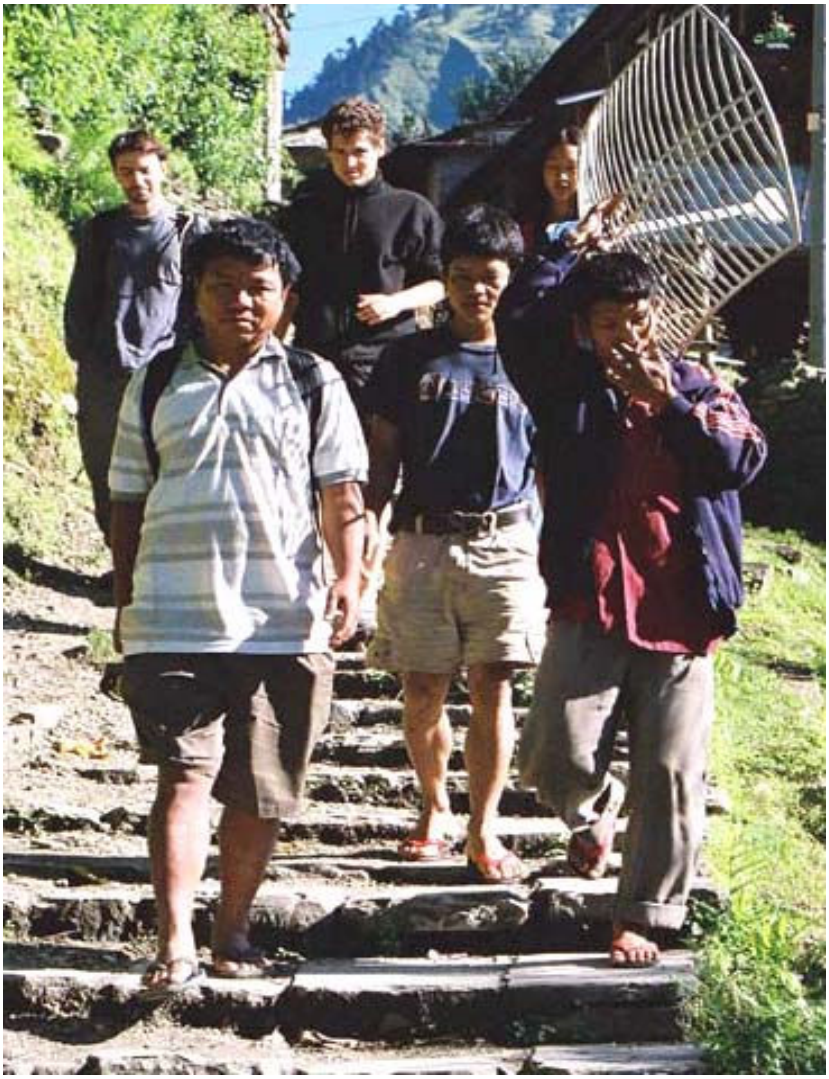
- **Health:** To increase the quality and availability of healthcare in the rural communities by bringing medical doctors virtually in the remote villages to provide medical assistances to the villagers in emergency and serious health situation through telemedicine program.

- **Local e-commerce**: To help villagers to buy and sell their products in the local market through local intranet.

- **Job Creation** To generate jobs for the younger generation through communication centers and e-learning programs.

While attaining all these goals will take some time, the project already provides some of the benefits mentioned above to the villagers, such as communication, educational, and telemedicine facilities. Right now we are focusing on live teleteaching and local e-commerce programs.

This case study and evaluation is a detailed report, and we have tried to provide all available information on how the network operates and its impact on the community. For further information, please feel free to contact the authors.



The villagers and the team walking towards reaching the goals - 2003

Raising antenna in Paudwar village

2. Project Implementation

Implementation of the Nepal Wireless Networking Project began with a pilot study in Spring of 2002 and continued with the first phase (Summer 2003) and expanded greatly through the second phase. A number of services are now offered by the project through fourteen communication centers established in villages, including:

- **Internet Access**: Available to students, teachers, community members, and tourists
- **Email:** Free accounts available through nepalwireless.net or other web mail services (e.g. yahoo and hotmail) to the villagers
- **Telephone Service:** Villagers can place ordinary landline phone calls through Internet telephony equipment and the PBX software on the network server.
- **Teleteaching**: We are currently testing programs to provide live classes using network cameras to address the shortages of qualified teachers.
- **Telemedicine:** In conjunction with Om Hospital in Pokhara, medial services are offered to the villagers in the remote areas through audio-video conferencing.
- **Community Discussion:** Using an online discussion forum (phpBB), villagers are able to engage in community discussions in Nepali.

Described in greater detail below, the communication centers offer valuable services, which were not accessible before in the villages.

2.1 Network Service Area

The Nepal Wireless Network currently offers connectivity and ICT facilities to fourteen communities of seven Village Development Committees (VDCs) in Myagdi, Parbat, and Kaski districts. Village Development Committees are the local governments in Nepal. Names of the VDCs serviced are listed in Table 1. The villages serviced by the network vary in size from 95 to 2,485 people with an average size of 1,081. Complete details of the village location, population, the services, and number of computers are given below in Table 2. Additionally, it has created two relay stations (to forward the signal over mountain passes), a base station/server facility, and a connection to Om Hospital in Pokhara. Photos of some of the villages are given below.

Himanchal Higher Secondary School

Paudwar village

Shikha village

Tikot village

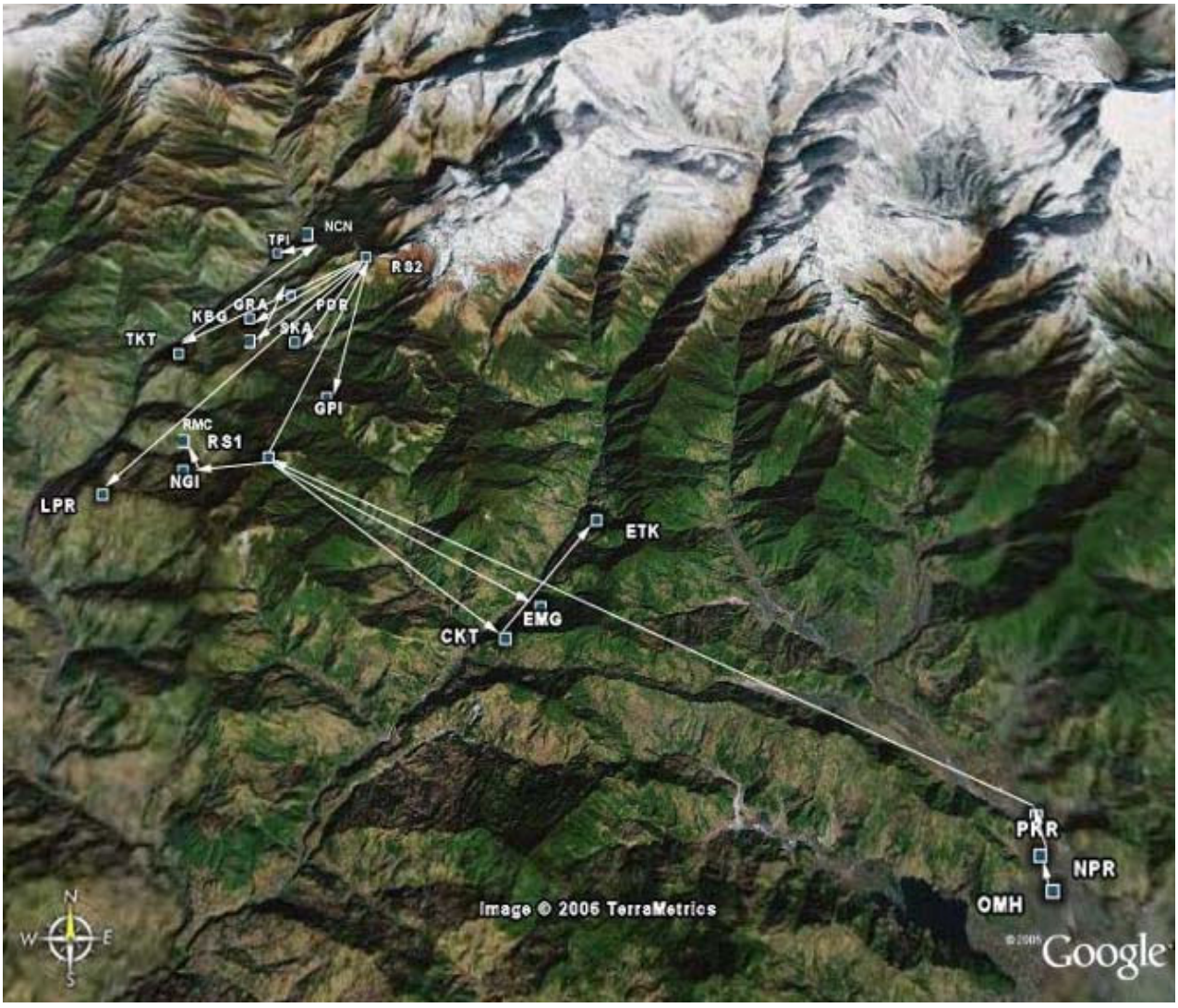


Figure 1: Satellite map of the network (from Google Earth) looking towards Myagdi District from Pokhara

Village Development Committee	District	Villages served
Ramche VDC	Myagdi	Nangi, Ramche
Histan VDC	Myagdi	Tikot
Shikha VDC	Myagdi	Khibang, Paudwar, Ghara, Shikha, Ghorepani
Narchynag VDC	Myagdi	Naychyang
BhurungVDC	Myagdi	Tatopani
Lekhphant VDC	Parbat	Lopre
Lumle VDC	Kaski	Chandrakot, Majhgaun, Tolka

Table 1: Name of the Village Development Committees connected

Node Name	Map Name (See Above)	Latitude	Longitude	Elevation (Meters)	Pop-ulation	Comp-uters	Services [1]
Nadipur (S)[2]	NPR	N28° 14.037'	E83° 59.335'	925	--	2	I T V
Dip (S)	PKR	N28° 14.765'	E83° 59.435'	980	--	1	I V
Mohare (S)	RS1	N28° 22.285'	E83° 40.758'	3,320	--	1	I V
Khopra (S)	RS2	N28° 28.336'	E83° 42.487'	3,650	--	2	I V
Nangi	NGI	N28° 22.300'	E83° 38.306'	2,360	780	20	I T M V
Ramche	RMC	N28° 22.876'	E83° 38.649'	2,277	655	3	I T M V
Tikot	TKT	N28° 25.836'	E83° 37.232'	2,250	845	10	I T M V
Khibang	KBG	N28° 27.077'	E83° 39.010'	2,015	900	4	I V
Ghara	GRA	N28° 27.079'	E83° 39.003'	1,965	2,400	4	I V
Paudwar	PDR	N28° 27.878'	E83° 40.090'	2,180	2,254	15	I T M V
Narchyang	NCN	N28° 30.846'	E83° 39.802'	1,425	735	3	I T V
Sikha	SKA	N28° 26.299'	E83° 40.500'	2,145	1,200	2	I V
Ghorepani	GPI	N28° 24.108'	E83° 41.935'	2,875	2,485	9	I T V
Tatopani	TPI	N28° 29.778'	E83° 39.197'	1,120	1450	2	---
Lopre	LPR	N28° 21.650'	E83° 36.349'	2,290	534	1	I V
Chandrakot	CKT	N28° 18.328'	E83° 47.153'	1,525	95	3	I V
Majhgaun	EMG	N28° 19.112'	E83° 47.153'	1,510	1125	4	I V
Tolka	ETK	N28° 21.172'	E83° 49.407'	1,782	675	8	I T V M
Om Hospital	OMH	N28° 13.395'	E83° 59.417'	888	--	2	I V

Table 2: Complete list of Network Nodes

The communication center in Tatopani is not operational yet because the villagers have not decided as who would run the communication center. Tatopani will start the center in September 2006. Furthermore, six schools as shown in Table 3 are connected to the networks in six villages that also serve as the communication centers for the villages.

Name of the school	Village	Number of students	School type
Himanchal Higher Secondary School	Nangi	330	K-12
Tikot High School	Tikot	220	K-10
Mukti Marg Higher Secondary School	Ghara	250	K-12
Shikha High School	Shikha	180	K-10
Paudwar High School	Paudwar	215	K-10
Himalaya High School	Tolka	205	K-10

Table 3: List of the schools that are connected

All the villages serviced by the network have no motorable roads and are accessible only by foot. Just to give a rough idea as to how one can get to the networked villages, the approximate walking distance in hours it takes to get from Pokhara to each of the villages in have given Table 4 and 5.

[1] I = Internet, T = landline Telephone, M = telemedicine, V = VoIP network phone
[2] (S) designates a network operation station or relay station where one person lives.

From	To	Distance (hours)	Means of travel
Pokhara Station	Beni	3:30	By bus
Beni	Lopre	7	By walk (Up hill)
Lopre	Nangi	2	By walk (Straight & down)
Nangi	Ramche	1:30	By walk (Down & up hill)
Ramche	Mohare (Relay Station)	4	By walk (Up hill)
Mohare	Ghorepani	2	By walk (Straight & down)
Ghorepani	Shikha	3	By walk (Down hill)
Shikha	Khopra (Relay Station)	10	By walk (Up hill)
Khopra	Paudwar	4	By walk (Down hill)
Paudwar	Narchyang	5	By walk (Straight & down)
Narchyang	Tatopani	1	By walk (Straight & down)
Tatopani	Ghara	5	By walk (Up hill)
Ghara	Khibang	1	By walk (Up hill)
Khibang	Tikot	3	By walk (Up, down & up hill)
Tikot	Beni	4	By walk (Down & straight)

Table 4: Walking distance in hours to the villages in Parbat and Myagdi

Three villages in Kaski District are closer to Pokhara base station than those in other districts. Therefore one needs to ride a bus from Beni for about two and half hours to a village called Lumle. If one goes from Pokhara side it is about one-hour bus ride to get to Lumle village and then can walk to the project sites as follows (Table 5).

From	To	Distance (hours)	Means of travel
Beni	Lumle	2:30	By bus
Lumle	Chandrakot	1	By walk (Straight)
Chandrakot	Majhgaun	1:30	By walk (Straight & up)
Majhgaun	Tolka	4	By walk (Down, straight & up)
Tolk	Kande	4	By walk (Up & straight)
Kande	Pokhara	1	By bus

Table 5: Walking distance in hours (villages near Pokhara)

2.2 Access Technology Used

Access to the services is provided mainly through used desktop computers and laptops. However, the recent addition of Internet telephony equipment and high-resolution network cameras facilitate phone services and teleteaching/telemedicine, respectively. Some 96 computers that are connected to the network now; most are Pentium I and Pentium II models that

have been donated by people and businesses from Nepal and aboard. Some villages and schools have also bought Pentium III and Pentium IV computers using various independent funding sources. Donors within Nepal include Himalayan Bank and Solutions Consultant, while donations from abroad were received from the USA, Canada, the Netherlands, Germany, Singapore, Australia, and Japan. The latter were acquired by requesting individuals and businesses to donate unused computer parts that were then sent to tourists or volunteers coming to Nepal. These parts are collected at a contact point in Kathmandu and then carried to villages where they are assembled. Generally, only the components of the CPU (motherboard, memories, hard disk, video and sound cards, etc) are sent from abroad; larger and heavier components such as the monitors, power supplies, CD ROMs and keyboards are bought in Nepal, while computer casings are mostly constructed in the village using wooden planks. In the case of laptops, the process is much simpler: the whole laptop is sent from abroad and then carried to the village.

With the addition of an Internet telephony system, we have added a number of network telephones in various villages. With this technology, users are able to directly dial a telephone number as they would on any landline. The call is then routed through the network server, and placed on the Nepal Telecom public switched telephone network (PSTN). We have acquired four Sipura SPA –3000 Wi-fi-to PSTN adaptors, eight GrandStream Budgetone network phones and five Cisco ATA adapters that provide this functionality, and client software (a "soft phone") can be used where the hard phone is not available.

A snapshot of telemedicine practice in Nangi taken remotely from Pokhara

A snapshot of tele-teaching by a teacher in Nangi. taken remotely from Tikot

For tele-teaching and telemedicine programs, high quality network cameras have been obtained. The teleteaching program uses the Axis 210 camera, while the telemedicine program uses the Panasonic BL-C10A. Both cameras offer a video quality that far surpasses ordinary webcams that has made possible through the relatively high speed of data transfer within the network. The network cameras are actually a camera and computer combined in one intelligent unit. Therefore they connect directly to the LAN without requiring a computer. Moreover, the zoom, pan, and tilt feature on the Panasonic BL-C10A camera can be controlled remotely. This feature of the Panasonic camera has been useful for the doctors in order to look at a patient from different angles. The video for tele-teaching is viewed with open source software called VLC, which is capable of receiving, broadcasting and recording multicast MPEG4 video streams. Also, it needs little CPU power and can use a large number of input devices.

2.3 Transport Technology Used

A considerable amount of resources is dedicated to the network infrastructure and management. This includes wireless devices, a network server and associated software, and power generation at the relay stations. Details of the equipment installed and computers running in each village are given in Appendix 1. The summary of the devices used now is as follows (Table 6). We also have about eight radios as spare.

Equiment	Number
2.4 GHZ 802.11b radios of different brands	28
5.7 GHz BH-20 Motorola radios with reflectors	5
24dB Pacific Wireless Directional Antennas	9
19 dB Homemade Directional Grid Antennas	3
15 dB Panel Antennas	2
14 dB Omni Directional Antennas	2
BEFSR41 Linksys Routers	3
Sipura Wi-fi to PSTN Phone adaptors	3

Table 6: Devices used as transport technology

2.3.1 Wireless Devices used in the Project

The network uses a variety of wireless devices to maintain connectivity between the nodes. Conceptually, we have divided this into a network backbone, which connects the Pokhara Base Station to the two major relay stations, and client connections, which connect villages to

the relay stations. In five cases, connected villages are also acting as a relay station due to the difficulty of transporting the signal over mountainous passes and ridges.

Antenna in Tikot pointing to Narchyang

Canopy at Mohare pointing to Pokhara

The network backbone is connected with Motorola Canopy radios at 5.7 GHz, whereas connections to other areas use wireless Ethernet (IEEE 802.11b standard) radios at 2.4GHz from various manufacturers. The Motorola devices were used for the backbone connection due to their high reliability, robustness, and to avoid signal interference. However, 802.11b radios were used for village connections due to their lower cost and the compatibility between manufacturers. A complete inventory of wireless devices and other accessories is provided in Appendix 1.

2.3.2 Network Server Set up

A network server in Pokhara facilitates network management and provides a number of services to network users. The server computer is a large Pentium IV system with dual hard disks. The system runs a Fedora Core 5 Linux distribution with additional third party software and is configured for maximum redundancy to guard against failure. Each of the disks is an identical copy of the other, and they are updated synchronously, referred to as a RAID0 (Redundant Array of Identical Disks) configuration. Linux was chosen for a multitude of reasons, primarily due to the large abundance of high quality Open Source software included

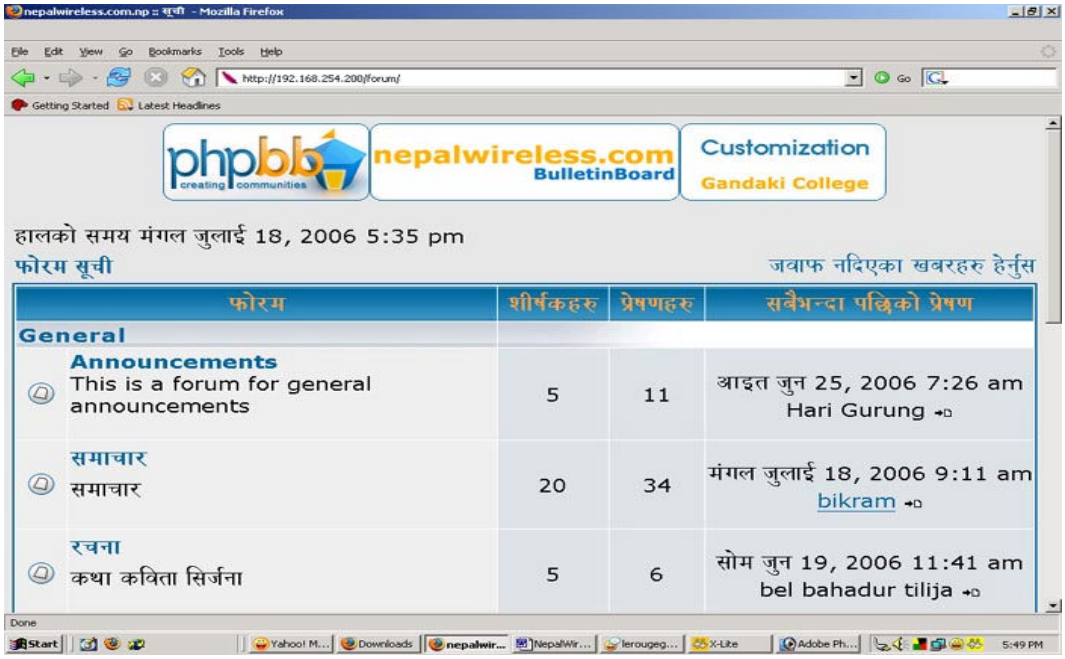
Philip Mucci working in the server

A woman in Ghorepani making telephone call

with the standard distributions and available online. Linux is well tested and proven in production environments and thus made a perfect choice for the server. This choice of operating system does present a bit of a maintenance problem, as many computer technicians are only trained on Microsoft. However, through the use of graphical user interfaces and the custom development of maintenance and management software, the system has proven to be maintainable by the local volunteers, when remote expertise has not been available.

Currently, the server runs the following software packages that provide both services to users and facilitate network management:

Asterisk PBX: This is an open source telephone exchange based on the SIP protocol to interface network phones with the Nepal Telecom PSTN. The system allows both incoming and outgoing phone calls. Incoming calls are answered by a person in Pokhara and then transferred to the appropriate extension on the network. The server allow users to place calls from within or outside the network using the Grandstream network telephones, Cisco ATA-186 phone adapters, or XtenLite phone software. Actually a person, who has an extension number, can call to the villages or get call from the villages from any location anywhere in the world. In this sense the system works just like other VoIP systems (e.g. Skype or Vonage) system do. The PBX performs complete call logging to the database on the server, which can then be displayed through a web interface. The Sipura SPA-3000 gateway is used to interface to the PSTN.



phpBB Bulletin Board

phpBB - The Nepali Language Bulletin Board: This bulletin board software provides an online discussion forum for the villagers. Using a localized Nepali version of the software, villagers can post and read announcements, local news, stories, songs, poems and urgent messages in the Devanagari script. However, many of the villagers have not yet learned how to type in Devanagari. Therefore, they are posting their messages in Romanized Nepali.

Apache and the Intranet Server: This popular open source HTTP server provides web pages customized for internal access. This includes links to network administration resources and a directory. Internal clients are provided with immediate to the intranet portal. This contains links to various other services provided by the server as well as useful external links. Currently, the server hosts a minimal page visible to the outside world. This is largely due to the limited bandwidth of the server to the outside world as external traffic would compete with that generated by the villagers browsing the Internet. A current version of the Home page of the Intranet can be seen in the following figure.

Home page of the internal website

Named - The Domain Name Caching Daemon: This network service caches domain name requests, which can significantly reduce Internet access speed during peak usage. The software stores IP addresses for domain names (e.g. "google.com" or "yahoo.com" or "hotmail.com") that have been accessed by users. These names can then be resolved within the network, reducing the amount of traffic that uses the limited 64 Kbps Internet connections. By configuring all the network clients to use the server as their primary DNS server, request/response traffic to the ISP is reduced by an order of magnitude, resulting in faster page loading times. It should be noted that the server only caches addresses, not data.

Samba - The Windows File Server and Master Browser: This cross-platform file server allows users to simply share files on the network. Samba allows both open and password protected shares and acts as a "workgroup master" by collecting the names and addresses of other computers on the network. The file server also makes the configuration of new computers very simple, as all the software necessary to image a new machine is

stored there. It provides the means to backup data from the server to other computers on the network to guard against data loss and hardware failure

MySQL: This open source database provides support for a number of other software packages, including Asterisk PBX and phpBB. It can be administered with a web browser using phpMyAdmin.

WebMin: This web based administration system allows one to perform virtually every task required to keep the server in operation, including security, account management and network configuration.

SSH: The Secure Shell Daemon allows administrators secure access to the server from anywhere in the world. From this interface, all aspects of the system can be analyzed, diagnosed, modified or upgraded from anywhere in the world.

2.3.2 Power Generation at the Relay Stations

As mentioned above, the network includes two Relay Stations on mountaintops that transmit the signal over the pass to form the backbone and connect villages. Because power from main grid line is not available at those sites, we have had to rely on solar, wind, and human power to generate the electricity necessary to run these stations. The following photos are the power sources we are using in at Mohare relay station.

Power Generation Equipment (from left to right) a bicycle generator, wind generator, and roof-mounted solar panels

This is not trivial, as each relay station has multiple wireless devices, an Ethernet hub, and a laptop computer. It is also complicated by the fact that several devices run off AC power, which uses 12 VDC to 110VAC power inverters. The power generation equipment for the relay stations is summarized below in (Table 7).

Item	Quantity
50 W Solar Panels	9
120W Solar Panels	2
30 Amp rated Solar Charge Controllers	2
10 Amp rated Solar Charge Controllers	1
400W Air-403 Wind Generators	2
12 VDC bicycle generator	1
75 amp-hour rated Trojan Gel Batteries	10
128 amp-hour rated Deep Cycle Batteries	2
12 VDC to 110VAC Inverter (150W)	2

Table 7: Power generation equipment for the relay stations

2.4 Financial Data of the Project

As mentioned above, implementation of the network occurred in three stages, the first of which was a pilot test conducted in 2002 to establish the feasibility of connecting the village to the network. It is also important to note the growth of wireless technologies and falling cost of hardware has influenced equipment expenditures: equipment that is purchased today costs considerably less and performs better than that acquired during our first years.

2.4.1 Pilot Testing

The pilot test was conducted in Spring 2002 mainly to determine the feasibility of connecting the village of Nangi to Pokhara to access the Internet. At that time (2002), the number of such long distance links using 802.11b technology was small and it was necessary to determine if such a link could be constructed using commercially available equipment. The pictures of the very first long range testing period using mesh dish antennas are given below

Different individuals in the US donated Dlink 900 AP access points that we used during the testing phase. The cost for each of the Dlink units that time was $70. The project had to spend some money on networking accessories in Nepal, but the total outlays were relatively small (Table 8).

The first long range testing from Mohare to Pokhara (34 KM) putting dishes on the ground in 2002

The first long range testing from Mohare to Pokhara (34 KM) putting dishes on the tree

Item	Quantity	Cost
12V, 50 amp-hour rated batteries	2	$200
8-port switches	3	$150
8-ft diameter used TV dish antennas	2	$90
3-ft diameter mesh dish antennas	2	$30
Ethernet cables, RJ45 Connectors, cans, poles, and metal boxes	--	$200
Miscellaneous	--	$200
Total		**$870**

Table 8: Pilot phase expenses

2.4.2 First Phase Implementation

The first phase implementation of the network constructed two relay stations as shown in the picture below and connected five villages to the network. A server using free software called Jana Server provided Internet access to the villages with a dial-up connection in Pokhara for about six months. However, the cost for the telephone connection and the Internet connection was very high. Therefore the project decided to replace the dial-up connection by a 64 Kpbs direct wireless connection from the Nepali ISP WorldLink.

Funds for the first phase were obtained from an undergraduate student of the Univeristy of California at Los Angeles (Mark Michalski) who received a grant from the Donald Strauss Foundation in the USA. The fund was augmented by subsidized equipment from smartBridges Company of Singapore and Pacific Wireless Company of the USA. The total spending for the first phase was approximately $6,000 and included the following (Table 9):

Photo of the Relay 1 built in the First Phase in 2003

Putting Antenna at Relay 2 built in the First Phase

Item	Number
smartBridges airPoint-PROOutdoor Access Points	12
Lightening arrestors for the access points	14
Pacific Wireless 24 dB Directional Antennas	14
120W Solar Panels and Voltage Regulators	2
400W Air-403 Wind Generators	2
75 Amp-Hour Trojan Gel Batteries	3
Cables, switches, poles	

Table 9: Equipment acquired in Phase One costing approximately $6,000

2.4.3 Second Phase Implementation

The second phase of the network implementation greatly expanded coverage, added a number of important network services, replaced equipment from the first phase that had malfunctioned and built a strong backbone for the network

The bulk of the funding for this phase was obtained from a World Bank grant through the Poverty Alleviation Funds of the Government of Nepal. The fund was supplemented by a grant from the International Center for Applied Studies in Information Technology (ICASIT) at the George Mason University School of Public Policy, USA handbook printing, training and publicity. The total amount received so far from the Poverty Alleviation Fund was US$17,800 in two installments and that from the International Center for Applied Studies in Information

Technology (ICASIT) at the George Mason University School of Public Policy USA was US$ 4,490. The last installment of about US$1,980 has not yet come.

Puttin g Canopy at Khopra in Second Phase 2005

Installation crew welcomed by Khibang villagers 2005

Outlays on equipment formed the bulk of the expenses, although we were able to allocate a substantial amount of funds to training, administration, and personnel. The total spending for the second phase by the middle of July 2006 is given in the following table (Table 10):

Item	Cost USD
Wireless Ethernet Radios (Motorola, Ascendance, Tranzeo, smartBridges)	13,715.02
Networking accessories (switches, cables, connectors, poles etc,)	2,809.05
Porterage/transportation	311.79
Training expenses	632.86
General Administration and installation expenses	2,284.19
Personnel	389.29
Handbook printing	571.00
Total USD	**20,713.20**

Table 10: Phase Two Expenses until July 15, 2006

2.5 Present Management Structure and Future Business Model

The Nepal Wireless Networking Project at present is a public enterprise because it is owned and run by a community high school. It uses an organization structure in which many community stakeholders are involved, including local schools, local governments and businesses. This allows an avenue for democratic participation as well as risk and profit sharing.

While most schools in Nepal are solely academic institutions, Himanchal Higher Secondary School has long been engaged in a number of community development projects, including animal husbandry, forest conservation, handicrafts and several income generation as well as vocational training programs. An elected school management committee of 7 members that meets regularly and makes policy decisions and governs the school including the projects it runs. Nepal Wireless Networking Project is just one of the several projects as mentioned above.

While Himanchal Higher Secondary School builds and manages the network, it does not provide services directly to the end-users. The services to the villagers are provided through independent communication centers in each village. Each of these centers is managed differently and is independent from each other. Common caretaker organizations include mother's groups, father's groups, school management committees, and communication center management committees formed by the villagers. By running the communication centers, the respective caretaker organizations also gain opportunity to share in the revenue produced by usage charges.

In summary Nepal Wireless Networking Project is a part of the income generating programs run by Himanchal Higher Secondary School because it is working purely as an Internet Service Provider for the village communication centers and the schools. It provides services and charges money to the customers on monthly basis.

As for future business model, the project hopes to start a limited liability company by including the public stakeholders such as the local governments, community schools and private partners from the communities as business partners. Therefore the structure of the future management committee will be totally different from the one it is now. The company will provide Internet connection to individuals in the villages, which is not available for them now.

The project is very much optimistic that some of the local governments will be interested to invest from 5% to 10% of the yearly grant they get from the government for networking their villages wirelessly. Each local government gets US$14,000 each year from Nepal Government for local development. We will start big campaigns to raise awareness of the importance of ICT to the local level leaders. Some leaders have already shown interests to do so.

Community Communication Center in Khibang

3. Outcomes of the Project

While the Nepal Wireless Networking Project has been operating only a short time, it is already possible to assess and evaluate some of the outcomes of the project. This includes information on whether the network is used, and, if so, how and by who. Additionally, examination of revenue streams can provide insight into the project sustainability. This section evaluates outcomes from the Nepal Wireless Project, providing data on network users and information on revenue streams.

3.1 Social Impact and Usage Characteristics

In order to assess the extent to which the Nepal Wireless Network services the needs of users, E-Networks Research and Development of Kathmandu, Nepal conducted a survey study. This involved a questionnaire administered to 100 users of the communication centers in villages connected to the network. While complete data is reported in Appendix 3, an overview of the results is presented here.

3.1.1 User Demographics

Demographic information collected on the users included age, gender, marital status, education, occupation, and income. Results show that users are primarily younger members of the community, 83% were under the age of 30. Furthermore, males tend to use the services offered more than females, as 72% of users were male. Also, users were generally single, only 18% of males and 5% of females reported they were married.

Generally, education levels of the users were quite high; in fact, literacy levels were at 100% (which is perhaps not surprising given the literacy required to use the World Wide Web). This is considerably higher than the nationwide literacy level of 53.7% reported by the Central Bureau of Statistics. Education levels (Table 11) show high levels of primary completion; other levels also reflect the fact that many users are students who have not yet completed their education.

Education level	Primary	Lower Secondary	Secondary	High School	Total
Percentage	4	35	37	24	100

Table 11: Education level of users

Economically, users tended to reflect the community as a whole. The data on occupations (Table 12) shows that agriculture is by far the predominant occupation, followed by service sector jobs (education and healthcare are likely the majority of these). While reporting income level is difficult due to fears of social stigma, the income distribution shows that the majority of users have incomes below US$ 135 (10,000 NRs.). While this is considerably lower than the per capita GDP ($250 reported by World Bank in 2005), it is perhaps reflective of lower incomes in rural areas and the younger age of the users.

Source of income	Percentage
Agriculture	78
Business	0
Service	21
Labor	0
Others(Carpenter)	1

Table 12: Occupation of users

3.1.2 Usage Characteristics

Users access services on the Nepal Wireless Network for a variety of reasons. One point of interest in collecting data was to determine what services are most accessed by users. The graph below (Figure 2) shows reasons surveyed users gave for accessing the communication center; users selected all reasons they used the network with many selecting more than one reason. Clearly, email is the most common use, followed closely by information and news

(presumably from the World Wide Web) and then telephone. These results would seem to indicate that the primary uses of the network are communication and information access.

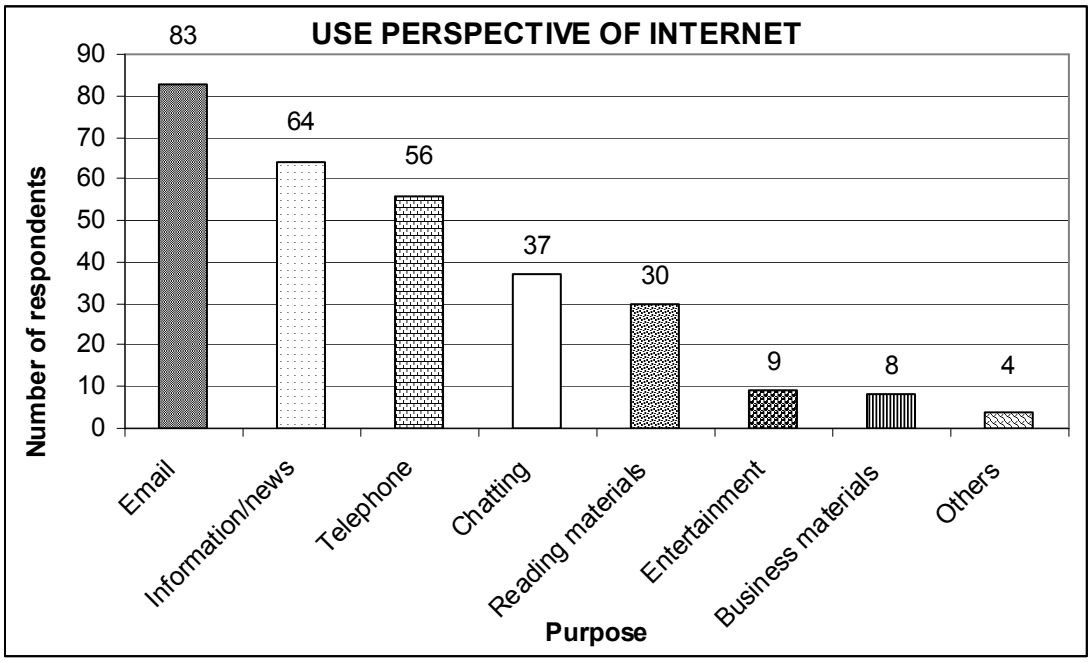


Figure 2: Reasons for Internet use

An additional area of interest is that of usage patterns, meaning how often users access services and when they first began to do so. Several questions of the survey addressed these issues, and revealed that the majority (58%) of users identify themselves as occasional users, although 37% responded that they are daily users. Studies of usage patterns also revealed that most users access services in the morning or afternoon, with relatively few in the early morning or evening. Finally, the study showed that many are long-term users, 58% had been accessing services on the network for one year or more.

A final usage characteristic investigated was that of service alternatives, meaning the availability of similar communication facilities if the Nepal Wireless Network did not exist. This was measured in terms of the distance users would have to walk to access similar services, and the results (Table 13) show that many would have to walk a considerable distance to do so. It can therefore be explained that the Nepal Wireless Network has penetrated a relatively remote area, and is not simply duplicating services that are offered elsewhere.

Travel time required	Respondents
One hour	9
2-3 hour	14
4-6 hour	32
one day	24
More than one days	23

Table 13: Travel time required reaching alternative services

3.1.3 Usage Benefits

Most importantly, the usage study sought to determine whether or not users tangibly benefited from the Nepal Wireless Networking Project. Several questions on the survey addressed this issue, the first of which directly asked respondents whether they saved time or money due to the availability of services. Results (Table 14) show that many respondents saved both time and money by using the network. Another question revealed that saved time was used for academic studies, domestic activities, and income generation.

Benefits	Percentage
Save time	48
Save money	38
Save time and money	58
Save time but not money	1
Save money but not time	3

Table 14: Time/Money benefits to network usage

As the network has closely been allied with regional schools, an additional area we investigate was how students in the area benefited by network access. When asked directly, 50 of the 55 students surveyed said that their studies had benefited as a result of network access. When asked what they used the network for, students primarily answered that they used the Internet to gather reading materials, while a significant amount also used it for chatting with friends.

3.2 Revenue Streams of the Project

As mentioned above, the Nepal Wireless Networking Project employs a management structure that allows community organizations to run the communications center in the local

village. This creates a system where the communication centers collect most of the revenue from end users, while the project as whole charges the centers at a reduced rate for access.

3.2.1 Communication Centers Revenue System

Communication centers use the services offered by the Nepal Wireless Networking Project to raise revenues in several ways. First, the center operates as a cyber café, charging users a small hourly fee (currently US$0.21 - US$0.43) to use the network. On major trekking routes, tourists are charged a higher rate (US$1.36 per hour) to increase revenue. In the communication centers that are run by schools, students and teachers pay only a small monthly fee (students pay $0.25 while teachers pay between US$0.50 and US$1.00). Thus, providing Internet access is one means of raising revenues.

For phone calls, the communication centers bill the user at a rate above that charged by the Nepal Wireless Networking Project. The per minute billing structure (Table 15) results in a surplus between the rates users pay and the rates the centers pay to Nepal Wireless (NW). Approximately, Nepal Wireless (NW) is making $ 0.01 per minute from the landline telephone calls provided by Nepal Telecom (NT). The communication centers are making from US$0.01 to US$0.11 per minute on local calls and from US$0.02 to US$0.12 per minute on domestic long distance calls. This surplus is the major source of income for the communication centers. Additionally, the communication centers bill for calls on Saturdays, which are offered at a 50% by Nepal Telecom, further increasing the amount revenues.

Village	**Local Calls**				**Domestic Long Distance Calls**			
	NT Charge	NW Charge	User Cost	Surplus to Com. Center	NT Charge	NW Charge	User Cost	Surplus to Com. Center
Nangi	$0.02	$ 0.03	$ 0.07	$ 0.04	$0.07	$ 0.08	$ 0.14	$ 0.06
Ghorepani	$0.02	$ 0.03	$ 0.14	$ 0.11	$0.07	$ 0.08	$ 0.20	$ 0.12
Shikha	$0.02	$ 0.03	$ 0.14	$ 0.11	$0.07	$ 0.08	$ 0.20	$ 0.12
Majhgaun	$0.02	$ 0.03	$ 0.04	$ 0.01	$0.07	$ 0.08	$ 0.10	$ 0.02
Tikot	$0.02	$ 0.03	$ 0.07	$ 0.04	$0.07	$ 0.08	$ 0.14	$ 0.06
Narchyang	$0.02	$ 0.03	$ 0.14	$ 0.11	$0.07	$ 0.08	$ 0.20	$ 0.12
Paudwar	$0.02	$ 0.03	$0.14	$ 0.11	$0.07	$ 0.08	$ 0.20	$ 0.12

Table 15: Per minute Costs for phone services (NT=Nepal Telecom, NW =Nepal Wireless)

The telephone service was provided first to Ghorepani village in January 2006. Then the services were provided to different villages at different times. Data was available from the following villages (Table 16) that show the total revenue each village collected, and the income each communication center made after paying the charge to Nepal Wireless Project.

Village	Total Income from telephone US$	Charge paid to Nepal WirelessUS$	Surplus to Comm. Center US$	Remark
Ghorepani	1032	289	843	In five months
Sikha	250	65	185	In three months
Narchyang	641	207	434	In four months
Tikot	180	55	125	In two months

Table 16:List of the money each village made from the telephone calls and paid to Nepal Wireless

Additionally, some communication centers have started running classes in basic computer literacy for which participants are charged between $2.00 and $10.00 per student per month. This both raises revenues and develops computer skills for people of all ages in the community. Currently, three villages have classes with enrollments between 10 to 20 students in each village. The names of the villages that are running classes are Paudwar, Shikha, Tikot and Majhgaun village during the summer vacation.

3.2.2 Network Revenue Streams

The Nepal Wireless Networking Project does not collect revenues directly from end users but instead bills communication centers to cover the cost of operating the network. Expenditure for running the network (Table 18), currently reaches nearly $290 per month, whereas fees collected from communication centers (see Table 17) now reaches about $225.

Additionally, the network charges communication centers a surcharge on telephone calls (approx. $0.01 per minute more than is billed by the national provider Nepal Telecom), resulting in a further profit. With estimated phone revenues of $80 per month, the network generates over $300 per month and is able to cover just about its operating expenses.

The reason Nangi village is charged US$110 now is that the school is using the network for maximum amount of time and is benefiting from the network the most. Moreover, it owns the network and it needs to pay the rest of the expenses incurred after deducting the revenues that come from different villages. The revenue of $10 per month per village a cnnection fee will start coming from the recently added four villages (Majhgaun, Chandrakot, Tolka and Lopre) from October of 2006.

Village Name	**Monthly Connection Fee US$**
Nangi	$110
Ramche	$10
Tikot	$15
Khibang	$10
Ghara	$15
Paudwar	$15
Narchyang	$15
Shikha	$15
Ghorepani	$20
Total Connection Fee Revenues	**$225**
Estimated Telephone Revenues	**$80**
Total Monthly Revenue	**$305**

Table 17: Monthly connection fee charged to each village and total income

Moreover, the communication center in Tatopani is not operational yet because the villagers have not decided as who would run the communication center. They are planning to run communication center in near future. Tatopani will be charged $20 per month as connection fee because it is a big tourist town. The communication center in Tatopani can generate much more income than other villages by charging more usage fee to the tourists on their way to or back from Mustang area. This town is also on the Annapurna Circuit trail.

S.N.	**Expenditure per month**	**Amount US$**
1	Internet connection fee to the ISP including tax	$165
2	Server room rent/power	$25
3	Relay Station in charge allowance	$70
4	Miscellaneous	$30
	Total	**$290**

Table 18: Monthly running expenditures of Nepal Wireless Project

With the growing user base, we anticipate that revenues from the Nepal Wireless Networking Project will continue to grow. With the planned addition of four more villages (Ghandruk, Landruk, Lamagaun, and Dana) by December 2006 and a rapidly growing user base, revenues could easily reach $400 per month within a couple of years. Ideally, this will help to cover not only the operation cost but also the expenses involved in network infrastructure.

3.3 Economic Opportunities and Growth Created

An additional benefit of the Nepal Wireless Networking Project is an increase in spending and economic opportunities in the region. This includes jobs offered through the project and business generated by the project, either directly or indirectly.

3.3.1 Jobs Created by the Project

So far, the project has created some part-time and full time jobs as well as volunteer opportunities (Table 19). However, full-time jobs are not yet fully paid, as communication centers are not yet generating sufficient revenues to pay a full-time worker.

Although the communication center operators are not paid a full-scale salary, workers at the communication centers may receive other incentives, and most jobs are still viewed as desirable as there are few cash-paying jobs available in the area. The photos of some of the communication center operators from different villages are given below

Bele Khoraja, Nangi

Gam Roka Paudwar

Hari Gurung Khibang

Tek Pun Tikot

Photos of some of the network operators

Job description	Schedule
Network Manager in Nangi	Full time
Relay Station in charge at Mohare	Full time
Relay Station in charge at Khopra	Part time
Communication center operator in Khibang	Full time
Communication center operator in Ghorepani	Full time
Communication center operator in Narchyang	Full time
Communication center operator in Majhgaun	Part time
Communication center operator in Shikha	Part time
Communication center operator in Tikot	Volunteer

Table 19: Jobs generated from the Nepal Wireless Networking Project

Volunteer students of Gandaki College of Engineering and Science making Ethernet cable in Chandrakot village

Volunteer students of College of Information Technology of Kathmandu teaching computer in Tikot village

In addition to these jobs, the project has created volunteer and internship opportunities for software developers and college students with computer science as major. For example, E-Networking Research and Development (ENRD), an NGO working in ICT field brought students of the College of Information Technology, Kathmandu to the villages for two weeks to teach basic computer skills to the villagers. The students helped to develop the first PHP bulletin board in Nepali. ENRD also organized two-week long hardware training program for the network operators of the villages at National Web College in Kathmandu. The faculty and the students of Gandaki College of Engineering and Science of Pokhara are customizing PHP bulletin board, developing library management software and local e-commerce software for the project. The practical experiences provided by this project to the college students will be very useful for them.

3.3.2 Business Opportunities Created by the Project

While business opportunities in rural Nepal are fairly limited, the Nepal Wireless Networking Project does act to stimulate both large and small-scale businesses. On a large scale, Nepal Wireless acts as a consumer to Nepal Telecom, the Nepal Hydro Power Company, the Nepali ISP WorldLink, local computer stores, and global wireless equipment manufacturers.

On average, the project is paying US$170 per month for the telephone bill and US$165 per month to Nepali ISP Wlink. It also pays on average about US$150 per month for power to the power company, which does not include the bills other communication centers pay.

Moreover, the project bought networking and computer accessories from local businesses that worth about US$ 3,000 in 2006. This amount does not represent the amounts used by 13 villages to buy computers and computer accessories for their school or communication centers. The project spent about US$14,000 in 2006 to buy wireless equipment from global markets.

Additionally, the survey results described in 3.1.2 show that at least some users are using the Internet for business-related purposes. The owners of stores in the villages are using the phone to order supplies to the suppliers in the cities like Beni, and Pokhara. Thus, many of the services offered yield indirect business benefits.

Several hotel owners of Ghorepani village (a tourist town) have started learning to send e-mail and to do chatting using Yahoo and MSN Messengers. They have been found writing e-mails to their past customers and their contacts travel agencies in Pokhara and Kathmandu. Himanchal High School ran a village tourism program in 2005 with the help of a company (3 Sister's Adventure) based in Pokhara and brought four groups of tourist to the villages. The wireless network was very helpful to organize the village tourism program because it provided immediate communication tools between the villages and the travel company in Pokhara.

As mentioned above, the plans to create an e-commerce system in the network is underway right now in order to help villagers sell and buy local products in local market. It will certainly increase benefits to business in near future.

4. Analysis, Successes, Legal Challenges, Lessons Learned, and Future Goals

4.1 Cost-Benefit Analysis

As an evaluation technique, it is useful to consider whether the funds used by Nepal Wireless are justified by the social benefits. We should also consider how funds might have otherwise been used, and what benefits would have been obtained in that case. Based on the evidence presented above, we argue that the funds used by the Nepal Wireless Networking Project were well used and have resulted in a sustainable community network that will continue to yield benefits for many years to come. Consider the following points:

- Given the total amount spent on the project by the end of June 2006 (US$27,583.20 reported in section 2.4) and the total population of all 14 villages (15,133 reported in Table 1), the total per capita implementation cost was US$1.82. To provide Internet and telephone services while supporting education and healthcare at this cost is unheard of elsewhere.

- Total funds spent on the project were less than US$30,000, much less than many similar programs spend on administrative overhead.

- The project has reached a point where minimal user fees cover operating costs; as the network grows and revenues increase it will also cover infrastructure-building cost.

In performing this analysis, it is important to note that the network implementation is still new and coverage is continually growing. Therefore, to perform rate-of-return analysis at this point would be premature and would not indicate the project's full socioeconomic utility.

4.2 Successes of the Project

The Nepal Wireless Networking Project was among the first grassroots movements to use ICT for rural areas in developing countries. Considering the very unfavorable political circumstances that includes the autocratic rule of the king, and Maoist insurgency in which it was implemented, the project was quite revolutionary and has received attention from around the world. We consider the following to be our main successes:

- Extending access to the wealth of information and global communication available on the Internet to an area where few thought was possible.
- Successfully piloting new technologies such as telemedicine, and teleteaching.
- Creating an ICT business opportunities in the rural area.
- Making every effort possible to adapt technologies to the local context.
- Maintaining the character of a grassroots, volunteer-run organization and working on to develop the project to a profit making business step by step.

4.3 Regulatory and Legal Challenges, and Recommendation to Nepal Government

As mentioned in the introduction, political instability has been a major obstacle for the Nepal Wireless Networking Project. First, the autocratic rule of the king created a situation in which importing and using wireless networking equipment was severely restricted, even though there were no proven instances in which this technology was used against the state. Second, conflict in rural Nepal made work extremely difficult. The project had to be implemented while constantly facing threats of closure and villagers were often reluctant to participate due to fears of violence from the government soldiers and the Maoists. Finally, restrictive trade laws to import and use the wireless gears had made acquiring equipment from abroad extremely difficult and expensive to use. Besides, a license fee of US$85 per year was imposed for every piece of wireless equipment used in a wireless network. Therefore the project had smuggled all the

wireless equipment from the USA, Canada and Singapore to build the network from the very beginning. Also the project did not pay any license fee imposed by the government.

Now the fact is that the trade laws are still as restrictive as it was before even after the restoration of democracy in Nepal. The project now is strongly lobbying along with the Internet Service Provider Association of Nepal to deregulate the import and use of the Industrial, Scientific and Medical Bands (2.4000-2.4835 GHz and 5.7250-5.8250 GHz). The project organized a one-day long seminar in Kathmandu on July 23, 2006 by inviting government minister, political leaders, government bureaucrats, and Internet Service Providers to inform the progress of the project and to discuss about existing regulatory and legal issues.

Based on the interaction program in the seminar, the following strong recommendation have been put forward to Nepal Government to bring liberal ICT policies and to use wireless technology to make the information technology within the reach of rural population of Nepal.

- De-license 2.4000-2.4835 GHz and 5.7250-5.8250 GHz bands (ISM bands) and make it license free to import and to use without paying any additional fee.
- Make VoIP free at least to make call from computer to computer and computer to landline telephone of Nepal Telecom.
- Bring liberal ICT policies by decreasing the high license fee that is being imposed by the government to the ISPs so that small business entrepreneurs can also start ISP companies in rural areas and provide cheaper Internet services.
- Provide subsidy to community based organizations that are interested to establish Community Internet Service Provider (CISP) companies in each district headquarter of Nepal and use wireless technology to extend the network to the remote villages of the district. Right now there is no ISP in 65 out of 75 districts in Nepal.

We are glad to inform that Nepal Government de-licensed the 2.4 GHz and 5.8 GHz bands after our hard lobbying for more than a month. The government published the notice on September 11, 2006. The copy of the notice and the unofficial translation of the government's notice are in Appendix 6. Our next step for lobbying will be to make VoIP free in Nepal.

4.4 Lessons Learned from the Project

Many lessons were learned from the Nepal Wireless Networking Project that might be of use to others interested undertaking similar projects. We will share these lessons in two parts: First, those of a technical nature and, second, those of a more practical nature.

4.4.1 Technical Lessons

Through our project, we learned several lessons about the technical aspects of setting up and installing a community wireless network. These include the following:

The capability of 802.11b devices exceed more than manufacturer specification: Many 802.11b wireless devices exceed manufacturer specifications if it is deployed in the remote areas where there are no interferences. In our pilot test, we found that an indoor access point rated to reach 300 meters outdoor had a range over 30 kilometers with a homemade mesh dish antenna at 2Mbps connection speed.

Device is susceptible to weather: Some wireless devices are susceptible to weather and lightening. While the weather of Nepal is quite harsh and lightening is very common during spring season, we have lost eight radios to date due to weather. Good grounding procedures is required to reduce the loss.

Wi-fi device is useful for delivering services other than just connecting to the Internet: People around the world are using the wireless devices mostly for connecting Internet at their homes. The project has learned that the technology can be useful more than people have thought of. The project has tested that the technology can be very useful for delivering telemedicine, and tele-teaching programs. Also the wireless network can be used to provide telephone services to remote mountain villages, where services from telephone companies can't reach, at much cheaper cost and easier way by connecting the Wi-fi network to landlines of telephone companies. The telephone services have been the main source of income to make the project sustainable.

Long-range network must have to have strong backbone: When setting up a long-range network above 15 km far, it is essential to have a strong backbone with reliable equipment and a high bandwidth. In our case, this equipment was the 5.7 GHz Motorola Canopy BH-20 even if it is much more expensive than other equipment.

Little training is required for setting up a Wi-fi network: Our experience tells that one does not have to be trained IT professional or college graduate to install Wi-fi wireless network. None of our Nepal team member or international volunteers had experience setting up a wireless network when the project began. Now even the village team members can setup and operate the network. Some of the network operators have a high school level education while others have only middle school level education. An 89-years old man is helping to maintain a relay station although he can't read English letters very well. Our experience tells that it is only for building a server we need professional help from qualified person.

Management and technical training should be provided to local people: Project needs to use local expertise or local capable individuals to help maintain the technical aspect of the network. Having their involvement is critical to the sustainability of the project.

Addressing and Routing should be done using hostnames: Our experiences say that using HOSTNAMES with DHCP and DNS is preferable to using static addressing for a big network. Furthermore, using a consistent routing system from the beginning allows the network to grow quickly. The routing system provides the ability to do monitoring, fault diagnosis, traffic rerouting/redundancy and to guarantee the quality of service.

Manuals and documents should be maintained well: Network manager needs to keep manuals for every piece of equipment in a central location. Having an equipment inventory would be a good idea. It is necessary to maintain backup of the configurations for all devices and computers. Having duplicates of every piece of equipment on the network and making notes of every failed experiment is very important.

4.4.2 Practical Lessons

These lessons are of a more practical nature and address the use of the network in a social environment.

Wireless network can be a very useful alternative communication means in emergency situations: Wireless community networks can be very useful when other means of communication (landline and mobile phones, radios, etc) are not working. On February 1, 2005, the king declared the state of emergency in Nepal around 10 AM. Soon after that all the telephone services, Internet services, FM stations, televisions, and newspapers in Nepal were shut down for indefinite period. However, the network of Nepal Wireless Networking Project was running even during that period. Villagers that were in the service area were able to communicate each other through VoIP phone services. They could also send/get messages to and from Pokhara through the network.

The number of users grows fast: The project has found that young people can quickly learn how to use the Internet, and play games from their friends. We have found that it will take weeks or months, not years, for villagers who had never used computers before to write e-mails, chat online, to play games, and to share ideas using computers. It just happens if it is available even in the remote areas.

Occasional training for the users should be organized: We found an imperative need to ensure that the users are kept fully trained to maximize the potentials offered by the network to the maximum number of villagers. Therefore occasional short-term refresher training programs in each of the villages is needed to keep the users up to date.

Networking projects create job opportunities: The project has learned that even a small network can create several jobs in a developing country like Nepal, where very little jobs are available on the job market for college graduates.

Networking projects help to reduce poverty: We have learned from our trial local e-commerce program that wireless networks help people to sell local products in local

market easily. The villagers can find the market price of their products easily from the Internet. The information on the market price will help them to get fair price for their product. It will thus help to reduce poverty in developing countries.

4.5 Future Goals of Nepal Wireless Networking Project

While we are proud of our successes to date, we also realize there are many areas where we can improve the network. In particular, we would like to concentrate on the following areas as we move forward.

Provide additional resources needed for the tele-teaching installation: The goal is to make live tele-teaching a viable educational opportunity for students in the community. While we have invested in some of the necessary technology, further work and investment is needed to reach a point where the live tele-teaching works perfectly helping to address the shortage of qualified teachers. The major investment that will be required for tele-teaching is buying LCD projectors, faster computers for each classroom, and better audio-video conferencing equipment.

Run training programs to implement local e-commerce program effectively: Students of Gandaki College of Engineering and Science are working to develop a web-based software platform for the local e-commerce. This program will be implemented in the near future and that it will be of real use to the community. No additional investment will be required for this program.

Provide quality of services: With so many users sharing a 64 Kbps Internet connection, Internet access is becoming slow. The plan is to upgrade this connection to at least 128 Kbps soon. Moreover, we plan to put more equipment to backup power at the relay stations and communication centers to increase performance and uptime.

Extend the network and the phone service to surrounding villages: By bringing network service to more villages, particularly phone and Internet service, we plan to provide a revenue stream both for the village and for the project. Nepal Telecom has

recently agreed to provide 20 telephone lines for the network, which will be extended to 20 villages. Of particular interest is the establishment of an Internet cafés with telephone services in Gandruk, Landruk, and Chhomorong villages that are the most active tourist spots in Nepal on the trail to Annapurna Base Camp.

Organize training programs for interested people to help replicate the network: The project has gotten good publicities in Nepal. Therefore several people including some members of parliament have shown their interests to replicate such network in their districts. In order to encourage people to replicate the project in different parts of Nepal occasional training programs will be organized in different parts of the country. For the training purpose, a handbook in simple Nepali language has already been published.

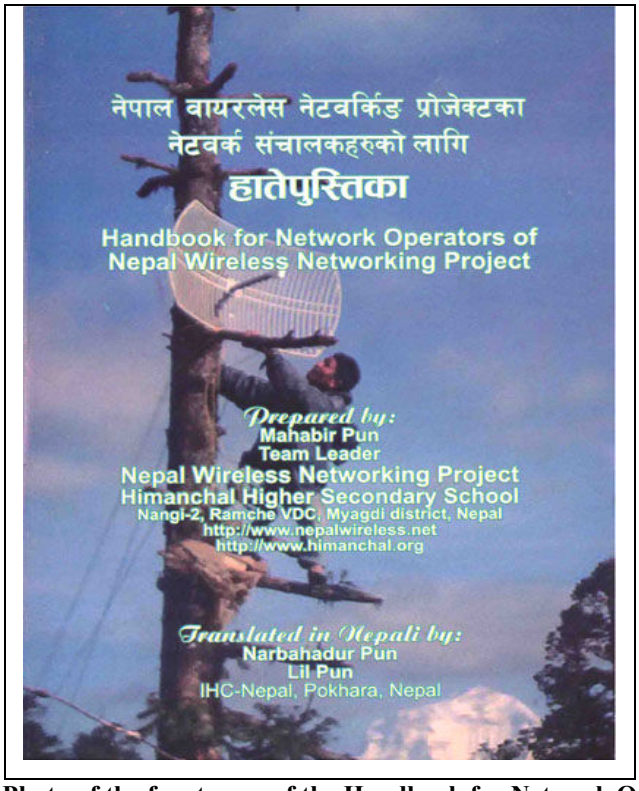


Photo of the front page of the Handbook for Network Operators

Develop a formal web application dedicated to the purposes of tele-medicine: Another important plan is to develop a simple 'portal' written in Java and PHP that contains the followings inside a single instance of a web browser:

- Two video windows, one of each peer

- A two-way text chat window, for exchange of prescriptions, diagnoses
- An information/status window filled by the server providing information to each endpoint about the status of the connection and the name and VoIP phone extension of the remote party.
- A link to call the remote party via the Xten VoIP software phone client.

Add redundancy and backup to the network services: The plan is to add an additional server, placed at Himanchal Higher Secondary School, Nangi that would maintain a full copy of the server in Pokhara as well as run a duplicate set of services. Should the server go or the link goes down to Pokhara, the network would still be fully operational, except the PSTN gateway functionality.

Develop a limited liability company including the stakeholders: The project is planning to set up a limited liability company in future by including the public stakeholders such as the local governments, community schools and private partners from the rural communities. Some of the local governments have already shown interest to invest from 5% to 10% of the yearly grant they get from Nepal Government for networking the villages wirelessly. The local governments get US$ 14,000 grant each year and are free to use for local development based on their needs.

4.6 Conclusion

The Nepal Wireless Networking project started with a dream, and the initial dream has now become true. We hope this report has given the readers an understanding of its design and implementation including the future dreams of the project. Over the past few years, much attention has been given to the promise of ICT in the field of international development, yet there are few tangible examples of success. Our project represents one such success, and as such it gives others an example to follow in planning future endeavors. As Nepal stands on the horizon of a bright new political future, we appeal to government, civil society, and the private sectors to institute liberal policies that will help such grassroots projects to help bring the promise of information technology to all. We hope that our next dream to develop this project as a limited liability company and to replicate the network in other parts of Nepal will also come true.

Appendix 1: Comprehensive Equipment Inventory

Nadipur Station	
Item	**No.**
802.11b airPoint-PROOutdoor smartBridges radios	2
Motorola canopy with reflector	1
Linksys Router	1
8-port switch	1
Mercantile Pentium 4 Computer for server	1
75 amp-hour rated Trojan Gel Batteries	2
5KVA Stabiline UPS	1
Sipura Wi-fi to PSTN adaptors	3
19dbi Wire grid antennas	2
Grandstream IP phone	1

Dip Pokhara	
Item	**No.**
802.11b Deliberant radio/14 dbi internal antenna	1
5.7 GHz Motorola BH-20 canopy with reflector	1
8-port switch	1
75 amp-hour rated Trojan Gel Batteries	2
5KVA Stabiline UPS	1

Mohare Station	
Item	**No.**
5.7 GHz Motorola BH-20 canopy with reflector	2
802.11b airPoint–PRO Total smarBridges radios	2
Linksys Router	1
75 amp-hour rated Trojan Gel Batteries	4
400W Air-403 Wind Generator	1
Pacific Wireless 24 dB Directional Antennas	2
50W Solar panels	5
120W Solar panels	1
12 VDC bicycle generator	1
150W 12 VDC to 110VAC inverter	1
Toshiba Satellite Laptop	1
30 Amp rated Solar Charge Controller	1
A metal roofed wooden house 22 ft long 15 ft wide	1

Khopra Station	
Item	**No.**
5.7 GHz Motorola BH-20 canopy with reflector	1
802.11b airPoint–PRO Total smarBridges radios	2
Linksys Router	1
75 amp-hour rated Trojan Gel Batteries	3
400W Air-403 Wind Generators	1
Pacific Wireless 24 dB Directional Antennas	2
50W Solar panels	2
120W Solar panels	1
150W 12 VDC to 110VAC inverter	1
Dell Inspiron 4000 Laptop	1
30 Amp rated Solar Charge Controller	1
A metal roofed wooden house 20ft long 14 ft wide	1
Grandstream IP phone	1

Nangi Village	
Item	**No.**
802.11b Deliberant radio/14 dBi internal antenna	2
802.11b airPoint-PROOutdoor smarBridges radios	1
Pacific Wireless 24 dB Directional Antenna	1
8-port switches	4
Toshiba Satellite A75–S206 Telemedicine Laptop	1
128 AH rated Lotus Energy Deep Cycle Batteries	2
5KVA Stabiline UPS	2
Grandstream IP phone	1
Used PII, PIII and PIV computers	20

Ramche Village	
Item	**No.**
802.11b Deliberant radio/14 dbi internal antenna	1
Assembled PI and PII PC computers	3
Panasonic BL-10 Web camera for telemedicine	1
8-port switch	1

Tikot Village	
Item	**No.**
802.11b airPoint-PRO Total smarBridges radios	2
Wireless Grid 24 dB Directional Antenna	2
8-port switch	1
2KVA Stabiline UPS	1
Grandstream IP phone	1
Assembled used PI and PII computers	8

Khibang Village	
Item	**No.**
802.11b airPoint-PRO Total smarBridges radios	2
8-port switch	1
2KVA Stabiline UPS	1
Assembled and used PI and PII computers	4

Ghara Village	
Item	**No.**
802.11b airPoint-PRO Total smarBridges radios	1
8-port switch	1
Assembled and used PI and PII computers	4

Paudwar Village	
Item	**No.**
802.11b airPoint-PRO Total smarBridges radio	1
8-port switch	2
50W Solar panels	5
Assembled and used PII and PIII computers	15

Narchyang Village	
Item	**No.**
802.11b airPoint-PRO Total smartBridges radio	1
802.11b Deliberant radio	1
8-port switch	1
Grandstream IP phone	1
14 dB Omni directional antenna	1
Pacific Wireless 24 dB Directional Antenna	1
Assembled PII computers	3

Shikha Village	
Item	**No.**
802.11b airPoint-PRO Total smarBridges radio	1
8-port switch	1
Pacific Wireless 24 dB Directional Antenna	1
Grandstream IP phone	1
Used computers	3
New computers	6

Ghorepani Village	
Item	**No.**
802.11b airPoint-PRO Total smarBridges radio	1
8-port switch	1
19 dB Wire Grid Directional Antenna	1
Grandstream IP phone	1
Used Computers	4

Lopre Village	
Item	**No.**
802.11b airPoint-PRO Total smarBridges radio	1
8-port switch	1
24 dB Grid Directional Antenna	1
50W Solar panel	1
10 amp rated Solar charge controller	1
NEC laptop	1

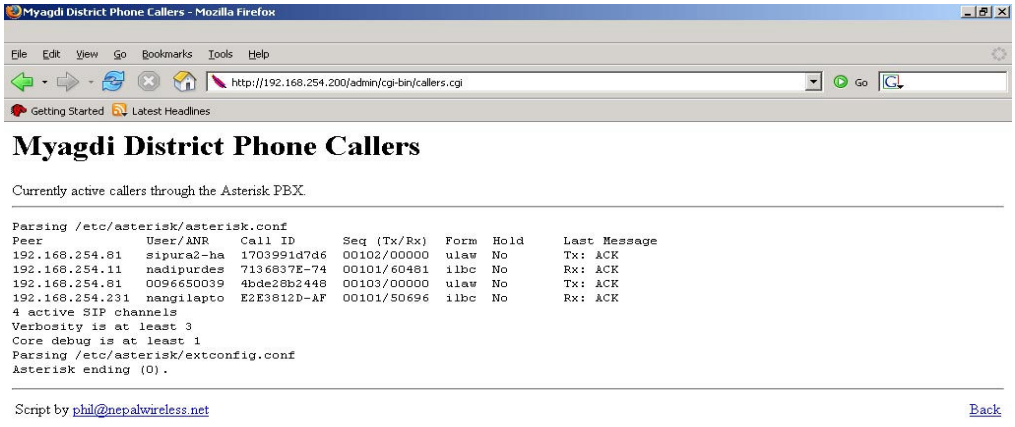
Chandrakot Village	
Item	**No.**
802.11b airPoint-PROOutdoor smarBridges radio	2
8-port switch	1
19 dB Wire Grid Directional Antenna	2
Used Computers	3

Majhgaun Village	
Item	**No.**
802.11b Deliberant radio/14 dBi internal antenna	1
8-port switch	1
Used Computers	4
Assembled new computers	1

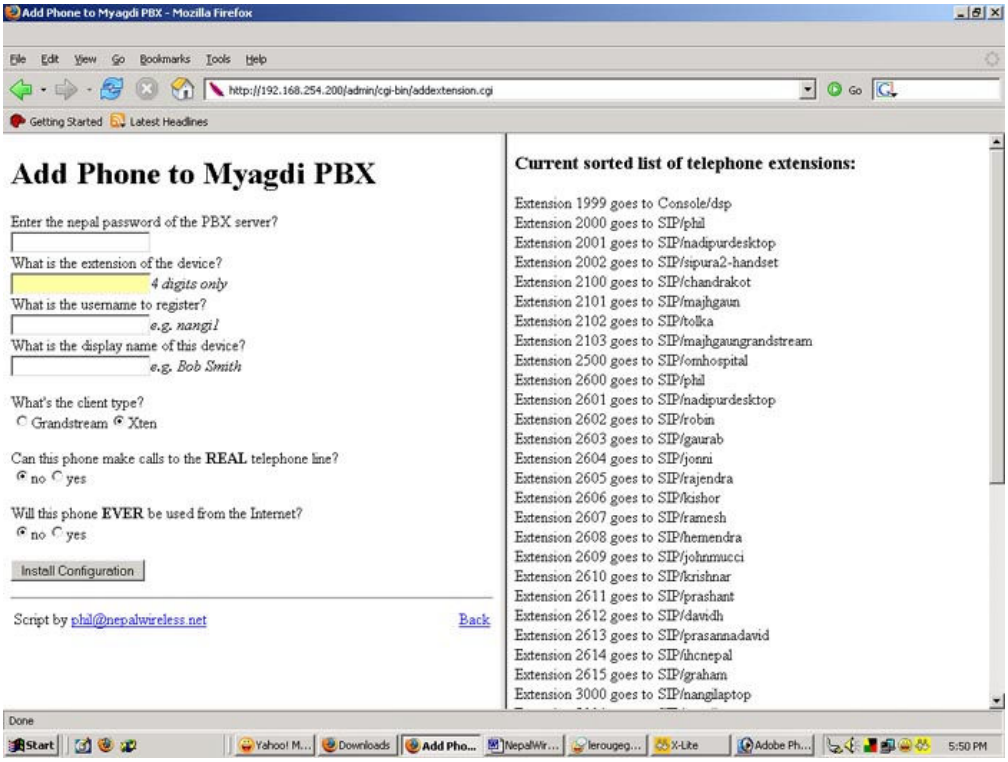
Tolka Village	
Item	**No.**
802.11b Deliberant radio	1
8-port switch	1
19 dB Wire Grid Directional Antenna	1
Used Computers	6
Assembled new computers	3

Om Hospital Pokhara	
Item	**No.**
802.11b Senao radio	1
8-port switch	1
15 dB Panel Antenna	1
Mercantile Professional PIV computer	1

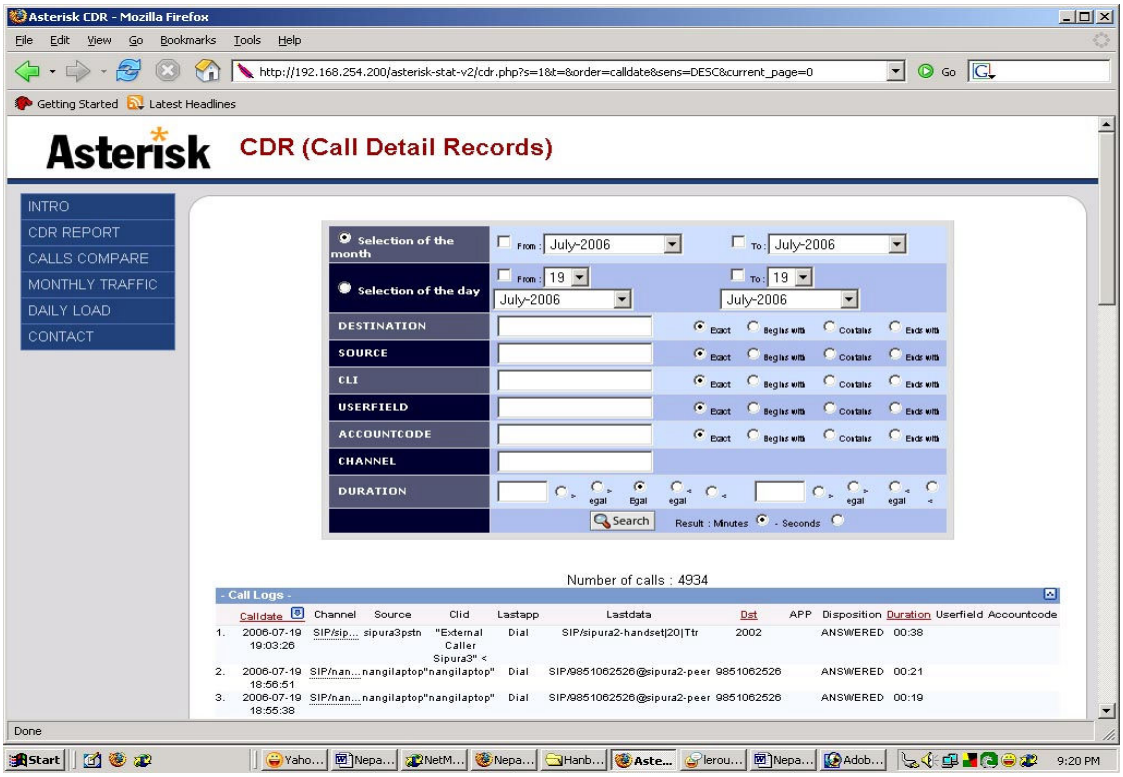
Appendix 2: Software Screenshots of VoIP system



Calls in progress on the PBX



Managing VoIP phone extensions with a web based interfac



Detailed records of calls made from different village

Appendix 4: Questionnaire Data

Family Size of Users	
People in Family	**Percentage**
3	4
4	30
5	28
6	22
7	7
8	2
9	4
10	2

Age of Users	
Age Group	**Percentage**
13-20	62
21-30	21
above 31	17

Frequency of Use	
Use of communications center	**Percentage**
Frequently	8
Everyday	34
Occasionally	58

Users' Income	
Income Level	**Percentage**
below 1000	16
1000-5000	16
5000-10000	38
above 10000	30

Users' Source of Income	
Source	**Percentage**
Agriculture	78
Business	0
Service	21
Labor	0
Others(Carpenter)	1

Users' Inspiration to Use the Internet	
Inspiration Factor	**Percentage**
Institution	13
Person(Mahabir Pun)	68
Communication Media	19

Reason for Using the Internet	
Reason	**Percentage**
Email	83
To get information and news	64
Telephone	56
Chatting with relatives and friends	37
Gather reading materials	30
Entertainment	9
Browse business related materials	8
Others	4

Distance to Alternative Services	
Travel Time	**Percentage**
One hour	9
2-3 hour	14
4-6 hour	32
One day	24
More than one days	23

Benefits to Internet Usage	
Benefits	**Percentage**
Save time	48
Save money	38
Save time and money	58
Save time but not money	1
Save money but not time	3

Attitude of Family to Internet	
Attitude	**Percentage**
Positive	97
Negative	0
No Concern	3

Impact of Internet	**Percentage**
Good	60
Bad	0
Not any	40

Types of Websites Visited by Users	
Type	**Percentage**
Mail Related (e.g. Yahoo, Hotmail, etc)	61
News Related (e.g. nepalnews, bbcnepal, etc)	56
Information Realtes (eg. Balsansar, khhatm, sports)	14

Appendix 4: Project Personnel, Past Volunteers, Donors and Affiliated Institutions

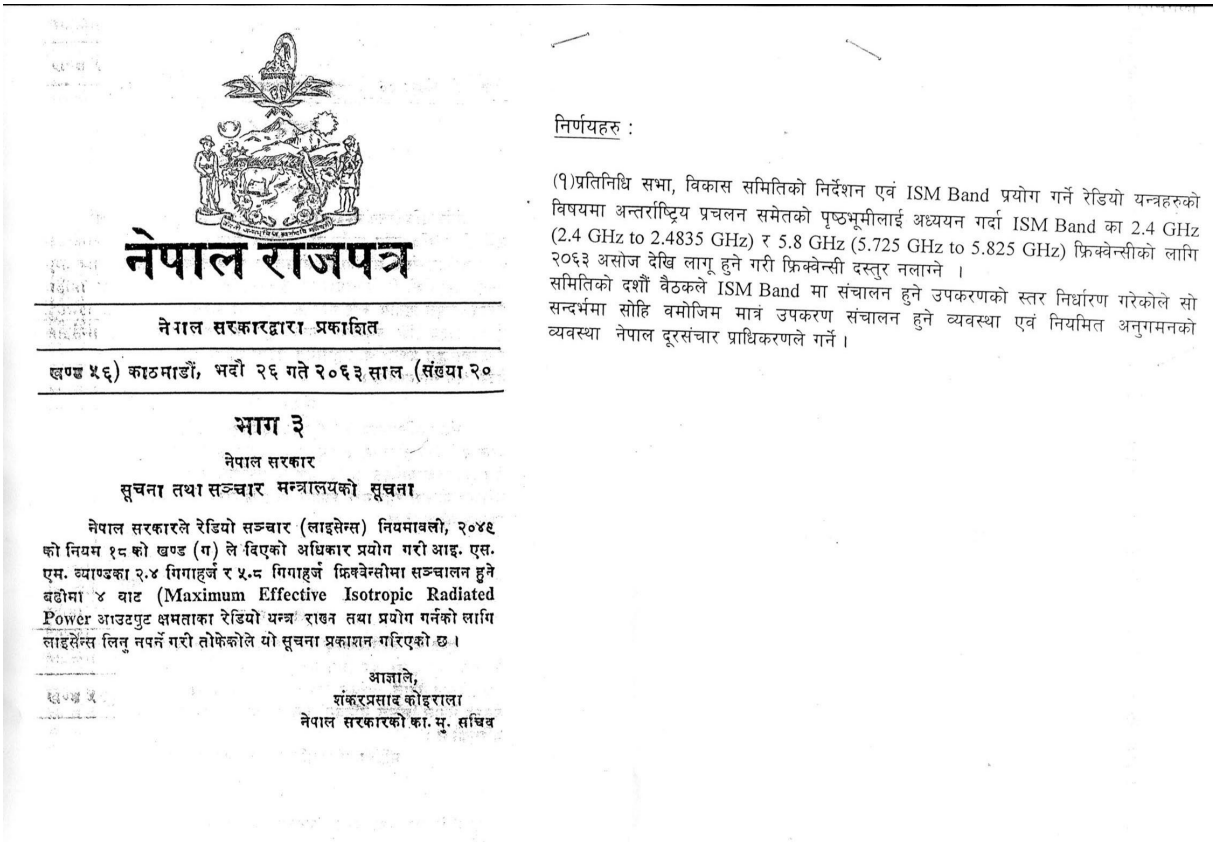
Mahabir Pun
Jonni Lehtiranta
Johan Verrept
Robin Shields
Mark Michalski
Philip Mucci
Sage Radachowsky
James Pearson
Peter Vredevald
Graham Bates
Rajendra Poudel
Prasanna David
Gaurab Upadhaya
Kishor Panth
Prashant Manandhar
Ramesh Shrestha
Abhinandan Sharma
Bikram Lal Shrestha

Huguenin Rallapalli Foundation, USA
Himanchal Educational Foundation, USA
Jim Forster – Networktheworld.org, USA
World Bank through Poverty Alleviation Fund of Nepal Government
International Center for Applied Studies in Information Technology (ICASIT), School of Public Policy, George Mason University, USA
E-Network for Research & Development, Kathmandu
Gandaki College of Engineering and Science, Lamachour Pokhara
Prime College, Kathmandu
Kathmandu Engineering College, Kalimati, Kathmandu
College of Information Technology, Baneshwor, Kathmandu

Appendix 5: List of People Met for the Information

1. Pradeep Pun, Headmaster of Tikot High School
2. Mankumar Garbuja, Communication Center Operator of Ghorepani
3. Sete Tilija, Network Operator of Shikha village
4. Taku Pun, Network Operator of Narchyang village
5. Thammaya Pun, Headmaster of Paudwar High School
6. Bisnu Poudel, Network Operator of Majhgaun
7. Krishna Bahadur Purja, Computer Teacher of Nangi School
8. Banika Pun, Health worker of Ramche Clinic
9. Tekbahaur Pun, Network Operator of Tikot village
10. Hari Gurung, Netowork Operator of Khibang Village
11. Ram Poudel, Health worker of Tolka Community Clinic
12. Tekbahadur Khoraja, Accountant of Himanchal Higher Secondary School
13. Students and teachers of school
14. Villagers of Nangi, Ramche, Tikot, Khibang, Shikha, Paudwar, Narchyang, Maghgaun

Appendix 6: Copy of the notice of Nepal Government de-licensing 2.4 and 5.8 GHz



नेपाल राजपत्र

नेपाल सरकारद्वारा प्रकाशित

खण्ड ५६) काठमाडौं, भदौ २६ गते २०६३ साल (संख्या २०

भाग ३

नेपाल सरकार

सूचना तथा सञ्चार मन्त्रालयको सूचना

नेपाल सरकारले रेडियो सञ्चार (लाइसेन्स) नियमावली, २०४९ को नियम १८ को खण्ड (ग) ले दिएको अधिकार प्रयोग गरी आइ. एस. एम. ब्याण्डका २.४ गिगाहर्ज र ५.८ गिगाहर्ज फ्रिक्वेन्सीमा सञ्चालन हुने बढीमा ४ वाट (Maximum Effective Isotropic Radiated Power आउटपुट क्षमताका रेडियो यन्त्र राख्न तथा प्रयोग गर्नको लागि लाइसेन्स लिनु नपर्ने गरी तोकेकोले यो सूचना प्रकाशन गरिएको छ ।

आज्ञाले,
शंकरप्रसाद कोइराला
नेपाल सरकारको का. मु. सचिव

निर्णयहरु :

(१)प्रतिनिधि सभा, विकास समितिको निर्देशन एवं ISM Band प्रयोग गर्ने रेडियो यन्त्रहरुको विषयमा अन्तर्राष्ट्रिय प्रचलन समेतको पृष्ठभूमीलाई अध्ययन गर्दा ISM Band का 2.4 GHz (2.4 GHz to 2.4835 GHz) र 5.8 GHz (5.725 GHz to 5.825 GHz) फ्रिक्वेन्सीको लागि २०६३ असोज देखि लागू हुने गरी फ्रिक्वेन्सी दस्तुर नलाग्ने ।
समितिको दशौं बैठकले ISM Band मा संचालन हुने उपकरणको स्तर निर्धारण गरेकोले सो सन्दर्भमा सोहि बमोजिम मात्र उपकरण संचालन हुने व्यवस्था एवं नियमित अनुगमनको व्यवस्था नेपाल दूरसंचार प्राधिकरणले गर्ने ।

(Unofficial translation of the notice published in Nepal Gazette de-licensing ISM Bands)

Insignia of Nepal Government

Nepal Gazette

Published by Nepal Government

Part 56) Kathmandu, Bhadra 26 2063 (Number 20

Part 3

Nepal Government

Notice of Ministry of Information and Communication

This notice has been published to notify that the Nepal Government using the authority given by Radio Communication (license) regulation, 2049, part 18 sub-part (c) has declared that use

and storage of radio equipment in the ISM Band of 2.4 GHz and 5.8 GHz with the Maximum Effective Isotropic Radiated Power of 4 Watts will not require any license.

As Directed,
Shankar Prasad Koirala
Acting Chief Secretary of Nepal Government
- ----------
Decision of the Frequency Management Committee

1. As per the directive of the Development Committee of the lower house of parliament and study and review of International practices, frequency fee is waived for the ISM Band in 2.4 GHz (2.4 GHz to 2.4835 GHz) and 5.8 GHz (5.725 to 5.825 GHz) from Asoj 2063.

In relation to the categorization of the equipment decided in the 10th meeting, Nepal Telecommunications authority is further assigned to monitor the use of such equipment.

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